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O'zbekiston Respublikasi Oliy attestatsiya komissiyasi Rayosatining 2025-yil 13-iyundagi №371/5-son qarori bilan 16.00.00 — Veterinariya fanlari hamda 2026-yil 5-martdagi №382/5-son qarori bilan 06.00.00 — Qishloq xo'jaligi fanlari bo'yicha dissertatsiyalar asosiy ilmiy natijalarini chop etish tavsiya etilgan milliy ilmiy nashrlar ro'yxatiga kiritilgan.

O'zbekiston Respublikasi Prezidenti Administratsiyasi huzuridagi Axborot va ommaviy kommunikatsiyalar agentligining 16.08.2022-yildagi №1701-sonli guvohnomasi asosida nashr etiladi.

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 RESEARCH FOCUS noshir • publisher	 VETERINARIYA ILMIY-TADQIQOT INSTITUTI 16.00.00	 PAXTA SELEKSIYASI, URUG'CHILIGI VA YETISHTIRISH AGROTEKNOLOGIYALARI ILMIY-TADQIQOT INSTITUTI 06.00.00
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JURNAL HAQIDA

MUASSIS VA NOSHIR	“Ilm-fan va innovatsiyalar akademiyasi” MChJ, O‘zbekiston. OAK ro‘yxati bo‘yicha hamkor tashkilotlar: Veterinariya ilmiy-tadqiqot instituti (16.00.00) hamda Paxta seleksiyasi, urug‘chiligi va yetishtirish agrotexnologiyalari ilmiy-tadqiqot instituti (06.00.00).
RO‘YXATDAN O‘TISH	O‘zbekiston Respublikasi Prezidenti Administratsiyasi huzuridagi Axborot va ommaviy kommunikatsiyalar agentligi tomonidan berilgan 16.08.2022-yildagi № 1701-sonli guvohnoma . Jurnal 2022-yildan nashr etiladi.
OAK QARORLARI	O‘zbekiston Respublikasi Oliy attestatsiya komissiyasi Rayosatining 2025-yil 13-iyundagi № 371/5-son (16.00.00 — Veterinariya fanlari) va 2026-yil 5-martdagi № 382/5-son (06.00.00 — Qishloq xo‘jaligi fanlari) qarorlari bilan jurnal dissertatsiyalar asosiy ilmiy natijalarini chop etish tavsiya etilgan milliy ilmiy nashrlar ro‘yxatiga kiritilgan (oak.uz).
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Ushbu to‘plamdan “Research Focus” xalqaro ilmiy jurnalining 2026-yil 9-soniga (5-jild) qabul qilingan ilmiy maqolalar o‘rin olgan.

Jurnalda O‘zbekiston Respublikasi va xorijiy oliy ta‘lim muassasalari professor-o‘qituvchilari, mustaqil ilmiy izlanuvchilari, doktorantlari va magistrantlari tomonidan olib borilayotgan ilmiy-tadqiqot ishlari natijalari ilmiy maqola tarzida chop etiladi. Shuningdek, jurnalga ilmiy-tadqiqot institutlari, ishlab chiqarish tashkilotlari va korxonalarda faoliyat ko‘rsatayotgan tadqiqotchilarning maqolalari ham qabul qilinadi.

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Eslatma! To‘plamga kiritilgan ilmiy maqolalardagi raqamlar, hisob-kitoblar va ma‘lumotlarning haqqoniyligi hamda keltirilgan iqtiboslarning to‘g‘riligi uchun mualliflar shaxsan javobgardirlar.

TAHRIRIYAT

— BOSH MUHARRIR

Saloydinov Sardorjon Qodirjon o'g'li — "Ilm-fan va innovatsiyalar akademiyasi" MChJ, O'zbekiston.

TAHRIR HAY'ATI

03.00.00 — BIOLOGIYA FANLARI

— TAHRIR HAY'ATI A'ZOLARI

Abdullayev Shavkat Vaxidovich — Kimyo fanlari doktori, Namangan davlat universiteti «Organik kimyo» kafedrası professori, tabobat fanlari akademigi, O'zbekiston.

Shodikulova Gulandom Zikriyevna — Samarqand davlat tibbiyot universiteti 3-son Ichki kasalliklar va endokrinologiya kafedrası dotsenti, kafedra mudiri, tibbiyot fanlari doktori, dotsent, O'zbekiston.

Asqarov Kamoliddin Abdug'aniyevich — Farg'ona davlat universiteti Tabiiy fanlar fakulteti dekani, biologiya fanlari bo'yicha falsafa doktori (PhD), O'zbekiston.

Rasulova Moxidil Tursunaliyevna — Farg'ona jamoat salomatligi tibbiyot instituti «Davolash ishi» fakulteti dekani, O'zbekiston.

Shavazi Nargiz Nuraliyevna — Samarqand davlat tibbiyot universiteti 3-son Akusherlik va ginekologiya kafedrası mudiri, O'zbekiston.

Baykulov Azim Kenjaevich — Samarqand davlat tibbiyot universiteti Farmatsevtika va toksikologik kimyo kafedrası mudiri, biologiya fanlari bo'yicha falsafa doktori, O'zbekiston.

Mirzayev Saidmaxmud — Namangan davlat universiteti Sport faoliyati kafedrası dotsenti, biologiya fanlari nomzodi, dotsent, O'zbekiston.

05.00.00 — TEXNIKA FANLARI

— TAHRIR HAY'ATI A'ZOLARI

Xudaykuliyeu Rajabboy Ruzmatovich — Qishloq xo'jaligini mexanizatsiyalash ilmiy-tadqiqot instituti direktori, texnika fanlari nomzodi, katta ilmiy xodim, O'zbekiston.

Ibragimov Abdirasuli Abdikarimovich — Qishloq xo'jaligini mexanizatsiyalash ilmiy-tadqiqot instituti ilmiy ishlar va innovatsiyalar bo'yicha direktor o'rinbosari, texnika fanlari doktori, professor, O'zbekiston.

Norchayev Davron Rustamovich — Qishloq xo'jaligini mexanizatsiyalash ilmiy-tadqiqot instituti direktorning ilm-fan va ilmiy faoliyat bo'yicha maslahatchisi, texnika fanlari doktori, professor, O'zbekiston.

G'aybullaev Burxonjon Shermatjonovich — Qishloq xo'jaligini mexanizatsiyalash ilmiy-tadqiqot instituti ilmiy kotibi, PhD, katta ilmiy xodim, O'zbekiston.

Zaxidov Romen Abdullayevich — Energetika muammolari instituti laboratoriyasi rahbari, texnika fanlari doktori, akademik, O'zbekiston.

Murzaqulov Nurqul Abdilazizovich — Qirg'iziston Respublikasi O'sh Texnika Universiteti professori, texnika fanlari doktori, «Elektroenergetika» instituti direktori, Qirg'iziston.

Abdurahmonov Abdukarim Athamovich — Qishloq xo'jaligini mexanizatsiyalash ilmiy-tadqiqot instituti «Ekin va o'simliklarni parvarishlash mashinalari» laboratoriyasi rahbari, texnika fanlari nomzodi, katta ilmiy xodim, O'zbekiston.

Muradov Rustam — Namangan davlat texnika universiteti professori, texnika fanlari doktori, O'zbekiston.

Ergashev Ma'rufjon Muhammadovich — Qishloq xo'jaligini mexanizatsiyalash ilmiy-tadqiqot instituti «Chorvachilik uchun ozuqa yem-xashak yetishtirish mashinalari» laboratoriyasi rahbari, PhD, katta ilmiy xodim, O'zbekiston.

Imomqulov Qutbiddin Boqijonovich — Qishloq xo'jaligini mexanizatsiyalash ilmiy-tadqiqot instituti «Bog'dorchilik va sabzavotchilikni mexanizatsiyalash» laboratoriyasi rahbari, texnika fanlari doktori, professor, O'zbekiston.

Artikbayev Baxtiyar Pirniyazovich — Qishloq xo'jaligini mexanizatsiyalash ilmiy-tadqiqot instituti «Mashina-texnologiyalar tizimi va mashina-traktor parkidan foydalanish» laboratoriyasi mudiri, PhD, katta ilmiy xodim, O'zbekiston.

Kambarov Baxtiyor Akbaraliyevich — Qishloq xo'jaligini mexanizatsiyalash ilmiy-tadqiqot instituti «Mobil energetika va transport vositalari» laboratoriyasi mudiri, texnika fanlari doktori, dotsent, O'zbekiston.

Ravshanov Shavkat Ulashovich — Qishloq xo'jaligini mexanizatsiyalash ilmiy-tadqiqot instituti «Ekinlar hosilini yig'ishtirish mashinalari» laboratoriyasi rahbari, texnika fanlari nomzodi, katta ilmiy xodim, O'zbekiston.

Rosabayev Abduqodir To'xtaqo'ziyevich — Qishloq xo'jaligini mexanizatsiyalash ilmiy-tadqiqot instituti «Innovatsion ishlanmalarni joriy etish va marketing» bo'limi bosh mutaxassisi, texnika fanlari nomzodi, katta ilmiy xodim, O'zbekiston.

Tuxtakuziyev Abdusalim — Qishloq xo'jaligini mexanizatsiyalash ilmiy-tadqiqot instituti «Tuproqqa ishlov berish mashinalari» laboratoriyasi rahbari, texnika fanlari doktori, professor, O'zbekiston.

Xoliqov Baxtiyor Abdug'opporovich — Qishloq xo'jaligini mexanizatsiyalash ilmiy-tadqiqot instituti «Suv tejoychi texnologiyalar va ularni amalga oshiruvchi mashinalar» laboratoriyasi rahbari, PhD, katta ilmiy xodim, O'zbekiston.

Tagayev Baxodir Kuchkarbekovich — Qishloq xo'jaligini mexanizatsiyalash ilmiy-tadqiqot instituti «Qishloq xo'jaligida mexatronika, dasturiy boshqarish va texnologik jarayonlarni avtomatlashtirish» laboratoriyasi rahbari, PhD, katta ilmiy xodim, O'zbekiston.

Rasuljonov Abduraxmon Ravshanbek o'g'li — Qishloq xo'jaligini mexanizatsiyalash ilmiy-tadqiqot instituti PhD, katta ilmiy xodim, O'zbekiston.

Sitdiqov Rashid Abduraxmanovich — Islom Karimov nomidagi Toshkent davlat texnika universiteti Energetika fakulteti professori, texnika fanlari doktori, O'zbekiston.

Ergashev Sirojiddin Fayazovich — Farg'ona davlat texnika universiteti ilmiy va ilmiy-pedagogik kadrlarni tayyorlash bo'limi boshlig'i, texnika fanlari doktori, dotsent, O'zbekiston.

Soliyev Rustamjon Hakimjanovich — Namangan davlat texnika universiteti Energetika fakulteti dekani, texnika fanlari doktori, dotsent, O'zbekiston.

Yunusov Baxtiyar Xodjakbarovich — Toshkent davlat texnika universiteti «Issiqlik energetikasi» kafedrasini mudiri, dotsent, O'zbekiston.

Quchqarov Akmaljon — Farg'ona davlat texnika universiteti «Elektronika va asbobsozlik» kafedrasini mudiri, texnika fanlari nomzodi (PhD), O'zbekiston.

Radionova Olga Vinsetovna — Islom Karimov nomidagi TDTU «Elektr stansiyalari, tarmoqlari va tizimlari» kafedrasini dotsenti, texnika fanlari nomzodi, O'zbekiston.

Vaxobova Sojida Komiljonovna — Namangan davlat texnika universiteti Energetika kafedrasini dotsenti, PhD, dotsent, O'zbekiston.

Agzamov Shovkat Kozimovich — Toshkent davlat texnika universiteti «Issiqlik energetikasi» kafedrasini dotsenti, O'zbekiston.

Saodullayev Tuymurod Mardullo o'g'li — Islom Karimov nomidagi Toshkent davlat texnika universiteti dotsenti, PhD, O'zbekiston.

Xolbayev Doniyor Juraboyevich — Namangan davlat texnika universiteti Energetika kafedrasini o'qituvchisi, PhD, dotsent, O'zbekiston.

Yusupov Dilshodbek Turdaliyevich — O'zbekiston Respublikasi Energetika vazirligi huzuridagi Qayta tiklanuvchi energiya manbalari milliy ilmiy-tadqiqot instituti laboratoriyasi rahbari, PhD, katta ilmiy xodim, O'zbekiston.

06.00.00 — QISHLOQ XO'JALIGI FANLARI

TAHRIR HAY'ATI A'ZOLARI

Raxmankulov Murod Said-Akbarovich — Paxta selektsiyasi, urug'chiligi va yetishtirish agrotexnologiyalari ilmiy-tadqiqot instituti direktori, qishloq xo'jaligi fanlari doktori (DSc), professor, O'zbekiston.

Rashidova Dilbar Karimovna — Paxta selektsiyasi, urug'chiligi va yetishtirish agrotexnologiyalari ilmiy-tadqiqot instituti Organik paxtachilik laboratoriyasi mudiri, qishloq xo'jaligi fanlari doktori (DSc), professor, O'zbekiston.

Suvanov Boymurod Uralovich — Ozuqa ekinlari ilmiy-tajriba stansiyasi Agrotexnika va o'simliklarni himoya qilish bo'limi boshlig'i, qishloq xo'jaligi fanlari doktori (DSc), katta ilmiy xodim, O'zbekiston.

Durdiyev Normat Hasanovich — TIQXMMI Milliy tadqiqot universiteti «Gidromeliorativ tizimlardan foydalanish» kafedrasini dotsenti, qishloq xo'jaligi fanlari doktori, O'zbekiston.

Sherov Anvar Gulamovich — TIQXMMI Milliy tadqiqot universiteti Gidromeliorativ tizimlardan foydalanish kafedrasini mudiri, texnika fanlari doktori (DSc), professor, O'zbekiston.

Abduraxmanov Ubaydulla Zulfiqorovich — O'zbekiston Respublikasi Oliy ta'lim, fan va innovatsiyalar vazirligi huzuridagi OAK kotibiyati qishloq xo'jaligi va veterinariya fanlari bo'yicha bosh inspektori, qishloq xo'jaligi fanlari doktori (DSc), katta ilmiy xodim, O'zbekiston.

Karimov Xusniddin Nagimovich — Ak. M.Mirzaev nomidagi bog'dorchilik, uzumchilik va vinochilik ilmiy-tadqiqot instituti «O'simliklar fiziologiyasi va agrokimyo» laboratoriyasi mudiri, qishloq xo'jaligi fanlari doktori (DSc), katta ilmiy xodim, O'zbekiston.

Allanov Xolik Keldiyorovich — Toshkent davlat agrar universiteti Agronomiya va agrotexnologiyalar kafedrasini professori, qishloq xo'jaligi fanlari doktori (DSc), O'zbekiston.

Nabiev Saydig'ani Muxtorovich — O'zbekiston Respublikasi Fanlar akademiyasi Genetika va o'simliklar eksperimental biologiyasi instituti laboratoriya mudiri, loyiha rahbari, biologiya fanlari doktori (DSc), professor, O'zbekiston.

Baboev Saidmurat Kimsanboevich — Donli ekinlar genetikasi, selektsiyasi va urug'chiligi laboratoriyasi mudiri, biologiya fanlari doktori (DSc), professor, O'zbekiston.

Nazarov Xudayberdi Kuydimuratovich — Toshkent davlat agrar universiteti «Qishloq xo'jaligi ekinlari genetikasi, selektsiyasi va urug'chiligi» kafedrasini dotsenti, qishloq xo'jaligi fanlari doktori (DSc), O'zbekiston.

Gafarova Aziza Israilovna — TIQXMMI Milliy tadqiqot universiteti katta o'qituvchisi, texnika fanlari falsafa doktori (PhD), O'zbekiston.

Ganiyev Sanjar Ernazarovich — Samarqand davlat veterinariya meditsinasi, chorvachilik va biotexnologiyalar universiteti Toshkent filiali Agrobiologiya va dorivor o'simliklar yetishtirish kafedrasini dotsenti, PhD, O'zbekiston.

Idrisov Xusanjon Abdujabborovich — Farg'ona davlat universiteti Mevachilik va sabzavotchilik kafedrasini dotsenti, qishloq xo'jaligi fanlari falsafa doktori (PhD), O'zbekiston.

Mamedov Normuxammad Mardanovich — Paxta selektsiyasi, urug'chilik va agrotexnologiya ilmiy-tadqiqot instituti Organik paxta laboratoriyasi katta ilmiy xodimi, PhD, O'zbekiston.

Yakubov Muzaffar Matyakubovich — Paxta selektsiyasi, urug'chilik va agrotexnologiyalar ilmiy-tadqiqot instituti, PhD, O'zbekiston.

Yaxyoeva Nafisa Nuriddinova — Paxta selektsiyasi, urug'chiligi va yetishtirish agrotexnologiyalari ilmiy-tadqiqot instituti Aqlli qishloq xo'jaligi texnologiyalari laboratoriyasi katta ilmiy xodimi, qishloq xo'jaligi fanlari bo'yicha falsafa doktori (PhD), O'zbekiston.

Mamatqulova Lobar O'rolovna — Termiz davlat muhandislik va agrotexnologiyalar universiteti Agronomiya, selektsiya va urug'chilik kafedrasida katta o'qituvchisi, qishloq xo'jaligi fanlari bo'yicha falsafa doktori (PhD), O'zbekiston.

Rayimberdiyev Xolyigit Abduraxmanovich — Paxta selektsiyasi, urug'chiligi va yetishtirish agrotexnologiyalari ilmiy-tadqiqot instituti Sirdaryo ilmiy-tajriba stansiyasi direktori, PhD, katta ilmiy xodim, O'zbekiston.

Xamidova Shaxnoza Muxamadxonova — TIQXMMI Milliy tadqiqot universiteti Gidromeliorativ tizimlardan foydalanish kafedrasida dotsenti, PhD, O'zbekiston.

Gaydayev Nodirjon Nosirjonovich — TIQXMMI Milliy tadqiqot universiteti Gidromeliorativ tizimlardan foydalanish kafedrasida dotsenti, texnika fanlari falsafa doktori (PhD), O'zbekiston.

Raximov Avazbek Xolmamatovich — Toshkent davlat agrar universiteti O'quv-ilmiy tajriba bo'limi bosh mutaxassisi, qishloq xo'jaligi fanlari doktori, katta ilmiy xodim, O'zbekiston.

Avtonomov Viktor Aleksandrovich — Paxta selektsiyasi, urug'chiligi va yetishtirish agrotexnologiyalari ilmiy-tadqiqot instituti Markerlarga asoslangan g'o'za navlari selektsiyasi laboratoriyasi mudiri, qishloq xo'jaligi fanlari doktori, professor, O'zbekiston.

Amanturdiyev Alisher Balkibovich — Paxta selektsiyasi, urug'chiligi va yetishtirish agrotexnologiyalari ilmiy-tadqiqot instituti laboratoriya mudiri, qishloq xo'jaligi fanlari doktori, professor, O'zbekiston.

Amanturdiyev Shavkat Balkibaevich — Paxta selektsiyasi, urug'chiligi va yetishtirish agrotexnologiyalari ilmiy-tadqiqot instituti Bada selektsiyasi va urug'chiligi laboratoriyasi mudiri, qishloq xo'jaligi fanlari doktori, katta ilmiy xodim, O'zbekiston.

Kozubaev Shuxrat Sattardjanovich — Paxta selektsiyasi, urug'chiligi va yetishtirish agrotexnologiyalari ilmiy-tadqiqot instituti «G'o'za urug'chiligi va urug'shunosligi» laboratoriyasi mudiri, qishloq xo'jaligi fanlari doktori, professor, O'zbekiston.

Jalolov Xurshidbek Xurram o'g'li — Paxta selektsiyasi, urug'chiligi va yetishtirish agrotexnologiyalari ilmiy-tadqiqot instituti ilmiy kotibi, qishloq xo'jaligi fanlari falsafa doktori (PhD), katta ilmiy xodim, O'zbekiston.

Avliyakov Mirzoolim Avazovich — Paxta selektsiyasi, urug'chiligi va yetishtirish agrotexnologiyalari ilmiy-tadqiqot instituti Aqlli qishloq xo'jaligi texnologiyalari laboratoriyasi mudiri, qishloq xo'jaligi fanlari doktori (DSc), professor, O'zbekiston.

Kurbonov Abrorjon Yorkinovich — Paxta selektsiyasi, urug'chiligi va yetishtirish agrotexnologiyalari ilmiy-tadqiqot instituti «G'o'za biotexnologiyasi» laboratoriyasi mudiri, qishloq xo'jaligi fanlari doktori (DSc), katta ilmiy xodim, O'zbekiston.

Negmatova Surayyo Teshayeva — Paxta selektsiyasi, urug'chiligi va yetishtirish agrotexnologiyalari ilmiy-tadqiqot instituti bosh ilmiy xodimi, qishloq xo'jaligi fanlari doktori (DSc), professor, O'zbekiston.

Ravshanov Azam Erkinovich — Paxta selektsiyasi, urug'chilik va agrotexnologiyalar ilmiy-tadqiqot instituti Tola texnologiyasi laboratoriyasi mudiri, qishloq xo'jaligi fanlari doktori, katta ilmiy xodim, professor, O'zbekiston.

Tungushova Dilbar Abdukayumova — Paxta selektsiyasi, urug'chiligi va yetishtirish agrotexnologiyalari ilmiy-tadqiqot instituti Agroinnovatsiyalar va trening markazi bo'lim boshlig'i, qishloq xo'jaligi fanlari doktori, professor, O'zbekiston.

Xalikova Maloxat Babamuradova — Paxta selektsiyasi, urug'chiligi va yetishtirish agrotexnologiyalari ilmiy-tadqiqot instituti laboratoriya mudiri, qishloq xo'jaligi fanlari doktori, professor, O'zbekiston.

Xalikov Baxodir Meylikovich — Paxta selektsiyasi, urug'chiligi va yetishtirish agrotexnologiyalari ilmiy-tadqiqot instituti laboratoriya mudiri, qishloq xo'jaligi fanlari doktori, professor, O'zbekiston.

Nurmatov Shermet — Paxta selektsiyasi, urug'chiligi va yetishtirish agrotexnologiyalari ilmiy-tadqiqot instituti Tuproqni eroziyadan himoya qilish, meliorativ holatini yaxshilash va agroekologiya laboratoriyasi yetakchi ilmiy xodimi, qishloq xo'jaligi fanlari doktori, professor, O'zbekiston.

Babaev Yashin Amanovich — Paxta selektsiyasi, urug'chiligi va yetishtirish agrotexnologiyalari ilmiy-tadqiqot instituti direktorining ilmiy ishlar va innovatsiyalar bo'yicha o'rinbosari, qishloq xo'jaligi fanlari doktori, professor, O'zbekiston.

07.00.00 — TARIX FANLARI

— TAHRIR HAY'ATI A'ZOLARI

Mirzayev Gulom Rizoqulovich — O'zbekiston Respublikasi Jamoat xavfsizligi universiteti Ijtimoiy-gumanitar fanlar kafedrasida dotsenti, tarix fanlari bo'yicha falsafa doktori (PhD), dotsent, O'zbekiston.

Yo'ldoshev Salimjon Valiyevich — Farg'ona davlat universiteti O'zbekiston tarixi kafedrasida o'qituvchisi, tarix fanlari bo'yicha falsafa doktori (PhD), dotsent, O'zbekiston.

13.00.00 — PEDAGOGIKA FANLARI

— TAHRIR HAY'ATI A'ZOLARI

Raxmatova Dilnoza Nigbayeva — O'zbekiston davlat jismoniy tarbiya va sport universiteti Jismoniy tarbiya, sport nazariyasi va uslubiyati kafedrasida professori v.b., O'zbekiston.

Ergashev Bobirjon Boxodirovich — Namangan davlat universiteti Ilmiy va ilmiy-pedagogik kadrlarni tayyorlash bo'limi boshlig'i, DSc, O'zbekiston.

Jalolova Pokiza Muzaffarova — Shahrisabz davlat pedagogika instituti Pedagogika kafedrasida professori v.b., pedagogika fanlari doktori (DSc), O'zbekiston.

Obidova Gulmira Kuzibayevna — Farg'ona politexnika instituti Magistratura bo'limi boshlig'i, pedagogika fanlari bo'yicha falsafa doktori (PhD), O'zbekiston.

Azizov Nosirjon Nematillayevich — Namangan davlat universiteti Sport faoliyati kafedrasini mudiri, pedagogika fanlari nomzodi, dotsent, O'zbekiston.

Qurbonova Maftuna Faxriddinovna — Toshkent viloyati Chirchiq davlat pedagogika instituti Iqtidorli talabalarning ilmiy tadqiqot faoliyatini tashkil etish bo'limi boshlig'i, pedagogika fanlari bo'yicha falsafa doktori (PhD), O'zbekiston.

Mirzayeva Nodira Abduxamidovna — Toshkent viloyati Chirchiq davlat pedagogika instituti «Genetika va evolyusion biologiya» kafedrasini dotsenti, pedagogika fanlari bo'yicha falsafa doktori (PhD), O'zbekiston.

Valiyeva Feruza Rashidovna — Maktabgacha ta'lim tashkilotlari direktor va mutaxassislarini qayta tayyorlash va malakasini oshirish instituti «Maktabgacha ta'lim menejmenti» kafedrasini mudiri, pedagogika fanlari bo'yicha falsafa doktori (PhD), O'zbekiston.

Yuldashov Ikromjon Abdulazizovich — Farg'ona davlat universiteti Jismoniy madaniyat fakulteti dekani, pedagogika fanlari bo'yicha falsafa doktori (PhD), stol tennisi bo'yicha oliy toifali hakam, O'zbekiston.

Hamidjonov Abdulaziz Usubjon o'g'li — Namangan davlat universiteti Sport faoliyati kafedrasini dotsenti, pedagogika fanlari bo'yicha falsafa doktori (PhD), xalqaro sport ustasi, O'zbekiston.

Qosimova Ozoda Xudoynazarovna — Samarqand davlat tibbiyot instituti Pedagogika va psixologiya kafedrasini dotsenti, pedagogika fanlari bo'yicha falsafa doktori (PhD), O'zbekiston.

Raximov Atanazar Karimovich — Toshkent viloyati Chirchiq davlat pedagogika instituti Tabiiy fanlar fakulteti dekani, pedagogika fanlari doktori, professor v.b., O'zbekiston.

Yunusova Nilufar Xamrayevna — Toshkent moliya instituti O'zbek va rus tili kafedrasini mudiri, pedagogika fanlari nomzodi, dotsent, O'zbekiston.

Umarov Mars Narziyevich — O'zbekiston davlat jismoniy tarbiya va sport universiteti Gimnastika sport turlari nazariyasi va uslubiyati kafedrasini professori, pedagogika fanlari nomzodi, professor, O'zbekiston.

Umarov Xurshidjon Xasanovich — O'zbekiston davlat jismoniy tarbiya va sport universiteti «Gimnastika nazariyasi va uslubiyati» kafedrasini dotsenti, PhD, O'zbekiston.

Sobirova Laylo Baxromovna — O'zbekiston davlat jismoniy tarbiya va sport universiteti «Adaptiv jismoniy tarbiya va parasport» kafedrasini dotsenti v.b., O'zbekiston.

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To'ychiev Tohirjon Saxodullaevich — Namangan davlat universiteti Jismoniy madaniyat kafedrasini o'qituvchisi, PhD, O'zbekiston.

Sirojiddinova Nodira Rivojiddinovna — Professional ta'limni rivojlantirish instituti «Innovatsion ta'lim texnologiyalari» kafedrasini mudiri, O'zbekiston.

Salimova Zebo Kenjayevna — Termiz davlat universiteti Fakultetlararo chet tillari kafedrasini o'qituvchisi, pedagogika fanlari bo'yicha falsafa doktori (PhD), O'zbekiston.

Mamatqulov Mirzaolim Xaydaraliyevich — Namangan davlat universiteti Jismoniy madaniyat kafedrasini katta o'qituvchisi, pedagogika fanlari doktori, O'zbekiston.

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Raxmatova Xayrixon Ashiraliyevna — Namangan davlat universiteti Pedagogika nazariyasi va tarixi kafedrasini professori, pedagogika fanlari nomzodi, O'zbekiston.

Karimov Ne'matjon Xolyigitovich — Namangan davlat universiteti Jismoniy madaniyat kafedrasini dotsenti, PhD, O'zbekiston.

14.00.00 — TIBBIYOT FANLARI

— TAHRIR HAY'ATI A'ZOLARI

Daminov Feruz Asadullayevich — Samarqand davlat tibbiyot universiteti akademik litsey va jamoat salomatligi texnikumlari bilan ishlash bo'yicha prorektori, tibbiyot fanlari doktori, O'zbekiston.

Ruziboyev Sanjar Abdusalomovich — Samarqand davlat tibbiyot instituti 2-xirurgik kasalliklar va urologiya kafedrasini mudiri, tibbiyot fanlari doktori, O'zbekiston.

Djabbarov Sherzod Raximberdiyevich — Sog'liqni saqlash boshqarmasi Lisenziyalash va akkreditatsiyalash sektori bosh mutaxassisi, tibbiyot fanlari nomzodi, O'zbekiston.

Mustafakulov Ishnazar Boynazarovich — Samarqand davlat tibbiyot instituti davolash fakulteti dekani o'rinbosari, tibbiyot fanlari nomzodi, O'zbekiston.

Shonazarov Iskandar Shonazarovich — Samarqand davlat tibbiyot universiteti Diplomdan keyingi ta'lim fakulteti Xirurgiya, endoskopiya va anesteziologiya-reanimatologiya kafedrasini o'qituvchisi, tibbiyot fanlari nomzodi, O'zbekiston.

Achilov Mirzakarim Temirovich — Samarqand davlat tibbiyot instituti Diplomdan keyingi ta'lim fakulteti Xirurgiya, endoskopiya, anesteziologiya va reanimatologiya kafedrasini dotsenti, tibbiyot fanlari nomzodi, O'zbekiston.

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- Kardjavova Gulnoza Abilkasimovna — Samarqand davlat tibbiyot universiteti 1-son Pediatriya kafedrası o'qituvchisi, PhD, O'zbekiston.
- Murtazaev Zafar Isrofilovich — Samarqand davlat tibbiyot universiteti Umumiy xirurgiya, nurli diagnostika va terapiya kafedrası dotsenti, O'zbekiston.
- Pulatov Ulugbek Sunatovich — Samarqand davlat tibbiyot universiteti Klinik (o'quv) bazalari bilan ishlash bo'limi boshlig'i, O'zbekiston.
- Boymanov Farxod Xolboyevich — Samarqand davlat tibbiyot universiteti «Sud tibbiyoti» kafedrası dotsenti, O'zbekiston.
- Mustafoev Zafarjon Mustafo o'g'li — Samarqand davlat tibbiyot universiteti Odam anatomiyasi kafedrası o'qituvchisi, O'zbekiston.
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- Yusupova Nargiza Abdikodirovna — Samarqand davlat tibbiyot universiteti Klinik laborator diagnostika kafedrası o'qituvchisi, PhD, O'zbekiston.
- Amonov Xudoyberdi Ravshanovich — Samarqand davlat tibbiyot universiteti 2-son Xirurgik kasalliklar kafedrası o'qituvchisi, PhD, O'zbekiston.
- Ismatil Odiljon Obidovich — Samarqand davlat tibbiyot universiteti 2-son xirurgik kasalliklar kafedrası o'qituvchisi, PhD, O'zbekiston.

16.00.00 — VETERINARIYA FANLARI

— TAHRIR HAY'ATI A'ZOLARI

- Yuldoshev Xojiakbar Toshpo'latovich — Veterinariya ilmiy-tadqiqot instituti direktori (Kengash raisi), O'zbekiston.
- Azimov Jaloliddin Azimovich — O'zbekiston Respublikasi Fanlar akademiyasi akademigi, O'zbekiston.
- Norqobilov Bahrom To'raevich — Veterinariya va chorvachilikni rivojlantirish qo'mitasi raisi, O'zbekiston.
- Djabbarov Shuxrat Abdumajidovich — Veterinariya va chorvachilikni rivojlantirish qo'mitasi raisi o'rinbosari, veterinariya fanlari doktori, professor, O'zbekiston.
- Mamatova Muborak Nurpo'latovna — Samarqand davlat tibbiyot instituti Klinik laborator diagnostika kafedrası professori v.b., veterinariya fanlari doktori, professor v.b., O'zbekiston.
- Yunusov Xudoynazar Beknazarovich — Samarqand davlat veterinariya meditsinasi, chorvachilik va biotexnologiyalar universiteti rektori, biologiya fanlari doktori, professor, O'zbekiston.
- Safarov Alisher Abduqahor o'g'li — Qo'mita boshqarmasi boshlig'i, biologiya fanlari doktori, dotsent, O'zbekiston.
- Mavlonov Sobirjon Ibodullaevich — Veterinariya fanlari doktori, professor, O'zbekiston.
- Daminov Asadullo Suvonovich — Veterinariya fanlari doktori, professor, O'zbekiston.
- Yuldoshev Nurbek Ergashevich — Veterinariya fanlari doktori, professor, O'zbekiston.
- Salimov Xait Salimovich — Veterinariya fanlari doktori, professor, O'zbekiston.

Gafurov Aktam Gafurovich — Veterinariya fanlari doktori, professor, O'zbekiston.
Elmurodov Bozorboy Aktamovich — Veterinariya fanlari doktori, professor, O'zbekiston.
Ruzimurodov Muxiddin Axrorovich — Veterinariya fanlari nomzodi, professor, O'zbekiston.
Mamadullayev Gulmurod Hamidovich — Veterinariya fanlari doktori, katta ilmiy xodim, O'zbekiston.
Kuldoshev Otamurod Urazovich — Veterinariya fanlari doktori, katta ilmiy xodim, O'zbekiston.
Salimov Ilxom Xayitovich — Veterinariya fanlari doktori, katta ilmiy xodim, O'zbekiston.
Eshburiyev Sobir Baxtiyorovich — Veterinariya fanlari doktori, dotsent, O'zbekiston.
Bo'tayev Maxmud Qarshievich — Veterinariya fanlari nomzodi, katta ilmiy xodim, O'zbekiston.
Djurayev Olimjon Axrorovich — Veterinariya fanlari nomzodi, katta ilmiy xodim, O'zbekiston.
Ismatova Ra'no Asadovna — Veterinariya fanlari nomzodi, katta ilmiy xodim, O'zbekiston.
Pulotov Faxriddin Sayfiddinovich — Veterinariya fanlari bo'yicha falsafa doktori (PhD), katta ilmiy xodim, O'zbekiston.
Ulug'muradov Azamat Daminovich — Veterinariya fanlari bo'yicha falsafa doktori (PhD), katta ilmiy xodim, O'zbekiston.
Isayev Jasur Muaffarovich — Veterinariya fanlari bo'yicha falsafa doktori (PhD), katta ilmiy xodim, O'zbekiston.
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This issue comprises the peer-reviewed scientific articles accepted for **Volume 5, Issue 9 (2026) of the Research Focus International Scientific Journal**.

The journal publishes the results of original research carried out by faculty members, independent researchers, doctoral and master's students of higher education institutions of the Republic of Uzbekistan and other countries, as well as by researchers of research institutes, industrial organizations and enterprises, in the fields of biological (03.00.00), technical (05.00.00), agricultural (06.00.00), historical (07.00.00), pedagogical (13.00.00), medical (14.00.00) and veterinary (16.00.00) sciences.

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О ЖУРНАЛЕ

УЧРЕДИТЕЛЬ И ИЗДАТЕЛЬ — ООО «Академия науки и инноваций», Узбекистан. Партнёры согласно перечню ВАК: Ветеринарный научно-исследовательский институт (16.00.00) и Научно-исследовательский институт селекции, семеноводства и агротехнологий выращивания хлопчатника (06.00.00).

РЕГИСТРАЦИЯ — Зарегистрирован Агентством информации и массовых коммуникаций при Администрации Президента Республики Узбекистан; **свидетельство № 1701 от 16.08.2022 г.** Издаётся с 2022 года.

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В настоящий выпуск вошли рецензируемые научные статьи, принятые в № 9 (том 5) международного научного журнала «Research Focus» за 2026 год.

Журнал публикует результаты оригинальных научных исследований профессорско-преподавательского состава, независимых исследователей, докторантов и магистрантов вузов Республики Узбекистан и зарубежных стран, а также сотрудников научно-исследовательских институтов и производственных организаций по направлениям биологических (03.00.00), технических (05.00.00), сельскохозяйственных (06.00.00), исторических (07.00.00), педагогических (13.00.00), медицинских (14.00.00) и ветеринарных (16.00.00) наук.

Все статьи размещаются в электронном архиве журнала (refocus.uz) и в международных системах индексации.

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РЕДАКЦИОННАЯ КОЛЛЕГИЯ

03.00.00 — БИОЛОГИЧЕСКИЕ НАУКИ

ЧЛЕНЫ РЕДАКЦИОННОЙ КОЛЛЕГИИ

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05.00.00 — ТЕХНИЧЕСКИЕ НАУКИ

ЧЛЕНЫ РЕДАКЦИОННОЙ КОЛЛЕГИИ

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06.00.00 — AGRICULTURAL SCIENCES

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06.00.00 — СЕЛЬСКОХОЗЯЙСТВЕННЫЕ НАУКИ

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07.00.00 — HISTORICAL SCIENCES

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13.00.00 — PEDAGOGICAL SCIENCES

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07.00.00 — ИСТОРИЧЕСКИЕ НАУКИ

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13.00.00 — ПЕДАГОГИЧЕСКИЕ НАУКИ

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14.00.00 — МЕДИЦИНСКИЕ НАУКИ

ЧЛЕНЫ РЕДАКЦИОННОЙ КОЛЛЕГИИ

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Taxonomic composition and morphological diagnostic characters of *Silene L.* species in the Fergana Valley

Farg'ona vodiysidagi *Silene L.* turlarining taksonomik tarkibi va morfologik diagnostik belgilari

Таксономический состав и морфологические диагностические признаки видов *Silene L.* в Ферганской долине

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ENGLISH

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Abstract. This study evaluates the taxonomic composition and morphological diagnostic characters of *Silene L.* in the Fergana Valley. Based on literature, herbarium material, regional floras, and taxonomic sources, 32 species were assigned to 12 sections. Sect. *Sclerocalycinae* was the most species-rich section with eight species (25.00%), followed by sect. *Holopetalae* with six species (18.75%). The principal characters used to distinguish sections were calyx shape and venation, degree of calyx inflation, division of the petal limb, structure of the petal claw, anthophore pubescence, inflorescence type, and selected vegetative traits. The results provide a concise taxonomic framework for identification of *Silene* species in the Fergana Valley and a basis for subsequent ecological, biogeographical, and conservation studies.

Keywords: *Silene*; Caryophyllaceae; Fergana Valley; taxonomy; section; taxonomic composition; morphological diagnosis; diagnostic characters; flora

O'ZBEKCHA

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Annotatsiya. Ushbu tadqiqotda Farg'ona vodiysidagi *Silene L.* turkumining taksonomik tarkibi va morfologik diagnostik belgilari baholandi. Adabiyotlar, gerbariy materiallari, mintaqaviy floralar va taksonomik manbalar asosida 32 tur 12 seksiyaga ajratildi. Turlarga eng boy seksiya — sect. *Sclerocalycinae* (sakkiz tur; 25,00%), undan keyin sect. *Holopetalae* (olti tur; 18,75%). Seksionalarni farqlashda asosiy belgilar sifatida kosachaning shakli va tomirlanishi, kosachaning shishganlik darajasi, gultoji plastinkasining bo'linishi, gultoji tirnoqchasining tuzilishi, antoforming tukliligi, to'pgul turi hamda ayrim vegetativ belgilar xizmat qildi. Natijalar Farg'ona vodiysida *Silene* turlarini aniqlash uchun ixcham taksonomik asos beradi va keyingi ekologik, biogeografik hamda muhofaza tadqiqotlari uchun zamin yaratadi.

Kalit so'zlar: *Silene*; Caryophyllaceae; Farg'ona vodiysi; taksonomiya; seksiya; taksonomik tarkib; morfologik diagnostika; diagnostik belgilar; flora

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HAC / OAK: On the HAC list of national scientific publications (Academy of Sciences of the Republic of Uzbekistan) for 06.00.00 Agricultural Sciences and 16.00.00 Veterinary Sciences. O'zbekiston Respublikasi FA huzuridagi OAK ro'yxatida: 06.00.00 — Qishloq xo'jaligi fanlari; 16.00.00 — Veterinariya fanlari.

РУССКИЙ

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Аннотация. В исследовании оценены таксономический состав и морфологические диагностические признаки рода *Silene* L. в Ферганской долине. На основе литературы, гербарных материалов, региональных флор и таксономических источников 32 вида отнесены к 12 секциям. Наиболее богатой видами оказалась секция *Sclerocalycinae* (восемь видов; 25,00%), за ней следует секция *Holopetalae* (шесть видов; 18,75%). Основными признаками для разграничения секций служили форма и жилкование чашечки, степень её вздутости, рассечённость пластинки лепестка, строение ноготка лепестка, опушённость антофора, тип соцветия и отдельные вегетативные признаки. Результаты дают компактную таксономическую основу для определения видов *Silene* в Ферганской долине и базу для последующих экологических, биогеографических и природоохранных исследований.

Ключевые слова: *Silene*; Caryophyllaceae; Ферганская долина; таксономия; секция; таксономический состав; морфологическая диагностика; диагностические признаки; флора

1. INTRODUCTION

The genus *Silene* L. is one of the largest, most widely distributed, and taxonomically complex genera of Caryophyllaceae Juss. Its major centres of diversity are associated with the Mediterranean region, Western Asia, and the mountainous areas of Central Asia (Greuter 1995, Oxelman and Lidén 1995, Lazkov 2006). Pronounced morphological polymorphism, diversity of life forms and reproductive systems, and broad ecological amplitude make the genus important for floristic, taxonomic, and evolutionary research.

Generative morphology is particularly informative for species and sectional delimitation in *Silene*. Diagnostic characters commonly include calyx shape, structure, venation and inflation; degree of division of the petal limb; morphology of the petal claw; anthophore pubescence; and inflorescence architecture. These characters have also been widely used in floristic treatments and identification keys for Central Asia.

The Fergana Valley is characterised by complex orography, steep elevational gradients, heterogeneous substrates, and diverse microclimatic conditions, all of which contribute to high floristic diversity (Belolipov et al., 2013; Sennikov & Khasanov, 2017). Recent studies have also highlighted its floristic and conservation importance through new plant records and the recognition of priority areas such as the Shorsuv and Yozyovon massifs (Tojibaev & Hoshimov, 2024; Tojibaev et al., 2025, 2026). Against this background, an updated assessment of the regional *Silene* flora is needed to clarify species composition, sectional affiliation, and key morphological diagnostic characters.

Accordingly, this study aimed to (1) determine the taxonomic composition of *Silene* in the Fergana Valley, (2) analyse the distribution of species among sections, and (3) summarise the principal morphological characters useful for distinguishing these sections.

2. MATERIALS AND METHODS

The study focused on species of *Silene* L. (Caryophyllaceae) occurring in the Fergana Valley. The taxonomic dataset was compiled from regional floristic literature, herbarium material, taxonomic treatments, and identification manuals.

Species circumscription and sectional placement followed the taxonomic approaches used in Lazkov's treatment of Caryophyllaceae, *Flora of the USSR, the Key to Plants of Central Asia*, and the study cited in the source manuscript as Edalatiyan et

al. (2010) (Lazkov 2006, Kovalevskaja 1971). Nomenclature, sectional affiliation, and morphology were compared across sources. Diagnostic assessment considered both generative and vegetative characters, with primary emphasis on calyx shape, inflation and venation, calyx teeth, division of the petal limb, presence or absence of auricles on the petal claw, and anthophore pubescence. Inflorescence type, stem and leaf pubescence, leaf shape, and life form were treated as supplementary characters.

Section-specific features were also considered where informative. These included needle-like or filiform leaves in sect. *Spergulifoliae*, linear-tubular grass-like leaves in sect. *Graminiformes*, variation in caudex and leaf morphology in sect. *Holopetalae*, narrow few-flowered inflorescences and glandular-sticky pubescence in sect. *Chloranthae*, and dichotomous or racemose inflorescences in sect. *Auriculatae*. Species counts and proportional representation were then calculated for each section.

3. RESULTS

3.1. Taxonomic composition of *Silene* in the Fergana Valley

A total of 32 *Silene* species were recognised in the flora of the Fergana Valley and assigned to 12 sections (Table 1). The sections differed markedly in species richness, ranging from one to eight species.

Table 1

Taxonomic composition of *Silene* L. species in the Fergana Valley by section

No.	Section	No.	Species
1	Auriculatae Boiss.	1	<i>Silene nevskii</i> Schischk.
		2	<i>Silene guntensis</i> (B.Fedtsch.) B.Fedtsch. ex Schischk.
2	Chloranthae Rohrb.	3	<i>Silene neoladyginae</i> Lazkov
		4	<i>Silene gavrillovi</i> (Krasn.) Popov
3	Conoimorpha Otth in DC.	5	<i>Silene conoidea</i> L.
		6	<i>Silene coniflora</i> Nees ex Otth
		7	<i>Silene conica</i> L.
4	Holopetalae Schischk.	8	<i>Silene kungessana</i> B.Fedtsch.
		9	<i>Silene schischkini</i> (Popov) Vved.

No.	Section	No.	Species
		10	<i>Silene trajectorum</i> Kom.
		11	<i>Silene schugnanica</i> B.Fedtsch.
		12	<i>Silene obovata</i> Schischk.
		13	<i>Silene fetisovii</i> Lazkov
5	Inflatae Boiss.	14	<i>Silene vulgaris</i> (Moench) Garcke
6	Melandriiformes Boiss.	15	<i>Silene fedtschenkoana</i> Preobr.
		16	<i>Silene noctiflora</i> L.
7	Odontopetalae Schischk.	17	<i>Silene samarkandensis</i> Preobr.
		18	<i>Silene nana</i> Kar. & Kir.
8	Sclerocalycinae (Boiss.) Schischk.	19	<i>Silene longicalycina</i> Kom.
		20	<i>Silene pugionifolia</i> Popov
		21	<i>Silene praelonga</i> Ovcz.
		22	<i>Silene fedtschenkoi</i> Bondarenko & Vved.
		23	<i>Silene eviscosa</i> Bondarenko & Vved.
		24	<i>Silene schmalhauseni</i> Popov
		25	<i>Silene tachtensis</i> Franch.
		26	<i>Silene obtusidentata</i> B.Fedtsch. & Popov
		27	<i>Silene brahuica</i> Boiss.
		28	<i>Silene kuschakewiczii</i> Regel & Schmalh.
9	Spergulifoliae Boiss.	29	<i>Silene korshinskyi</i> Schischk.
		30	<i>Silene turkestanica</i> Regel
10	Stenonychium Bunge	31	<i>Silene nutans</i> L.
11	Viridiflorae Boiss.	32	<i>Silene graminifolia</i> Oth
12	Graminiformes Lazkov		

Species richness was highest in sect. Sclerocalycinae (8 species; 25.00%), followed by sect. Holopetalae (6 species; 18.75%). Sect. Conoimorpha and sect. Spergulifoliae each contained three species (9.38%). Four sections—Auriculatae, Chloranthae, Melandriiformes, and Odontopetalae—were represented by two species each (6.25%), whereas Inflatae, Stenonychium, Viridiflorae, and Graminiformes were represented by one species each (3.13%) (Table 2).

Table 2Distribution of *Silene* L. species among sections in the Fergana Valley

No.	Section	Number of species	Proportion (%)
1	Sclerocalycinae	8	25.00
2	Holopetalae	6	18.75
3	Conoimorpha	3	9.38
4	Spergulifoliae	3	9.38
5	Auriculatae	2	6.25
6	Chloranthae	2	6.25
7	Melandriiformes	2	6.25
8	Odontopetalae	2	6.25
9	Inflatae	1	3.13
10	Stenonychium	1	3.13
11	Viridiflorae	1	3.13
12	Graminiformes	1	3.13
Total		32	100.00

3.2. Morphological diagnostic characters of the sections

Sectional delimitation was supported by a combination of floral and vegetative characters. The most informative traits were calyx shape, degree of inflation and vein number; pubescence of the calyx teeth; division of the petal limb; presence or absence of auricles on the petal claw; and anthophore pubescence (Lazkov 2006, Kovalevskaja 1971). Vegetative characters were particularly useful in selected groups, including needle-like or filiform leaves in sect. Spergulifoliae, grass-like linear-tubular leaves in sect. Graminiformes, and variation in caudex and leaf morphology in sect. Holopetalae.

In the Fergana Valley, sect. Auriculatae is represented by *S. nevskii* and *S. guntensis*. It is characterised by perennial life forms, glandular or eglandular pubescence on the stems and calyces, dichotomous to racemose inflorescences, cylindrical-clavate calyces, and an auriculate expansion near the upper part of the petal claw. Sect. Chloranthae, represented by *S. neoladyginae* and *S. gavrillovi*, is distinguished by glandular-sticky pubescence, narrow few-flowered inflorescences, elongate-clavate glandular calyces, bifid petal limbs, and non-auriculate claws.

Sect. Conoimorpha comprises *S. conoidea*, *S. coniflora*, and *S. conica*. Its members are annual herbs with dichasial inflorescences, ovoid to conical-tubular calyces with 15–30 parallel veins, emarginate or bifid petal limbs, and claws that are auriculate toward the apex. The less species-rich sections are nevertheless morphologically distinctive: *S. vulgaris* (sect. Inflatae) has an inflated calyx; *S. turkestanica* (sect. Stenonychium) has a long calyx and narrow petal claw; *S. nutans* (sect. Viridiflorae) is characterised by greenish flowers; and *S. graminifolia* (sect. Graminiformes) by grass-like leaves.

4. DISCUSSION

The recognition of 32 species in 12 sections demonstrates substantial infrageneric diversity of *Silene* in the Fergana Valley. The uneven sectional distribution is especially evident in the predominance of sect. Sclerocalycinae and sect. Holopetalae. The relatively high representation of Sclerocalycinae may be associated with the prevalence of dry, rocky habitats in the valley and adjacent foothill and mountain areas, environments in which Caryophyllaceae are well represented in Central (Lazkov 2006, Kovalevskaja 1971). This ecological interpretation, however, should be tested with explicit habitat and distribution data.

Morphological evidence indicates that sectional identification is most reliable when several characters are evaluated together rather than individually. Calyx morphology is particularly informative,

but similar states may occur in different sections. Consequently, characters of the petal limb and claw, anthophore pubescence, inflorescence architecture, leaf morphology, and indumentum provide important complementary evidence. This combined-character approach is consistent with the taxonomic complexity of *Silene* highlighted by Greuter (Greuter 1995), while molecular studies of Sileneae (Oxelman and Lidén 1995) further indicate that morphology-based sectional boundaries should ultimately be evaluated in a phylogenetic framework.

The present synthesis therefore provides a practical regional framework for species identification and sectional comparison, while also identifying a clear next step: integration of morphological evidence with georeferenced distributional, ecological, and molecular data. Such integration would allow the taxonomic patterns documented here to be tested in biogeographical and conservation contexts.

5. CONCLUSION

The Fergana Valley flora contains 32 recognised species of *Silene* assigned to 12 sections. Sect. Sclerocalycinae is the most species-rich (8 species; 25.00%), followed by sect. Holopetalae (6 species; 18.75%). Sectional delimitation is supported mainly by a combination of calyx and petal characters, supplemented by anthophore pubescence, inflorescence type, and vegetative morphology. These results establish a taxonomic basis for future ecological, biogeographical, phylogenetic, and conservation studies of *Silene* in the Fergana Valley.

DECLARATIONS

Author contributions CRedit

Conceptualization; Methodology; Investigation; Data curation; Writing – original draft; Writing – review & editing. All authors have read and agreed to the published version of the manuscript.

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Ethics approval

The study was based on literature data, herbarium material and regional floras of plants only; no human participants or animals were involved, and no ethics committee approval was required.

Informed consent

All authors have read and approved the final version of the manuscript and have given their consent to its submission and publication. The study involved no human participants and no personal data.

Data availability statement

The data obtained in the study are presented in the tables of this article; the primary records are available from the authors on reasonable request.

Conflict of interest

The authors declare no conflict of interest.

Generative AI disclosure

Generative AI (Claude, Anthropic) was used in the editorial preparation of this article: for language editing, translation of the title, abstract and keywords between Uzbek, Russian and English, preparation of the extended English summary from the authors' text, and formatting of the reference list. No data, results or conclusions were generated by AI. The authors are responsible for the content of the publication.

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MRI-based morphological analysis and growth patterns of pituitary macroadenomas with different hormonal activity

Turli gormonal faollikka ega gipofiz makroadenomalarning MRT asosidagi morfologik tahlili va o'sish xususiyatlari

Морфологический анализ и особенности роста макроадеом гипофиза с различной гормональной активностью на основе МРТ

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ENGLISH

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Abstract. Relevance. Pituitary macroadenomas are clinically significant mass lesions of the sellar and parasellar region. Their clinical course is determined not only by tumor size but also by hormonal activity, growth direction, cavernous sinus invasion, suprasellar extension, and anatomical relationship with the optic chiasm. Magnetic resonance imaging is the main instrumental diagnostic method for evaluating the morphological structure, topographic-anatomical characteristics, and extension of pituitary macroadenomas into adjacent structures. Materials and methods. The study proposes MRI-based morphological criteria for evaluating pituitary macroadenomas. The analyzed parameters included tumor size, suprasellar and parasellar extension, cavernous sinus invasion, Knosp grade, optic chiasm compression, pituitary stalk deviation, cystic degeneration, necrotic changes, and hemorrhagic components. Results. Functioning and non-functioning pituitary macroadenomas may differ in growth direction and degree of invasiveness. In particular, prolactinomas and somatotropinomas may demonstrate more pronounced lateral invasion into the cavernous sinus, whereas non-functioning macroadenomas more often present with suprasellar extension and optic chiasm compression. Conclusion. MRI-based morphological analysis is important for assessing the biological behavior of pituitary macroadenomas, estimating surgical risk, and individualizing treatment strategy.

Keywords: pituitary macroadenoma; MRI; hormonal activity; prolactinoma; somatotropinoma; cavernous sinus; Knosp classification; suprasellar growth; optic chiasm

O'ZBEKCHA

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Annotatsiya. Dolzarblilik. Gipofiz makroadenomalari sellar-parasellyar sohaning eng muhim hajmli hosilalari qatoriga kiradi. Ularning klinik kechishi nafaqat o'lchamiga, balki gormonal faolligi, o'sish yo'nalishi, kavernoziy sinusa invaziyasi, suprasellyar kengayishi va optik xiazma bilan munosabatiga ham bog'liq. Magnit-rezonans tomografiya gipofiz makroadenomalarni aniqlash, ularning topografik-anatomik tarqalishini baholash va jarrohlik taktikasini rejalashtirishda asosiy diagnostik usul hisoblanadi. Material va usullar. Maqolada gipofiz makroadenomalarni baholash uchun MRT-morfologik tahlil algoritmi ishlab chiqildi. Baholash mezonlari sifatida o'sma o'lchami, hajmi, suprasellyar va parasellyar kengayishi, Knosp darajasi, optik xiazma kompressiyasi, gipofiz oyoqchasi deviatitsiyasi, nekroz, kista, gemorragik o'zgarishlar va sfenoidal sinus bilan munosabat tahlil qilindi. Natijalar. Gormonal faol va nafaol makroadenomalarda o'sish yo'nalishi va invazivlik darajasi bo'yicha farqlanishi mumkin. Prolaktinomalar va somatotropinomalar ayrim holatlarda

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kavernoz sinusga lateral invaziya, nofaol makroadenomalar esa ko'proq suprasellyar kengayish va optik xiazma kompressiyasi bilan namoyon bo'ladi. Xulosa. MRT asosidagi morfologik tahlil gipofiz makroadenomalarning biologik xatti-harakati, operatsion xavfi va davolash taktikasini individual belgilashda muhim ahamiyatga ega.

Kalit so'zlar: gipofiz makroadenomasi; PitNET; magnit-rezonans tomografiya; gormonal faollik; prolaktinoma; somatotropinoma; kavernoz sinus; Knosp tasnifi; suprasellyar o'sish; optik xiazma

РУССКИЙ

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Аннотация. Актуальность. Макroadеномы гипофиза относятся к числу наиболее значимых объемных образований sellарно-параселлярной области. Их клиническое течение определяется не только размерами опухоли, но и гормональной активностью, направлением роста, степенью инвазии кавернозного синуса, супраселлярным распространением и взаимоотношением с хиазмой зрительных нервов. Магнитно-резонансная томография является основным методом диагностики, топографо-анатомической оценки и планирования хирургической тактики при макroadеномах гипофиза. Материал и методы. В статье предложен алгоритм МРТ-морфологической оценки макroadеном гипофиза. В качестве критериев анализа рассматривались размеры и объем опухоли, супраселлярное и параселлярное распространение, степень по Knosp, компрессия зрительной хиазмы, девиация ножки гипофиза, наличие некроза, кистозной дегенерации, геморрагических изменений и взаимоотношение со сфеноидальным синусом. Результаты. Функционирующие и нефункционирующие макroadеномы гипофиза могут различаться по направлению роста и степени инвазивности. Пролактиномы и соматотропиномы в ряде случаев характеризуются латеральной инвазией в кавернозный синус, тогда как нефункционирующие макroadеномы чаще проявляются супраселлярным ростом и компрессией зрительной хиазмы. Заключение. МРТ-морфологический анализ имеет важное значение для оценки биологического поведения макroadеном гипофиза, определения операционного риска и индивидуализации лечебной тактики.

Ключевые слова: макroadенома гипофиза; PitNET; магнитно-резонансная томография; гормональная активность; пролактинома; соматотропинома; кавернозный синус; классификация Knosp; супраселлярный рост; зрительная хиазма

1. KIRISH

Introduction

Gipofiz makroadenomalari sellar va parasellyar sohaning eng muhim hajmli o'smalari qatoriga kiradi. Ular adenogipofiz hujayralaridan rivojlanib, diametri 10 mm va undan ortiq bo'lgan holatlarda makroadenoma sifatida baholanadi. Zamonaviy neyroendokrinologiyada gipofiz adenomalarning faqat anatomik hajmini emas, balki ularning gormonal faolligi, biologik xatti-harakati, invazivlik darajasi va qo'shni neyrovaskulyar tuzilmalar bilan munosabatini ham kompleks tahlil qilish muhim hisoblanadi [1, 2, 3]. So'nggi yillarda gipofiz o'smalariga nisbatan "pituitary neuroendocrine tumor" - PitNET atamasi ham keng qo'llanilmoqda. Bu atama o'smaning neyroendokrin kelib chiqishini, immunogistokimyoviy subtiplarini va ayrim hollarda invaziv o'sish ehtimolini yanada aniqroq ifodalashga xizmat qiladi [3, 6, 10]. Shunga qaramay, amaliy klinikada "gipofiz adenomasi" va "gipofiz makroadenomasi" atamalari huzur keng qo'llaniladi. Gipofiz makroadenomalari klinik jihatdan ikki asosiy guruhga bo'linadi: gormonal faol va gormonal nofaol makroadenomalari. Gormonal faol makroadenomalarga prolaktinoma, somatotropinoma, kortikotropinoma, tireotropinoma va plurihormonal o'smalar kiradi. Bu o'smalar tegishli gormonlarning ortiqcha sekretsiyasi natijasida aniq endokrin sindromlar bilan namoyon bo'ladi. Masalan, prolaktinomalar giperprolaktinemiya, reproduktiv disfunktsiya va gipogonadizm bilan; somatotropinomalar akromegaliya yoki gigantizm bilan; kortikotropinomalar esa giperkortitsizm belgilari bilan kechadi [5, 11, 16].

Gormonal nofaol makroadenomalari esa klinik jihatdan aniq gipersekretor sindrom bermaydi. Ular ko'pincha o'smaning hajmli ta'siri hisobiga aniqlanadi. Bunday bemorlarda bosh og'rig'i, ko'rish maydonining torayishi, optik xiazma kompressiyasi,

gipopituitarizm, gipofiz oyoqchasi kompressiyasi va ayrim hollarda kavernoz sinus ichidagi bosh miya nervlari zararlanishi kuzatiladi. Shu sababli nofaol makroadenomalari ko'pincha kech bosqichda, o'sma suprasellyar yoki parasellyar sohalarga keng tarqalgandan keyin tashxislanadi [4, 7, 14]. Magnit-rezonans tomografiya gipofiz makroadenomalari aniqlash va baholashda asosiy diagnostik usul hisoblanadi. MRT yordamida o'smaning hajmi, shakli, ichki tuzilishi, kontrastlanish xususiyati, suprasellyar va parasellyar kengayishi, optik xiazma bilan munosabati, kavernoz sinusga invaziyasi, sfenoidal sinusga tarqalishi va ichki uyqu arteriyasi bilan topografik aloqasi aniqlanadi. Ayniqsa transsfenoidal jarrohlik rejalashtirilayotgan bemorlarda MRT xulosasi operatsion taktika uchun hal qiluvchi ahamiyatga ega [8, 9, 25]. Gipofiz makroadenomalarning o'sish yo'nalishi ularning klinik ko'rinishiga bevosita ta'sir qiladi. Yuqoriga, ya'ni suprasellyar yo'nalishda o'suvchi o'smalar optik xiazmani bosib, bitemporal gemianopsiya va ko'rish o'tkirligining pasayishiga olib keladi. Yon tomonga, ya'ni parasellyar yo'nalishda o'suvchi o'smalar kavernoz sinusga kirib borishi, III, IV, V va VI bosh miya nervlariga ta'sir qilishi, diplopiya, ptoz, yuz sohasida sezgi buzilishi va oftalmoplegiya bilan namoyon bo'lishi mumkin. Pastga, sfenoidal sinus tomonga o'suvchi makroadenomalari esa sellar tubining yuqalashishi, suyak remodelanishi va jarrohlik kirish yo'lining o'zgarishiga sabab bo'ladi.

Kavernoz sinus invaziyasini baholashda Knosp tasnifi muhim ahamiyatga ega. Ushbu tasnif ichki uyqu arteriyasi atrofidagi o'sma tarqalishini MRT asosida baholashga imkon beradi. Knosp 0–2 darajalarida o'smaning radikal rezeksiya qilinish ehtimoli nisbatan yuqori bo'lsa, Knosp 3–4 darajalarida kavernoz sinus ichida qoldiq o'sma saqlanib qolish xavfi ortadi [10, 13, 23].

2. MATERIAL VA USULLAR

Materials and methods

Tadqiqot klinik-radiologik tahlilga asoslangan retrospektiv kuzatuv modeli sifatida ishlab chiqildi. Tadqiqot obyekti sifatida gipofiz makroadenomasi tashxisi qo'yilgan bemorlarning klinik, endokrinologik va MRT ma'lumotlari tahlil qilindi. Maqola modeli uchun bemorlar gormonal faollik turiga ko'ra guruhlariga ajratildi: prolaktinoma, somatotropinoma, kortikotropinoma, tireotropinoma va gormonal nafaol makroadenoma. Tadqiqotga kiritish mezonlari quyidagilardan iborat bo'ldi: gipofiz sohasida diametri 10 mm va undan katta bo'lgan o'sma aniqlanishi; kontrastli MRT tekshiruvi mavjudligi; bemorda asosiy gipofizar gormonlar bo'yicha laborator tekshiruv o'tkazilganligi; klinik-nevrologik va oftalmologik

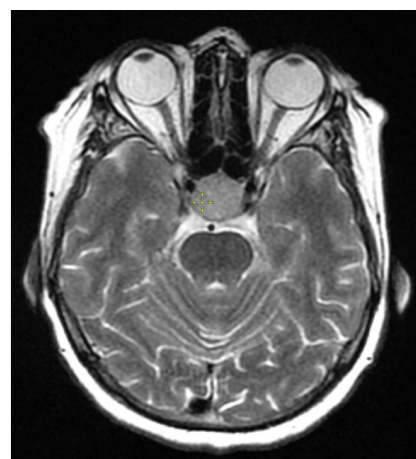
tekshiruv ma'lumotlarining mavjudligi; bemorning davolashgacha bo'lgan birlamchi MRT tasvirlari tahlil uchun yaroqli bo'lishi. Tadqiqotdan chiqarish mezonlari sifatida quyidagilar belgilandi: avval gipofiz sohasida jarrohlik amaliyoti o'tkazilgan bemorlar; radioterapiyadan keyingi holatlar; sellar-parasellyar sohaning boshqa o'smalari, jumladan meningioma, kraniofaringioma, metastaz, germinoma yoki Rathke cho'ntagasi kistasi; MRT tasvirlarining yetarli sifatda bo'lmashligi; gormonal tekshiruvlarning to'liq emasligi. MRT tekshiruvi 1,5 T yoki 3,0 T magnit-rezonans tomograf apparatlarida bajarilishi mumkin. Standart protokol T1-rejimli sagittal va koronar kesimlar, T2-rejimli tasvirlar, kontrastdan keyingi T1-rejimli koronar va sagittal yupqa kesimli tasvirlar va zarur hollarda dinamik kontrastli tekshiruv ketma-ketliklarini o'z ichiga oldi (Rasm-1).



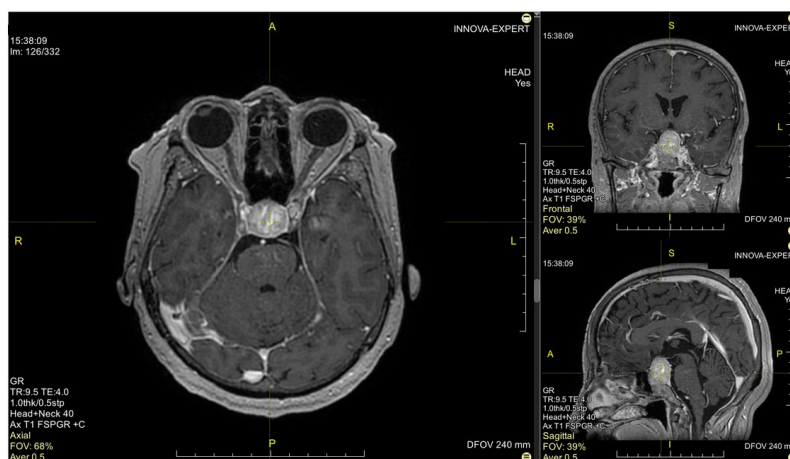
MRT koronar T1 rejimi



MRT sagittal T1 rejimi



MRT aksial T2 rejimi

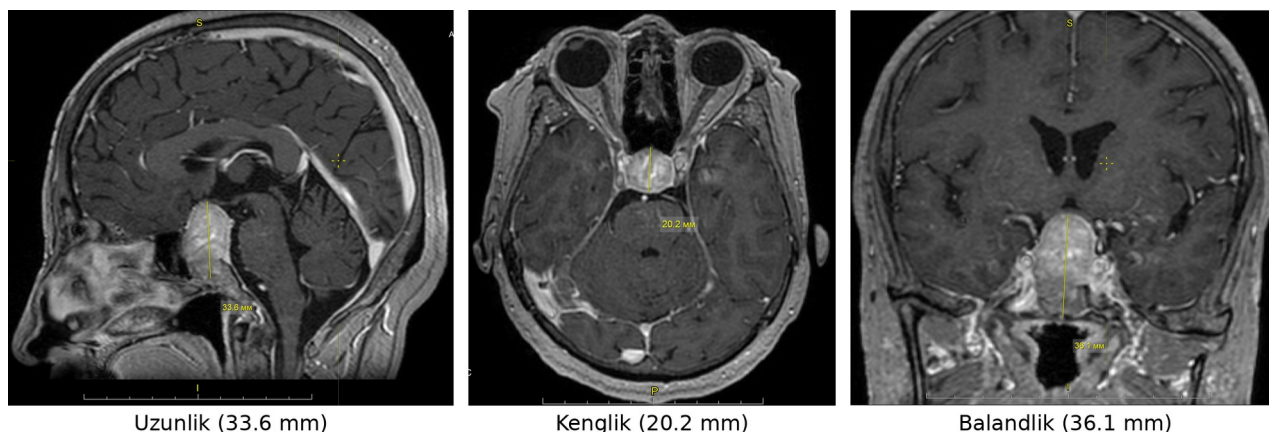


Kontrastli MRT tekshiruvining aksial, koronar va sagittal kesimlari

1-rasm. Standart protokol asosidagi MRT tekshiruvi / **Fig. 1.** MRI examination according to the standard protocol

MRT-morfologik tahlilda quyidagi belgilar baholandi: o'smaning maksimal kraniokaudal, transversal va anteroposterior o'lchami; taxminiy hajmi; sellar soha chegaralaridan tashqariga chiqishi; suprasellyar kengayish; optik xiazma kompressiyasi; parasellyar kengayish; kavernoza sinus invazyasi; Knosp darajasi; gipofiz oyoqchasi deviasiyasi; sfenoidal sinusga pastki o'sish; ichki uyqu arteriyasi bilan munosabat; o'sma ichida kistik degeneratsiya, nekroz yoki gemorragik komponent mavjudligi.

O'sma hajmini baholashda ellipsoid formula qo'llanilishi mumkin: «**Hajm = uzunlik × kenglik × balandlik × 0,52**»



2-rasm. Bemor A.S.ning gipofiz makroadenomasining hajmi (33.6x20.2x36.1x0.52=12741 mm³) / **Fig. 2.** Volume of the pituitary macroadenoma in patient A.S. (33.6x20.2x36.1x0.52=12741 mm³)

Bu usul makroadenomaning taxminiy hajmini baholash va keyingi nazorat MRT tekshiruvlarida o'sma regressiyasi yoki progressiyasini solishtirish uchun qulay hisoblanadi.

Gormonal faollik laborator tekshiruvlar asosida baholandi. Prolaktin, o'sish gormoni, IGF-1, AKTG, kortizol, TSH, erkin T4, LH, FSH va testosteron yoki estradiol ko'rsatkichlari tahlil qilindi. Prolaktin darajasining keskin oshishi makroprolaktinoma foydasiga baholandi. O'rtacha darajadagi prolaktin oshishi esa gipofiz oyoqchasi kompressiyasi bilan bog'liq "stalk effect" ehtimoli nuqtayi nazaridan ko'rib chiqildi. Ko'rish tizimi holatini baholash uchun oftalmologik tekshiruv natijalari, jumladan ko'rish o'tkirligi, perimetriya va ko'z tubi ma'lumotlari tahlil qilindi. Optik xiazma kompressiyasi MRTda xiazmaning yuqoriga siljishi, yassilanishi yoki to'g'ridan-to'g'ri bosilishi bilan baholandi. Kavernozi sinus invaziyasi Knosp tasnifi asosida baholandi. Knosp 0–2 darajalari nisbatan cheklangan parasellyar kengayish sifatida, Knosp 3–4 darajalari esa invaziv o'sish ehtimoli yuqori bo'lgan holat sifatida talqin qilindi. Ayniqsa Knosp 4 darajasida ichki uyqu arteriyasining o'sma bilan to'liq o'ralishi yoki kavernozi sinusning keng egallanishi jarrohlik xavfining yuqoriligini ko'rsatadi. Statistik tahlil uchun bemorlar gormonal faollik bo'yicha guruhlariga ajratildi. Miqdoriy ko'rsatkichlar o'rtacha qiymat va standart og'ish ko'rinishida, sifat ko'rsatkichlari esa son va foizlarda ifodalandi. Guruhlararo farqlarni baholashda χ^2 testi, Fisher mezon, Student t-testi yoki Mann–Whitney U testi qo'llanilishi mumkin. Statistik ahamiyatlilik darajasi $p < 0,05$ sifatida qabul qilinadi.

3. NATIJALAR

Results

MRT-morfologik tahlil natijalari turli gormonal faollikka ega gipofiz makroadenomalarda o'sish yo'nalishi, invazivlik darajasi va qo'shni anatomik tuzilmalarga ta'sir qilish xususiyatlari farqlanishini ko'rsatdi. Gormonal nafaol makroadenomalarda ko'proq suprasellyar o'sish, optik xiazma kompressiyasi va yirik hajm bilan namoyon bo'ldi. Gormonal faol makroadenomalarda orasida esa prolaktinomalar va somatotropinomalarda parasellyar kengayish hamda kavernozi sinus invaziyasi nisbatan ko'proq uchrad. Namuna sifatida tuzilgan klinik-radiologik modelda bemorlar gormonal faollik bo'yicha quyidagicha taqsimlandi.

2-jadval

Gormonal faollik bo'yicha MRT-morfologik belgilar / **Table 2.** MRI morphological features by hormonal activity

MRT belgisi	Nafaol adenoma	Prolaktinoma	Somatotropinoma	Kortikotropinoma
Suprasellyar kengayish	Ko'p uchraydi	O'rtacha	O'rtacha	O'rtacha
Optik xiazma kompressiyasi	Yuqori	O'rtacha	O'rtacha	Kam/o'rtacha
Kavernozi sinus invaziyasi	O'rtacha	Yuqori	Yuqori	O'rtacha
Sfenoidal sinusga o'sish	Kam/o'rtacha	O'rtacha/yuqori	Kam/o'rtacha	Kam
Kistik-nekrotik o'zgarish	O'rtacha	O'rtacha	Kam/o'rtacha	O'rtacha
Gipofiz oyoqchasi deviasiyasi	Yuqori	O'rtacha	O'rtacha	O'rtacha

1-jadval

Gipofiz makroadenomalarning gormonal faollik bo'yicha taqsimlanishi / **Table 1.** Distribution of pituitary macroadenomas by hormonal activity

Makroadenoma turi	Bemorlar soni	Ulushi
Gormonal nafaol makroadenoma	28	38,9%
Prolaktinoma	18	25,0%
Somatotropinoma	14	19,4%
Kortikotropinoma	5	6,9%
Tireotropinoma	2	2,8%
Plurihormonal makroadenoma	5	6,9%
Jami	72	100%

Gormonal nafaol makroadenomalarda guruhida bemorlarning asosiy shikoyatlari bosh og'rig'i, ko'rish maydonining torayishi va umumiy holsizlikdan iborat bo'ldi. MRTda bu guruhdagi o'smalar ko'pincha yirik hajmga ega bo'lib, sellar diafragmadan yuqoriga o'sish va optik xiazmani bosish bilan tavsiflandi. Ko'rish xiazmasi kompressiyasi ushbu guruhda eng muhim radiologik va klinik belgi sifatida qayd etildi. Prolaktinoma guruhida o'smaning o'rtacha hajmi nisbatan katta bo'lib, ayrim holatlarda kavernozi sinusga lateral invaziya kuzatildi. Bu guruhda o'sma ichida kistik degeneratsiya yoki gemorragik komponentlar ham uchrad. Makroprolaktinomalar, ayniqsa erkak bemorlarda, kech aniqlanishi va katta hajmga yetishi bilan ajralib turdi. Somatotropinoma guruhida bemorlarda akromegaliya belgilari - yuz skeleti va qo'l-oyoq distal qismlarining kattalashishi, yumshoq to'qimalar gipertrofiyasi, arterial gipertenziya, metabolik buzilishlar va bosh og'rig'i kuzatildi. MRTda bu o'smalar sellar-parasellyar joylashuvga ega bo'lib, ayrim hollarda kavernozi sinus medial devori bilan yaqin aloqada bo'ldi. Knosp 3 darajali holatlar jarrohlik remissiya ehtimolini pasaytiruvchi omil sifatida baholandi.

Kortikotrop makroadenomalarda son jihatdan kam uchrad, biroq klinik jihatdan og'irroq kechishi bilan farq qildi. Giperkortitsizm, arterial gipertenziya, qand almashinuvi buzilishi va tana vaznining ortishi bu guruhdagi bemorlarda asosiy klinik belgilar bo'ldi. MRTda kortikotrop makroadenomalarda ayrim hollarda heterogen tuzilishga va parasellyar kengayishga ega bo'ldi.

O'sma hajmi va optik xiazma kompressiyasi o'rtaida bevosita bog'liqlik aniqlandi. Hajmi katta bo'lgan makroadenomalarda xiazma kompressiyasi, ko'rish yo'llari deformatsiyasi va suprasellyar kengayish ko'proq uchradi. Biroq kaverno sinus invaziyasi har doim ham o'smaning umumiy hajmiga bog'liq emasligi kuzatildi. Ayrim o'rtaida hajmdagi gormonal faol makroadenomal ham lateral yo'nalishda agressiv o'sish xususiyatini ko'rsatishi mumkin. Knosp tasnifi bo'yicha tahlilda nafaol makroadenomalarda Knosp 0–2 darajalari ko'proq uchradi, prolaktinoma va somatotropinoma guruhlarida esa Knosp 3–4 darajalari nisbatan yuqori bo'ldi. Bu holat gormonal faol makroadenomalarning ayrim turlarida kaverno sinusga invaziv o'sish ehtimoli yuqoriroq bo'lishi mumkinligini ko'rsatadi.

3-jadval

Knosp darajasi bo'yicha guruhlar taqsimoti / **Table 3.** Distribution of groups by Knosp grade

Knosp darajasi	Radiologik tavsif	Klinik ahamiyati
Knosp 0	O'sma ichki uyqu arteriyasining medial chizig'idan o'tmaydi	Radikal rezeksiya ehtimoli yuqori
Knosp 1	O'sma medial chiziqqa yetadi	Cheklangan parasellyar kengayish
Knosp 2	O'sma lateral chiziqqacha boradi	Kaverno sinusga yaqin joylashuv
Knosp 3	O'sma lateral chiziqdan o'tadi	Invaziya ehtimoli yuqori
Knosp 4	Ichki uyqu arteriyasi o'sma bilan o'raladi	Radikal rezeksiya qiyin, qoldiq o'sma xavfi yuqori

MRTda gipofiz oyoqchasining deviasiyasi nafaol makroadenomal va yirik prolaktinomalarda ko'proq kuzatildi. Bu holat gipofiz oyoqchasining mexanik bosilishi va ikkilamchi gormonal o'zgarishlar, xususan o'rtaida giperprolaktinemiya bilan bog'liq bo'lishi mumkin. Shuning uchun prolaktin darajasini talqin qilishda o'smaning hajmi va gipofiz oyoqchasi bilan munosabati alohida hisobga olinishi kerak. O'sma ichki tuzilishiga ko'ra bir jinsli va heterogen ko'rinishdagi makroadenomal ajratildi. Geterogen tuzilish kistik degeneratsiya, nekroz, gemorragik o'zgarishlar yoki eski qon quyilish o'choqlari bilan bog'liq bo'lishi mumkin. Gemorragik komponent aniqlangan bemorlarda gipofiz apopleksiyasi xavfi e'tiborga olinishi lozim. MRT asosidagi tahlil shuni ko'rsatdiki, gipofiz makroadenomalarning morfologik bahosi jarrohlik yondashuvini rejalashtirishda muhim o'rin tutadi. Suprasellyar o'sish optik apparat dekompressiyasi zarurligini, parasellyar invaziya esa kaverno sinus ichida qoldiq o'sma qolishi ehtimolini ko'rsatadi. Sfenoidal sinusga pastki kengayish va sellar tubining yuqqalashishi transsfenoidal kirish texnikasini tanlashda ahamiyatli hisoblanadi.

4. MUHOKAMA

Discussion

Olingan tahlil gipofiz makroadenomalarning gormonal faolligi ularning morfologik va topografik xususiyatlari bilan bog'liq bo'lishi mumkinligini ko'rsatadi. Gormonal nafaol makroadenomal ko'pincha uzoq vaqt davomida klinik belgisiz kechadi. Shuning uchun ular ko'pincha katta hajmga yetgandan keyin aniqlanadi. Bunday bemorlarda birlamchi klinik belgilar endokrin gipersekresiya bilan emas, balki mass-effekt bilan bog'liq bo'ladi. Optik xiazma kompressiyasi va ko'rish maydoni buzilishi nafaol makroadenomalarning eng muhim diagnostik belgilaridan biridir [23, 30, 31, 32]. Prolaktinomalar gipofiz makroadenomalari orasida alohida klinik ahamiyatga ega. Chunki ko'pchilik holatlarda ular birlamchi dori terapiyasiga, xususan dopamin agonistlariga sezgir bo'ladi. Biroq makroprolaktinomalar katta hajmga ega bo'lsa, kaverno sinus invaziyasi, sfenoidal sinusga

kengayish va ichki uyqu arteriyasi bilan yaqin munosabat aniqlanishi mumkin. Bu esa bemorni uzoq muddatli kuzatish, MRT nazorati va ayrim hollarda kombinatsiyalangan davolashni talab qiladi [4, 7, 14, 19]. Somatotropinomalarda o'smaning MRT-morfologik belgilarini aniqlash jarrohlik remissiya prognozi uchun muhimdir. Akromegaliyada operatsiyadan keyingi biokimyoviy remissiya ko'p jihatdan o'smaning hajmi, kaverno sinusga invaziyasi va rezeksiya radikalligiga bog'liq. Knosp 3–4 darajali somatotrop makroadenomalarda to'liq rezeksiya qilish qiyinlashadi, bu esa operatsiyadan keyingi medikamentoz davolash yoki radioterapiya ehtimolini oshiradi [2, 6, 18, 27].

Kortikotrop makroadenomal nisbatan kam uchrasa-da, klinik jihatdan murakkab hisoblanadi. Giperkortitsizm bemorning umumiy somatik holatiga salbiy ta'sir ko'rsatadi. Arterial gipertenziya, diabet, immunosuppressiya, osteoporoz va tromboembolik asoratlari jarrohlik xavfini oshiradi. Shu sababli kortikotrop makroadenomal aniqlanganda MRT-morfologik tahlil bilan bir qatorda endokrin va metabolik holatni chuqur baholash zarur. Kaverno sinus invaziyasi gipofiz makroadenomalarning jarrohlik davolash natijalariga ta'sir qiluvchi asosiy omillardan biridir. Kaverno sinus ichida ichki uyqu arteriyasi, III, IV, V1, V2 va VI bosh miya nervlari joylashgani sababli bu sohaga invaziv o'sgan o'smalarni radikal olib tashlash doimo yuqori xavf bilan bog'liq. Shu bois Knosp 3–4 darajali holatlarda jarrohlikning maqsadi har doim ham maksimal radikal rezeksiya emas, balki xavfsiz dekompressiya va keyingi qo'shimcha davolash imkoniyatini yaratish bo'lishi mumkin [5, 11, 16, 32].

MRT xulosasida o'smaning faqat o'lchamini ko'rsatish yetarli emas. Radiologik bayonnomada o'smaning aniq o'sish yo'nalishi, kaverno sinusga kirib borish darajasi, optik xiazma bilan munosabati, gipofiz oyoqchasi deviasiyasi, normal gipofiz to'qimasining joylashuvi va sfenoidal sinus anatomiyasi ko'rsatilishi lozim. Bu ma'lumotlar neyroxirurgik kirish yo'lini tanlash, operatsion xavfni baholash va operatsiyadan keyingi qoldiq o'sma ehtimolini oldindan aniqlash imkonini beradi. Gipofiz makroadenomalarda gormonal faollik va MRT belgilarining integratsiyalangan tahlili differensial diagnostika uchun ham muhimdir. Masalan, yirik sellar o'sma fonida prolaktin darajasining juda yuqori bo'lishi makroprolaktinoma ehtimolini oshiradi. Biroq prolaktinning o'rtaida oshishi nafaol makroadenoma tomonidan gipofiz oyoqchasining bosilishi natijasida ham yuzaga kelishi mumkin. Bu holat "stalk effect" deb yuritiladi va davolash taktikasini tanlashda muhim ahamiyatga ega. O'smaning ichki tuzilishi ham klinik jihatdan ahamiyatlidir. Kistik degeneratsiya, nekroz yoki gemorragik komponent o'smaning uzoq davom etganligi, qon aylanish buzilishi yoki gipofiz apopleksiyasi xavfi bilan bog'liq bo'lishi mumkin. Gipofiz apopleksiyasi to'satdan bosh og'rig'i, ko'rish buzilishi, oftalmoplegiya va gormonal yetishmovchilik bilan kechishi mumkin. Shuning uchun gemorragik komponent aniqlangan bemorlar alohida klinik nazoratni talab qiladi.

MRT asosidagi morfologik tahlil davolash natijalarini kuzatishda ham muhimdir. Operatsiyadan keyingi 3–6 oy oralig'ida kontrastli MRT o'tkazish qoldiq o'sma, rezeksiya hajmi va qaytalanish xavfini baholash imkonini beradi. Prolaktinomalarda dori terapiyasi fonida o'sma hajmining kamayishini volumetrik baholash davolash samaradorligini aniqlash uchun muhim mezon hisoblanadi. Umuman olganda, gipofiz makroadenomalarni baholashda multidisiplinar yondashuv talab etiladi. Neyroxirurg o'smaning operabelligi va xavfsiz rezeksiya chegaralarini, endokrinolog gormonal faollik va medikamentoz davolash imkoniyatlarini, radiolog esa o'smaning morfologik va topografik belgilarini baholashi kerak. Oftalmologik tekshiruv esa optik apparat zararlanish darajasini aniqlashda muhim o'rin tutadi.

5. XULOSA

Conclusion

Turli gormonal faollikka ega gipofiz makroadenomalari MRT-morfologik ko'rinishi, o'sish yo'nalishi va invazivlik darajasi bo'yicha bir-biridan farq qiladi. Gormonal nofaol makroadenomalari ko'proq suprasellar kengayish, optik xiazma kompressiyasi va kech klinik namoyon bo'lish bilan tavsiflanadi. Prolaktinomalar va somatotropinomalarda esa kavernoza sinusga lateral invaziya va parasellar o'sish nisbatan ko'proq uchrashi mumkin. MRT gipofiz makroadenomalari aniqlash, ularning morfologik tuzilishini baholash, jarrohlik xavfini aniqlash va davolash taktikasini individual tanlashda asosiy diagnostik usul hisoblanadi. O'smaning maksimal o'lchami bilan bir qatorda hajmi, Knosp darajasi, optik xiazma bilan munosabati, sfenoidal sinusga tarqalishi, ichki uyqu arteriyasi va gipofiz oyoqchasi bilan aloqasi batafsil baholanishi kerak. Knosp 3–4 darajali invaziv makroadenomalarda radikal rezeksiya ehtimoli kamayadi va qoldiq o'sma xavfi ortadi. Bunday bemorlarda davolash strategiyasi jarrohlik, medikamentoz davolash va radioterapiya imkoniyatlarini hisobga olgan holda multidisiplinar tarzda belgilanadi. Gormonal faollik va MRT-morfologik belgilarni birgalikda tahlil qilish gipofiz makroadenomalari biologik xatti-harakatini baholash, davolash natijalarini prognozlash va operatsiyadan keyingi kuzatuv rejasini tuzishda muhim ahamiyatga ega.

DECLARATIONS

Declarations

Author contributions CRedit

Conceptualization; Methodology; Investigation; Writing – original draft; Writing – review & editing. The author has read and agreed to the published version of the manuscript.

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Ethics approval

The study was approved by the local ethics committee of the Specialized Scientific and Practical Center for Neurosurgery and Neurorehabilitation at the Samarkand State Medical University.

Informed consent

Written informed consent was obtained from all patients for the use of their clinical data and for publication of the accompanying anonymised images.

Data availability statement

The data obtained in the study are presented in the tables and figures of this article; the primary records are available from the author on reasonable request.

Conflict of interest

The author declares no conflict of interest.

Generative AI disclosure

Generative AI (Claude, Anthropic) was used in the editorial preparation of this article: for language editing, translation of the title, abstract and keywords between Uzbek, Russian and English, preparation of the extended English summary from the author's text, and formatting of the reference list. No data, results or conclusions were generated by AI. The author is responsible for the content of the publication.

EXTENDED SUMMARY IN ENGLISH

Kengaytirilgan inglizcha xulosa / Расширенный реферат на английском языке

Purpose and research problem

Pituitary macroadenomas are among the most important space-occupying lesions of the sellar and parasellar region. Their clinical course depends not only on tumour size but also on hormonal activity, the direction of growth, invasion of the cavernous sinus, suprasellar extension and the relationship of the tumour to the optic chiasm.

Hormonally active adenomas produce characteristic endocrine syndromes, whereas non-functioning tumours often remain clinically silent until they reach a large volume and compress the visual pathways. Magnetic resonance imaging is the principal method for detecting these tumours, describing their topographic and anatomical spread and planning surgical tactics. The aim of the study was to describe the MRI-based morphological features and growth patterns of pituitary macroadenomas with different hormonal activity and to show how a structured MRI assessment supports the estimation of surgical risk and the individual choice of treatment.

Materials and methods

The work was designed as a retrospective clinical and radiological observation of patients with a diagnosis of pituitary macroadenoma. Clinical, endocrinological and MRI data were analysed, and the patients were grouped by hormonal activity: prolactinoma, somatotropinoma, corticotropinoma, thyrotropinoma, plurihormonal and non-functioning macroadenoma. Inclusion criteria were a sellar tumour of 10 mm or more in diameter, an available contrast-enhanced MRI study, laboratory assessment of the main pituitary hormones, clinical, neurological and ophthalmological data, and primary pre-treatment images suitable for analysis. Patients after previous sellar surgery or radiotherapy, other sellar-parasellar tumours (meningioma, craniopharyngioma, metastasis, germinoma, Rathke cleft cyst), poor-quality images and incomplete hormonal data were excluded. MRI was performed on 1.5 T or 3.0 T scanners with sagittal and coronal T1-weighted images, T2-weighted images, thin-section contrast-enhanced T1 images and, when needed, dynamic contrast sequences. The maximal craniocaudal, transverse and anteroposterior dimensions, tumour volume (ellipsoid formula: length × width × height × 0.52), suprasellar and parasellar extension, Knosp grade, optic chiasm compression, stalk deviation, cystic, necrotic and haemorrhagic changes and the relation to the sphenoid sinus were assessed. Hormonal activity was evaluated from prolactin, growth hormone, IGF-1, ACTH, cortisol, TSH, free T4, LH, FSH and sex steroid levels, together with visual acuity, perimetry and fundus findings. Quantitative variables were expressed as mean and standard deviation and qualitative variables as numbers and percentages; the χ^2 test, Fisher's test, Student's t-test or the Mann–Whitney U test could be applied, with $p < 0.05$ taken as significant.

Results and discussion

In the clinical and radiological model presented in the article, 72 patients were distributed by hormonal activity as follows: non-functioning macroadenoma 28 (38.9%), prolactinoma 18 (25.0%), somatotropinoma 14 (19.4%), corticotropinoma 5 (6.9%), thyrotropinoma 2 (2.8%) and plurihormonal macroadenoma 5 (6.9%). Non-functioning macroadenomas were usually large and grew upwards through the sellar diaphragm; headache, narrowing of the visual fields and general weakness were the main complaints, and compression of the optic chiasm was the leading radiological and clinical sign. Prolactinomas had a relatively large mean volume, showed lateral invasion into the cavernous sinus in some cases and sometimes contained cystic or haemorrhagic components; macroprolactinomas in men were detected late and reached a large size. Somatotropinomas were accompanied by acromegalic features, arterial hypertension and metabolic disorders and were in close contact with the medial wall of the cavernous sinus; Knosp grade 3 was regarded as a factor reducing the probability of surgical remission. Corticotropinomas were few but clinically severe, with hypercortisolism, hypertension, impaired glucose metabolism and weight gain, and were sometimes heterogeneous with parasellar extension. Tumour volume was directly related to optic chiasm compression, whereas cavernous sinus invasion did not always depend on the overall volume: some medium-sized functioning adenomas grew aggressively in a lateral direction. Knosp grades 0–2 predominated in non-functioning tumours, while grades 3–4 were relatively more frequent in prolactinomas and somatotropinomas. Stalk deviation was more common in non-functioning and large prolactin-secreting tumours and may explain moderate hyperprolactinaemia through the stalk effect. Heterogeneous structure reflected cystic degeneration, necrosis or haemorrhage, and haemorrhagic components indicated a risk of pituitary apoplexy. Suprasellar growth pointed to the need for decompression of the optic apparatus, parasellar invasion to the likelihood of residual tumour in the

cavernous sinus, and inferior extension to the sphenoid sinus influenced the choice of the transsphenoidal approach.

Conclusion and contribution

Pituitary macroadenomas with different hormonal activity differ in their MRI morphology, direction of growth and degree of invasiveness. Non-functioning macroadenomas are characterised mainly by suprasellar extension, optic chiasm compression and late clinical presentation, whereas prolactinomas and somatotropinomas more often show lateral invasion of the cavernous sinus and parasellar growth. Besides the maximal diameter, the radiological report should describe tumour volume, Knosp grade, the relation to the optic chiasm, extension into the sphenoid sinus and the relation to the internal carotid artery and the pituitary stalk. In invasive Knosp 3–4 tumours the probability of radical resection decreases and the risk of residual tumour increases, so treatment should be planned by a multidisciplinary team combining surgery, medical therapy and radiotherapy. Joint analysis of hormonal activity and MRI morphological features helps to assess tumour behaviour, predict treatment outcomes and plan postoperative follow-up.

ADABIYOTLAR RO'YXATI

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Kimmerle anomaly: history of discovery, classification, and evolution of clinical concepts

Kimmerle anomaliyasi: kashf etilish tarixi, tasnifi va klinik qarashlarning evolyutsiyasi

Аномалия Киммерле: история открытия, классификация и эволюция клинических представлений

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Abstract. Background. Kimmerle anomaly is an anatomical variant of the atlas characterized by formation of a partial or complete osseous bridge over the vertebral artery groove on the posterior arch of C1. Initially regarded predominantly as an anatomical and radiographic curiosity, the anomaly subsequently attracted clinical interest because of its close relationship with the V3 segment of the vertebral artery, the suboccipital nerve, and the surgical anatomy of the craniovertebral junction. Materials and Methods. A structured narrative review of classical and contemporary publications addressing the historical description, terminology, epidemiology, morphological classification, radiological evaluation, vascular relationships, and surgical relevance of Kimmerle anomaly was performed. Historical anatomical and radiographic studies were compared with modern CT, CT angiographic, morphometric, systematic-review, and meta-analytic evidence. Results. Concepts regarding Kimmerle anomaly evolved from recognition of an anatomical bony bridge to radiographic identification, epidemiological characterization, morphological classification, appreciation of C1 instrumentation-related risk, and, more recently, assessment of potential dynamic neurovascular conflict. Classification systems progressed from simple complete/incomplete forms to laterality-based, morphometric, and vascularly oriented phenotypes. Contemporary evidence emphasizes that morphological presence alone does not demonstrate symptom causality. Conclusion. The concept of Kimmerle anomaly has evolved from a simple atlas variant into a patient-specific craniovertebral phenotype with morphological, vascular, neurological, and surgical dimensions. Contemporary clinical interpretation requires separation of incidental anatomy from surgically significant morphology and dynamically verified symptomatic neurovascular conflict.

Keywords: Kimmerle anomaly; ponticulus posticus; arcuate foramen; atlas; vertebral artery; V3 segment; craniovertebral junction; classification; history

O'ZBEKCHA

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Annotatsiya. Dolzarblik. Kimmerle anomaliyasi atlasning posterior yoyida umurtqa arteriyasi egati ustidan o'tuvchi qisman yoki to'liq suyak ko'prigi shakllanishi bilan tavsiflanadigan kraniovertebral anatomik variantdir. Ushbu tuzilma XIX–XX asrlarda avvalo anatomik va rentgenologik topilma sifatida o'rganilgan bo'lsa, keyinchalik uning vertebral arteriyaning V3 segmenti, subokspital nerv va kraniovertebral jarrohlik anomaliyasi bilan munosabati klinik qiziqishni oshirdi. Zamonaviy tasvirlash usullari anomaliyani oddiy “bor yoki yo'q” shaklida baholashdan ko'p komponentli morfologik va funksional fenotiplashga o'tish imkonini berdi. Material va usullar. Kimmerle anomaliyasining anatomik tavsifi, terminologiyasi, epidemiologiyasi, morfologik klassifikatsiyasi, radiologik diagnostikasi, vertebral arteriya bilan o'zaro munosabati va jarrohlik ahamiyatiga bag'ishlangan klassik va zamonaviy ilmiy manbalar strukturaviy narrativ usulda tahlil qilindi. Tarixiy

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anatomik-rentgenologik ishlar zamonaviy KT, KT-angiografiya, morfometrik tadqiqotlar, sistematik sharhlar va meta-tahlillar bilan solishtirildi. Natijalar. Kimmerle anomaliyasi haqidagi ilmiy qarashlar bir necha bosqichda rivojlangan: anatomik variantni tavsiflash, rentgenologik identifikatsiya, populyatsion prevalensiyani o'rganish, complete va incomplete shakllarni tasniflash, C1 instrumental fiksatsiyasidagi jarrohlik xavfini anglash va nihoyat dinamik neyrovaskulyar konflikt konsepsiyasiga o'tish. Zamonaviy adabiyotlar morfologik mavjudlikning o'zi simptomlarning sababiyligini isbotlamasligini ko'rsatadi. Klinik ahamiyat morfologiya, vertebral arteriya anatomiyasi, simptomlarning reproduktivligi va funksional gemodinamik o'zgarishlar birgalikda mavjud bo'lganda oshadi. Xulosa. Kimmerle anomaliyasi haqidagi tushuncha oddiy atlas anatomik variantidan individual morfologik, vaskulyar va jarrohlik xususiyatlariga ega kraniovertebral fenotip konsepsiyasigacha evolyutsiya qilgan. Zamonaviy klinik yondashuvda terminologik aniqlik, morfologik klassifikatsiya va simptomatik holatlarni tasodifiy topilmalardan ajratish asosiy ahamiyatga ega.

Kalit so'zlar: Kimmerle anomaliyasi; orqa yoy; arcuate foramen; atlas; C1; vertebral arteriya; V3 segment; kraniovertebral birikma; tasnif; tarix

РУССКИЙ

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Аннотация. Актуальность. Аномалия Киммерле представляет собой анатомический вариант атланта, характеризующийся формированием частичного или полного костного мостика над бороздой позвоночной артерии на задней дуге C1. Первоначально данная особенность рассматривалась преимущественно как анатомическая и рентгенологическая находка. В дальнейшем изучение ее взаимоотношений с V3-сегментом позвоночной артерии, субокципитальным нервом и хирургической анатомией краниовертебрального перехода привело к существенному пересмотру клинического значения аномалии. Материалы и методы. Проведен структурированный нарративный анализ классических и современных публикаций, посвященных истории описания, терминологии, эпидемиологии, морфологической классификации, лучевой диагностике, сосудистым взаимоотношениям и хирургическому значению аномалии Киммерле. Исторические анатомические и рентгенологические исследования сопоставлены с современными КТ-, КТ-ангиографическими, морфометрическими исследованиями, систематическими обзорами и метаанализами. Результаты. Представления об аномалии Киммерле прошли последовательную эволюцию от описания костного мостика как анатомической вариации до современного понимания его как потенциально значимого элемента краниовертебральной нейроваскулярной анатомии. Были сформированы классификации по полноте костного моста, стороне поражения, морфологии канала и взаимоотношению с позвоночной артерией. Особое значение аномалия приобрела после широкого внедрения инструментальной фиксации C1–C2. Современный подход не допускает автоматического отождествления морфологической находки с симптоматическим синдромом. Заключение. Современная концепция аномалии Киммерле основана на разграничении случайного анатомического варианта, хирургически значимой морфологии и клинически значимого динамического нейроваскулярного конфликта.

Ключевые слова: аномалия Киммерле; ponticulus posticus; arcuate foramen; атлант; позвоночная артерия; V3-сегмент; краниовертебральный переход; классификация; история

1. KIRISH

Introduction

Kimmerle anomaliyasi atlasning yuqori yuzasidagi umurtqa arteriyasi egati ustida suyak ko'prigi shakllanishi bilan tavsiflanadigan kraniovertebral anatomik variant bo'lib, zamonaviy adabiyotlarda ko'pincha orqa yoy yoki yoysimon teshik terminlari bilan ifodalanadi [1–3]. Suyak ko'prigi atlasning yuqori bo'g'im o'simtasining orqa qismi bilan orqa yoyining yuqori-lateral qismi orasida hosil bo'lib, normal holatda ochiq bo'lgan umurtqa arteriyasi egatini qisman yoki to'liq suyak kanaliga aylantiradi. Ushbu kanalda umurtqa arteriyasining V3 segmenti, subokspital nerv va periarterial yumshoq to'qima komponentlari joylashadi [1, 10, 11].

Terminologik jihatdan ushbu anatomik variant tibbiy adabiyotlarda juda ko'p nomlar bilan tavsiflangan. Orqa yoy, atlasning orqa suyak ko'prigi, yoysimon teshik, atlasning orqa teshigi, retroartikulyar kanal, umurtqa arteriyasining retroartikulyar suyak halqasi, umurtqa arteriyasi kanali, atlas yoyining suyak ko'prigi va Kimmerle anomaliyasi bir xil yoki anatomik jihatdan bir-biriga juda yaqin holatlarni ifodalash uchun qo'llanilgan [1, 8–

10]. Zamonaviy anatomik nomenklaturada “orqa yoy” suyak ko'prigining o'zini, “yoysimon teshik” esa to'liq ko'prik hosil qilganda vujudga keladigan suyak teshigini ifodalash jihatidan aniqroq hisoblanadi [1, 10].

Anomaliyaning tarixi Kimmerle eponimidan ancha oldin boshlanadi. Zamonaviy tarixiy-anatomik sharhlarda atlas orqa yoyidagi bunday suyak ko'priklari XIX asr anatomik adabiyotlarida qayd etilgani, keyinchalik Louis Bolk tomonidan XX asr boshlarida batafsilroq morfologik tavsiflangani ko'rsatiladi [1, 27]. Biroq klinik va rentgenologik adabiyotlarda “Kimmerle anomaliyasi” atamasi 1930-yillardagi radiologik tavsiflardan keyin ommalashgan. Shu sababli Kimmerle tarixan muhim eponim bo'lsa-da, u mazkur anatomik strukturaning mutlaq birinchi kashfiyotchisi deb qaralishi terminologik jihatdan to'liq aniq emas [1, 26, 27].

XX asrning o'rtalariga kelib atlas orqa yoyidagi ushbu tuzilma sistematik rentgenologik tadqiqot obyekti bo'la boshladi. Selby, Garn va Kanareff 1955-yilda suyak ko'prigining populyatsion va oilaviy xususiyatlarini tahlil qildilar [3]. Pyo va Lowman 1959-yilda 300 ta normal rentgenogrammani o'rganib, orqa yoyning

rentgenologik morfologiyasi, uchrash chastotasi va klinik anatomiyasini batafsil bayon qildilar [2]. Ularning ishlari atlas orqa qismidagi umurtqa arteriyasi egati ustidagi suyak ko'prigini oddiy anatomik kazuistikadan ajratib, kengroq radiologik fenomen sifatida qarashga yordam berdi [2, 3].

Kendrick va Biggs bolalar va o'smirlarda bu anatomik variantni o'rganib, uning yosh populyatsiyada ham mavjudligini ko'rsatdilar [4]. Bu kuzatuv anomaliyani faqat qarilikda orqa atlanto-oksipital membrananing degenerativ ossifikatsiyasi natijasi deb tushuntiruvchi nazariyalarga qarshi muhim dalillardan biri bo'ldi. Radojević va Negovanović umurtqa arteriyasi egati hamda uning suyak halqalarini anatomik-rentgenologik tahlil qildilar [5]. Lamberty va Zivanovic esa "umurtqa arteriyasining retroartikulyar suyak halqasi" tushunchasini rivojlantirib, uning evolyutsion va anatomik xususiyatlariga e'tibor qaratdilar [6]. Saunders va Popovich atlas yoyining suyak ko'prigining oilaviy uchrashini o'rganib, rivojlanish va genetik komponent mavjud bo'lishi mumkinligini ko'rsatdilar [7]. Keyingi antropologik ishlarda Le Minor va Trost odamlarda va primatlarda umurtqa arteriyasi egati ustidagi suyak pontikullarni taqqoslab, ularni faqat patologik ossifikatsiya emas, balki evolyutsion va morfologik polimorfizm sifatida ham ko'rib chiqish kerakligini ta'kidladilar [10]. Shu tariqa anomaliya etiologiyasi bo'yicha "degenerativ ossifikatsiya" modeli asta-sekin tug'ma, rivojlanish va filogenetik komponentlarni ham o'z ichiga oluvchi ko'p faktorli konsepsiyaga aylandi.

Dugdale 1981-yilda ponticulus posteriorni radiologik nuqtai nazardan muhokama qildi [8], Stubbs esa 1992-yilda yoysimon teshik tarqalishining irq va jins bilan bog'liqligini o'rganib, populyatsiyalar o'rtasida sezilarli tafovutlar mavjudligini ko'rsatdi [9]. Bu bosqich Kimmerle anomaliyasining klinik kasallikdan ko'ra keng tarqalgan anatomik variant ekanligi haqidagi qarashlarni kuchaytirdi.

XX asr oxiri va XXI asr boshida morfologik tasniflash muhim yo'nalishga aylandi. Anomaliya dastlab to'liq va to'liq bo'lmagan shakllarga ajratilgan bo'lsa, Miki tomonidan taklif etilgan va keyingi radiologik ishlarda keng qo'llanilgan tasnif to'liq, to'liq bo'lmagan va kalsifikatsiyalangan tiplarni ajratdi [17, 20]. To'liq shaklda umurtqa arteriyasi egati ustida yopiq suyak halqasi hosil bo'ladi. To'liq bo'lmagan shaklda yuqori bo'g'im o'simtasi yoki orqa yoydan chiqqan suyak o'simtalari bir-biriga to'liq qo'shilmaydi. Kalsifikatsiyalangan shaklda esa ligamentar yo'nalish bo'ylab chiziqli yoki amorf mineralizatsiya kuzatiladi [17, 20].

Paraskevass va hammualliflarning morfologik anatomik tahlili atlasning umurtqa arteriyasi egati ustidagi ko'priklarini yanada batafsil tavsiflab, orqa va lateral variantlarning mavjudligini ko'rsatdi [11]. Tubbs va hammualliflar foramen arcuolening anatomiyasi va jarrohlik ahamiyatini tizimlashtirdilar [10]. Kim va hammualliflar esa oddiy rentgenogramma bilan uch o'lchamli KTni taqqoslab, orqa yoy morfologiyasini baholashda uch o'lchamli tasvirlashning ustunligini ko'rsatdilar [12].

Anomaliyaga klinik qiziqishning keskin ortishi C1–C2 instrumental fiksatsiya texnologiyalari rivojlanishi bilan bog'liq bo'ldi. Young va hammualliflar 2005-yilda orqa yoyning C1 lateral massaga vint o'rnatishdagi ahamiyatini ta'kidlab, suyak ko'prigi orqa yoyning qalin qismi sifatida noto'g'ri talqin qilinsa, vint umurtqa arteriyasi kanaliga yo'nalishi mumkinligini ko'rsatdilar [13]. Hong va hammualliflarning uch o'lchamli KT-angiografik ishi atlas orqa yoyi va V3 segment anatomiyasining yuqori darajada o'zgaruvchan ekanligini tasdiqladi [14]. Cho Koreya populyatsiyasida radiologik tahlil o'tkazib, to'liq va to'liq bo'lmagan shakllarning uchrash xususiyatlarini ko'rsatdi [15].

Elliott va Tanweer tomonidan bajarilgan katta meta-tahlil anomaliya haqidagi epidemiologik qarashlarni sezilarli darajada standartlashtirdi [16]. 21 mingdan ortiq subyekt ma'lumotlarini umumlashtirgan tahlilda orqa yoy umumiy prevalensiyasi 16,7%

atrofida baholandi. Bu natija Kimmerle anomaliyasini "kam uchraydigan tug'ma nuqson" sifatida emas, nisbatan keng tarqalgan anatomik variant sifatida ko'rish kerakligini mustahkamladi [16].

Konus-nurli kompyuter tomografiyasi va ko'p detektorli kompyuter tomografiyasining keng tarqalishi morfologik tasnifni yangi bosqichga olib chiqdi. Bayrakdar va hammualliflar 730 bemor konus-nurli KT ma'lumotlarida orqa yoyning to'liq/to'liq bo'lmagan va tomonlama variantlarini yuqori aniqlikda baholadilar [17]. Geist va hammualliflar bolalar va o'smirlarda PP hamda ponticulus lateralisni konus-nurli KT bilan o'rgandilar [18]. Chen va hammualliflar dental konus-nurli KT tekshiruvlarida anomaliya prevalensiyasini baholadilar [19], Sekerci va hammualliflar esa to'liq, qisman, bir tomonlama va ikki tomonlama konfiguratsiyalarning sezilarli variabelligini ko'rsatdilar [20].

Tambawala va hammualliflar orqa yoy bilan servikogen bosh og'rig'i o'rtasidagi ehtimoliy bog'liqlikni o'rgandilar [21]. Giri va hammualliflar lateral tsefalogrammalarda anomaliyani aniqlash chastotasini baholab, dental va ortodontik tasvirlarda bu topilma tasodifan ko'p uchrashini yana bir bor ko'rsatdilar [22]. Saleh va hammualliflarning 2917 bemorni qamrab olgan KT tadqiqoti PPning prevalensiyasi va demografik xususiyatlariga katta klinik tasvirlash bazasida baho berdi [23]. Klinik simptomlar bilan bog'liqlik masalasi uzoq vaqt davomida bahsli bo'lib keldi. Pqkala va hammualliflarning 2018-yilgi sistematik sharh va meta-tahlilida yoysimon teshik mavjud bemorlarda bosh og'rig'i chastotasi yuqoriroq ekan ko'rsatildi [24]. Biroq epidemiologik assotsiatsiya individual bemorda sababiy munosabatni isbotlamaydi. Shu sababli zamonaviy klinik paradigma morfologik anomaliyaning o'zini "Kimmerle sindromi" deb baholashdan voz kechib, simptom, anatomik konflikt va gemodinamik dalilni birgalikda talab qiladigan yondashuvga o'tmoqda [24, 26].

Arslan va hammualliflar orqa yoyi C1 lateral massaga vint kiritilishida umurtqa arteriyasi uchun xavf omili sifatida yana bir bor tasdiqladilar [25]. Xu va hammualliflarning 2022-yilgi katta narrativ sharhi epidemiologiya, etiologiya, klinik simptomlar, tasvirlash va jarrohlik ahamiyatini birlashtirib, PP haqidagi zamonaviy bilimlarni tizimlashtirdi [26]. Olszewski va hammualliflar 2023-yilda to'liq orqa yoyi "yupqa" va "qalin" morfometrik tiplarga ajratishga asoslangan yangi konus-nurli KT klassifikatsiyasini taklif qildilar [27]. Bu ish Kimmerle anomaliyasi klassifikatsiyasi oddiy to'liq/to'liq bo'lmagan dixotomiyadan miqdoriy morfometriyaga o'tayotganini ko'rsatadi. Gul va Atik 2024-yilda orqa yoy bilan umurtqa arteriyasi diametri munosabatini bevosita radiologik baholab, morfologik tasnifni vaskulyar fenotiplash bilan birlashtirish zarurligini ko'rsatdilar [28]. 2025-yilgi faqat KT ma'lumotlariga asoslangan meta-tahlilda Ordoñez-Cure va hammualliflar 31 mingdan ortiq bemorda orqa yoyning umumiy tarqalishini taxminan 21% deb baholadilar, to'liq bo'lmagan shakl to'liq shakldan ko'proq uchrashini qayd etdilar [29]. 2026-yilda Valenzuela-Fuenzalida va hammualliflarning sistematik sharh va meta-tahlili yoysimon teshikni kraniovertebral klinik ahamiyat kontekstida qayta baholab, morfologik variantning to'liq, to'liq bo'lmagan, bir tomonlama va ikki tomonlama fenotiplarini klinik va jarrohlik xavf bilan bog'lash zarurligini ta'kidladi [30].

Shu bilan birga, umurtqa arteriyasi anatomiyasi zamonaviy klinik tasnifning muhim komponentiga aylandi. Wakao va hammualliflarning uch o'lchamli KT-angiografik tadqiqoti C1–C2 darajasida persistirlovchi birinchi intersegmentar arteriya, fenestratsiya, anomal PICA va yuqori joylashgan umurtqa arteriyasi kabi variantlar orqa yoy bilan birga yoki undan mustaqil ravishda mavjud bo'lishi mumkinligini ko'rsatdi [31]. Elgafy va hammualliflar yoysimon teshikning shu tomondagi yuqori joylashgan umurtqa arteriyasi bilan birga kelishi instrumental fiksatsiya xavfini yanada murakkablashtirishini ko'rsatdilar [32]. Natsis va hammualliflar atlas orqa yoyi hamda umurtqa arteriyasi egati variantlarini kengroq morfometrik klassifikatsiya qilib,

anomalijani faqat suyak ko'prigiga emas, butun V3 segment anatomik koridoriga bog'liq holda baholashni taklif qildilar [33]. Zhang va hammualliflar orqa yoy mavjud bemorlarda C1 pedikulyar vintini o'rnatish imkoniyatini individual uch o'lchamli anatomik rejalashtirish asosida baholadilar [34]. Song va hammualliflar esa oksipitoservikal spondilodez uchun PPning morfometrik ahamiyatini tahlil qildilar [35]. Nihoyat, Lukianchikov va hammualliflarning klinik ishi orqa yoy va ponticulus lateralis kombinatsiyasida umurtqa arteriyasining simptomatik kompressiyasi yuzaga kelishi va mikrojarrohlik dekompresiyasi bilan tuzatilishi mumkinligini ko'rsatdi [36].

Bu kabi kuzatuvlar zamonaviy klinik qarashni yangi bosqichga olib chiqdi: Kimmerle anomalijasi endi nafaqat anatomik variant va nafaqat jarrohlik xavf omili, balki juda tanlangan bemorlarda dinamik kraniovertebral neyrovaskulyar konfliktning anatomik substrati sifatida ko'rilishi mumkin [28–36].

2. MATERIAL VA USULLAR

Materials and methods

Mazkur ish strukturaviy narrativ sharh shaklida bajarildi. Kimmerle anomalijasiga oid tarixiy anatomiya, rentgenologiya, antropologiya, epidemiologiya, klinik nevrologiya, vertebral arteriya anatomiyasi va kraniovertebral jarrohlik bo'yicha klassik hamda zamonaviy ilmiy manbalar tahlil qilindi. Tahlilga orqa yoy, yoysimon teshik, yoysimon teshik, Kimmerle anomalijasi, atlas yoyining suyak ko'prigi, umurtqa arteriyasi egati, C1 lateral massasiga vint o'rnatish, kraniovertebral birikma, umurtqa arteriyasi kompressiyasi va tegishli anatomik tasnif tushunchalarini yorituvchi nashrlar kiritildi. Tarixiy evolyutsiya shartli ravishda anatomik kuzatuv davri, rentgenologik identifikatsiya davri, epidemiologik-morfologik davr, jarrohlik xavfi konsepsiyasi va zamonaviy neyrovaskulyar fenotiplash davrlariga ajratildi. Klassifikatsiyalarni taqqoslashda uchta asosiy mezon ishlatildi: suyak ko'prigining to'liqligi, lateralizatsiyasi va morfometriyasi.

Zamonaviy klinik yondashuvni baholashda esa morfologik topilma, umurtqa arteriyasi bilan topografik munosabat, klinik simptomatiklik va jarrohlik ahamiyati alohida tahlil qilindi. Natijalar bo'limida berilgan "evolyutsion klinik fenotip" modeli mualliflik konseptual sintezi bo'lib, xalqaro validatsiyalangan klassifikatsiya sifatida talqin qilinmaydi.

3. NATIJALAR

Results

Tarixiy rivojlanishning asosiy bosqichlari. Kimmerle anomalijasi tarixini tahlil qilish mazkur anatomik variantning ilmiy talqini tasvirlash texnologiyalari va kraniovertebral jarrohlik rivoji bilan birga o'zgarganini ko'rsatadi. Dastlabki anatomik davrda asosiy savol atlas posterior yoyidagi qo'shimcha suyak strukturasining mavjudligi va uning kelib chiqishi bo'lgan. XIX asr oxiri va XX asr boshidagi anatomik kuzatuvlar suyak ko'prigi odam skeletida muntazam uchrab turishini ko'rsatdi. Rentgenografiya rivojlangandan so'ng anomalija tirik bemorlarda aniqlana boshlandi. Kimmerle eponimi aynan shu radiologik davrda klinik terminologiyada kengroq o'rin oldi. XX asr o'rtalarida rentgenografik prevalensiya, jins, yosh va tomonlama farqlar o'rganildi. Shu davrning o'zida bolalarda ham anomalija mavjudligi tug'ma yoki rivojlanish komponenti haqidagi nazariyalarni kuchaytirdi. XX asr oxirida anomalija antropologiya, evolyutsion morfologiya va klinik radiologiya nuqtai nazaridan o'rganildi. Complete va incomplete shakllar, unilateral va bilateral holatlar klassifikatsiyaning asosini tashkil qildi. XXI asr boshida anomalijaning ilmiy ahamiyati keskin o'zgardi. C1 lateral mass va posterior arch orqali vint o'rnatish texnikalarining rivojlanishi orqa yoyini potensial vertebral artery injury risk factor darajasiga olib chiqdi.

So'nggi bosqichda CT, CTA va 3D rekonstruksiya rivojlanishi bilan anomalija morfometriya, vertebral arteriya anatomiyasi va dinamik klinik sindrom bilan bog'liq holda talqin qilina boshladi.

1-jadval

Kimmerle anomalijasi haqidagi ilmiy qarashlarning tarixiy evolyutsiyasi / Table 1. Historical evolution of scientific concepts of Kimmerle anomaly

Davr	Asosiy ilmiy qarash	Yetakchi metod	Klinika uchun ahamiyati
XIX asr oxiri – 1930	Anatomik suyak varianti	Skelet/anatomik preparat	Asosan morfologik qiziqish
1930–1960	Rentgenologik variant	Oddiy rentgenografiya	Tirik bemorda identifikatsiya
1960–1990	Populyatsion va antropologik polimorfizm	Rentgen, osteologiya	Prevalensiya va etiologiya
1990–2005	Complete/incomplete morfologik fenotip	Rentgen + dastlabki CT	Standartlashtirilgan an tasnif
2005–2015	C1–C2 jarrohlik xavf omili	3D CT/CTA	Vertebral artery injury profilaktikasi
2015–2024	Morfometrik va vaskulyar fenotiplash	CBCT, MSKT-A	Individual operativ planning
2025–2026	Dinamik kraniovertebral neurovascular konsepsiya	CT/CTA + funksional tekshiruv	Incidental va klinik ahamiyatli variantni ajratish

Terminologiyaning evolyutsiyasi. Tarix davomida terminlarning ko'pligi ma'lum metodologik muammolar yaratgan. "Kimmerle anomaly" eponimik nom bo'lib, klinik adabiyotda mashhur bo'lsa-da, strukturani morfologik jihatdan to'liq ifodalamaydi. "Orqa yoy" lotinchada "kichik posterior ko'priki" ma'nosini bildiradi va suyak strukturasining o'zini tavsiflaydi. "Foramen arcuale" yoki "arcuate foramen" complete suyak ko'prigi hosil qilib, vertebral artery groove yopiq kanalga aylanganda anatomik jihatdan aniqroq termin hisoblanadi.

"Retroarticular canal" atamasi suyak kanalining superior articular mass orqasida joylashuviga urg'u beradi. Shu sababli ilmiy maqolalarda "Kimmerle anomaly (orqa yoy/arcuate foramen)" shaklidagi birlashtirilgan nomenklatura terminologik noaniqlikni kamaytiradi.

Klassik morfologik tasnif. Eng sodda va amaliy klassifikatsiya anomalijani complete va incomplete shakllarga ajratadi. Complete variantda superior articular process va posterior arch o'rtasidagi suyak ko'prigi to'liq birikib, arcuate foramen hosil qiladi. Incomplete variantda bir yoki ikkala tomondan suyak o'simtasi mavjud bo'ladi, biroq yopiq kanal shakllanmaydi. Keyinchalik radiologik tasnifga calcified variant ham qo'shilgan. Bunda posterior atlanto-occipital membrane yo'nalishida linear yoki amorf mineralizatsiya ko'riladi, ammo yetilgan suyak ko'prigi hali shakllanmagan bo'ladi.

2-jadval

Kimmerle anomaliasi tasniflarining rivojlanishi / **Table 2.** Development of the classifications of Kimmerle anomaly

Tasnif mezon	Variantlar	Asosiy afzallik	Asosiy cheklov
To'liqlik	Complete / incomplete	Oddiy va reproduktiv	Kanal morfometriyasini bermaydi
Radiologik rivojlanish	Complete / incomplete / calcified	Ossifikatsiya bosqichini hisobga oladi	CT davrida qisman subyektiv
Laterallik	Unilateral / bilateral	Jarrohlik planning uchun muhim	Funksional ahamiyatni bermaydi
Lokalizatsiya	Posterior / lateral / combined	V3 yo'nalishini yaxshiroq tavsiflaydi	Kam qo'llanadi
Morfometriya	Thin / thick complete PP	Kanal geometrik xususiyatini beradi	Klinik validatsiya cheklangan
Vaskulyar fenotip	PP + VA normal / kinking / stenoz / variant	Klinik va jarrohlik jihatdan informativ	Universal standart mavjud emas

Complete va incomplete shakllarning klinik talqini. Tarixan complete ponticulus ko'proq klinik ahamiyatga ega deb qaralgan, chunki arteriya to'liq suyak tunnel ichida qoladi. Biroq bu taxmin individual darajada doimo to'g'ri emas. Katta diametrli complete arcuate foramen ichidagi arteriya erkin harakatlanishi mumkin. Aksincha, qalin incomplete suyak spiculum bosh rotatsiyasi vaqtida V3 segment bilan fokal konflikt hosil qilishi mumkin. Shuning uchun zamonaviy yondashuvda complete/incomplete klassifikatsiya boshlang'ich morfologik tavsif bo'lib qoladi, biroq klinik riskni yakka o'zi aniqlamaydi.

Unilateral va bilateral shakllar. Laterallik klinik va jarrohlik planning uchun alohida ahamiyatga ega. Unilateral complete PP mavjudligida aynan shu tomondagi vertebral artery dominant bo'lsa, anatomik topilmaning klinik og'irligi potensial ravishda

3-jadval

Kimmerle anomaliasining taklif etilayotgan zamonaviy klinik fenotiplari / **Table 3.** Proposed contemporary clinical phenotypes of Kimmerle anomaly

Fenotip	Anatomik topilma	Klinik holat	Vaskulyar dalil	Talqin
KA-A	PP mavjud	Simptomsiz	Yo'q	Incidental anatomik variant
KA-S	PP mavjud	Nospetsifik simptom	Yo'q	Sababiylik isbotlanmagan
KA-V	PP + V3 yaqin konflikt	Mos vertebro bazilyar simptom	Statik vaskulyar o'zgarish	Potensial klinik ahamiyat
KA-D	PP + V3 konflikt	Pozitsion reproduktiv simptom	Dinamik flow reduction	Klinik ahamiyatli dinamik fenotip
KA-O	PP mavjud	Simptom bo'lishi shart emas	—	C1–C2 operatsiyasi uchun anatomik risk

Ushbu model validatsiyalangan xalqaro klassifikatsiya emas, balki morfologik va klinik tushunchalarni birlashtirishga qaratilgan konseptual taklifdir.

4. MUHOKAMA

Discussion

Kimmerle anomaliasining ilmiy tarixini tahlil qilish bir anatomik strukturaning tibbiyotdagi ahamiyati diagnostik va jarrohlik texnologiyalariga qarab qanday o'zgarishini yaqqol ko'rsatadi. Ahn va hammualliflarning nomenklatura va embriologiyaga bag'ishlangan sharhi [1] hamda zamonaviy tarixiy-morfologik tadqiqotlar [26, 27] bu struktura Kimmerle eponimidan avval ham anatomik adabiyotlarda ma'lum bo'lganini ko'rsatadi. Shu sababli "Kimmerle anomaliasi" tarixiy jihatdan qulay, lekin "orqa yoy" anatomik jihatdan ko'proq neytral termin hisoblanadi. Pyo va Lowmanning 1959-yildagi klassik rentgenologik tadqiqoti [2] ushbu strukturaning tibbiy tasvirlashdagi o'rnini mustahkamladi. Selby va hammualliflar [3] oilaviy va populyatsion belgilarni, Kendrick va Biggs [4] bolalar va o'smirlardagi

oshadi. Bilateral PP ikki tomonlama suyak tunnel mavjudligini bildiradi, biroq ikkala vertebral arteriya uchun gemodinamik ta'sir teng bo'lishi shart emas. Shuning uchun zamonaviy CTA baholashida PP lateralligi bilan vertebral artery dominantligi birgalikda ko'rsatilishi maqsadga muvofiq.

Posterior va lateral ponticuluslar. Orqa yoy vertebral arteriyaning atlas posterior yoyi ustidagi qismiga tegishli bo'lsa, ponticulus lateralis lateral mass/transverse process yaqinida qo'shimcha suyak kanal hosil qilishi mumkin. Ularning kombinatsiyasi V3 segmentni ikki anatomik nuqtada cheklashi mumkin. Bunday "double osseous constraint" modeli juda kam uchraydi, biroq dinamik arterial kinking uchun biologik jihatdan kuchli substrat bo'lishi mumkin.

Zamonaviy morfometrik tasnif. CBCT va MSKT tasvirlari anomaliani miqdoriy baholashga imkon berdi. Complete arcuate foramen uchun kraniokaudal balandlik, anteroposterior kenglik, ko'ndalang diametr, maydon, suyak ko'prigining qalinligi va posterior arch bilan birikish burchagi o'lchanishi mumkin. Olszewski tomonidan taklif etilgan "thin" va "thick" complete PP modellari aynan shu morfometrik yondashuvni aks ettiradi. Biroq morfometriyaning klinik ahamiyati hali to'liq validatsiyalanmagan. Kanal kichik bo'lishi avtomatik stenozni anglatmaydi, chunki vertebral artery diametri ham individualdir. Shu sababli eng mantiqiy kelajak yo'nalishi suyak kanal maydonini arterial tashqi diametr bilan nisbatda baholashdir.

Klinik qarashlarning evolyutsiyasi. Kimmerle anomaliasiga klinik munosabatni shartli ravishda to'rtta paradigmaga ajratish mumkin. Birinchi paradigma anomaliani simptomlarsiz anatomik variant deb ko'radi. Ikkinchi paradigma uni vertebro bazilyar yetishmovchilik, cervicogenic headache va vestibulyar simptomlarning potensial sababi sifatida baholadi. Uchinchi paradigma C1–C2 instrumentation davrida uni vertebral artery injury uchun muhim anatomik risk sifatida tan oldi. To'rtinchi, zamonaviy paradigma esa incidental morfologik variant bilan haqiqiy klinik neyrovaskulyar konfliktlarni ajratishga intiladi.

uchrashni, Radojević va Negovanović [5] esa umurtqa arteriyasi egati anatomiyasini o'rganish orqali uning faqat qarilkdagi ossifikatsiya bo'lishi haqidagi soddalashtirilgan qarashni zaiflashtirdilar.

Lamberty va Zivanovicning umurtqa arteriyasining retroartikulyar suyak halqasi haqidagi anatomik ishi [6] va Saunders hamda Popovichning oilaviy tadqiqoti [7] rivojlanish, irsiy va filogenetik komponentlarga e'tibor qaratdi. Dugdale [8] anomaliani radiologik adabiyotda davom ettirdi, Stubbs [9] esa irq va jins bo'yicha tarqalish variabelligini ko'rsatdi. Ushbu tarixiy ishlar [2–9] zamonaviy meta-tahlillarda ko'riladigan yuqori heterogenlikning ildizlari yangi emasligini ko'rsatadi. Tubbs va hammualliflarning anatomik sharhi [10] hamda Paraskevas va hammualliflarning makromorfologik tadqiqoti [11] orqa yoyini butun umurtqa arteriyasi egati anatomiyasi doirasida baholash zarurligini ko'rsatdi. Kim va hammualliflarning rentgenografiya va uch o'lchamli KTni birlashtirgan tadqiqoti [12] esa tasvirlash metodining o'zi prevalensiya va morfologik klassifikatsiyaga ta'sir qilishini tasdiqladi. Young va hammualliflarning 2005-yildagi ishi

Kimmerle anomaliyasi tarixidagi klinik burilish nuqtalaridan biri hisoblanadi [13]. Anomaliya endi faqat rentgenologik topilma emas, C1 lateral massasiga vint o'rnatish paytida umurtqa arteriyasiga real zarar yetkazishi mumkin bo'lgan jarrohlik anatomiya elementi sifatida ko'rila boshlandi. Keyinchalik Hong va hammualliflarning uch o'lchamli KT-angiografik tahlili [14] bu qarashni yanada kengaytirib, orqa yoy va V3 segmentning birgalikdagi uch o'lchamli anatomiyasini operatsiyadan oldin baholash zarurligini ko'rsatdi. Cho tomonidan berilgan radiologik ma'lumotlar [15] va Elliott–Tanweer meta-tahlili [16] Kimmerle anomaliyasining “kam uchraydigan nuqson” emasligini aniq ko'rsatdi.

Elliott va Tanweerning 16,7% umumiy tarqalish darajasi natijasi anomaliyaning klinik talqiniga fundamental ta'sir ko'rsatadi: populyatsiyaning taxminan har oltinchi kishisida morfologik variant mavjud bo'lishi mumkin bo'lsa, nospetsifik bosh og'rig'i yoki bosh aylanishining mavjudligi avtomatik sababiy bog'lanish sifatida talqin qilinishi mumkin emas [16]. Bu epidemiologik nuqta klinik ortiqcha tashxislash xavfini ko'rsatadi. Masalan, keng tarqalgan bosh og'rig'i bilan keng tarqalgan anatomik variant o'rtaida statistik assotsiatsiya mavjud bo'lishi mumkin, ammo individual bemorda patofiziologik sababiylik uchun qo'shimcha dalil talab qilinadi.

Konus-nurli kompyuter tomografiyasi davri ushbu masalani yanada aniqlashtirdi. Bayrakdar [17], Geist [18], Chen [19] va Sekerci [20] tomonidan bajarilgan tadqiqotlar rentgenografiyada ko'rilmagan qisman yoki tomonlama variantlarni uch o'lchamli tasvirlashda aniqroq identifikatsiya qilish mumkinligini ko'rsatdi. Shu sababli tarqalish darajasi faqat biologik populyatsion farq emas, diagnostik metodga bog'liq o'zgaruvchi ham hisoblanadi [17–20]. Tambawala va hammualliflar [21] servikogen bosh og'rig'i bilan assotsiatsiyani o'rgandilar, Giri va hammualliflar [22] lateral tsefalogrammalar orqali yuqori aniqlanish chastotasini ko'rsatdilar, Saleh va hammualliflar esa 2917 KT tekshiruviga asoslangan katta kohortda anomaliyaning zamonaviy epidemiologik ko'lamini aniqladilar [23]. Ushbu ishlarni birgalikda talqin qilish shuni ko'rsatadiki, Kimmerle anomaliyasi juda ko'p hollarda boshqa maqsadda olingan radiologik tasvirda tasodifan aniqlanadi.

Pekala va hammualliflarning bosh og'rig'i va migren bo'yicha meta-tahlili [24] klinik simptomlar masalasiga muhim dalil qo'shdi. Foramen arcuale mavjud guruhda bosh og'rig'i ko'proq uchragan. Biroq meta-tahlildagi assotsiatsiyaning o'zi mexanistik geterogenlikni hal qilmaydi. Bosh og'rig'i umurtqa arteriyasi kompressiyasi, C1 nervining ta'sirlanishi, periarterial simpatik chigalning ta'sirlanishi, servikal mushak-skelet disfunktsiyasi yoki boshqa birlamchi bosh og'rig'i buzilishi bilan bog'liq bo'lishi mumkin [24]. Shu sababli zamonaviy klinik qarash “to'liq PP simptomatik, to'liq bo'lmagan PP simptomatik emas” kabi soddalashtirilgan klassifikatsiyadan voz kechishi kerak. Arslan va hammualliflarning jarrohlik xavf bo'yicha tahlili [25] PPning klinik ahamiyati simptomatik bo'lmagan bemorda ham mavjud bo'lishini ko'rsatadi. Bemor hech qanday vertigo yoki bosh og'rig'iga ega bo'lmashligi mumkin, biroq C1–C2 instrumental fiksatsiya vaqtida PP uning umurtqa arteriyasi anatomiyasini o'zgartirganligi uchun juda muhim topilmaga aylanadi.

Xu va hammualliflarning 113 manbani qamrab olgan zamonaviy sharhi [26] aynan shu ko'p qirrali xususiyatni tasdiqlaydi. PP bir vaqtning o'zida anatomik variant, potensial klinik simptom substrati va jarrohlik xavfi ko'rsatkichi bo'lishi mumkin. Bu uch rolni bir-biridan ajratmaslik ilmiy va klinik noaniqlikka olib keladi. Olszewski va hammualliflarning yangi morfometrik klassifikatsiyasi [27] ham tasniflarning evolyutsiyasi haqida muhim xulosa beradi. Klassik to'liq/to'liq bo'lmagan tasnif klinik amaliyot uchun hali ham qulay, ammo zamonaviy yuqori fazoviy aniqlikdagi tasvirlash suyak ko'prigining qalinligini, kanal o'lchamini va shaklini qayd etish imkonini beradi. “Yupqa” va “qalin” to'liq PP

tiplari kelajakda vaskulyar xavf bilan bog'lanishi mumkin, biroq hozircha bunday sababiy korrelyatsiya yetarli klinik validatsiyaga ega emas [27]. Gul va Atikning umurtqa arteriyasi diametri bilan bog'liq zamonaviy tadqiqoti [28] muhim konseptual yo'nalishni belgilaydi: suyak kanalining o'lchami arteriya o'lchamidan alohida qaralmasligi kerak. Masalan, 5 mm yoysimon teshik 2,5 mm diametrlilik dominant bo'lmagan arteriya uchun keng bo'lishi mumkin, ammo 4,5 mm dominant V3 segment uchun nisbatan cheklovchi bo'lishi mumkin. Shuning uchun kelajakda “suyak kanali–arteriya nisbati” kabi individual indekslar klassik morfologik tasnifdan ko'ra ko'proq klinik axborot berishi mumkin.

Ordoñez-Cure va hammualliflarning 2025-yilgi faqat KT ma'lumotlariga asoslangan meta-tahlili [29] orqa yoyning umumiy tarqalish darajasini 21% atrofida qayd etib, to'liq bo'lmagan PPning ko'proq uchrashini ko'rsatdi. Bu natija tarixiy rentgenografik tadqiqotlardan yuqoriroq bo'lishi mumkin, chunki KT qisman suyak ko'priklarini yaxshiroq aniqlaydi. Demak, anomaliya tarqalish darajasining “o'sishi” biologik hodisa emas, kamida qisman diagnostik aniqlikning oshishi natijasidir [16, 17, 29]. Valenzuela-Fuenzalida va hammualliflarning 2026-yilgi sistematik meta-tahlili [30] bu masalani kranioservikal klinik ahamiyat bilan bog'ladi. Zamonaviy epidemiologik tadqiqotlarning eng katta xulosasi shuki, morfologik mavjudlik keng tarqalgan, ammo klinik ahamiyatli fenotip bundan ancha kam bo'lishi kerak. Shuning uchun prevalensiya va “Kimmerle sindromining tarqalish darajasi” bir xil tushuncha emas [29, 30].

Umurtqa arteriyasi variantlarini hisobga olmasdan Kimmerle anomaliyasini zamonaviy tasniflash to'liq bo'lmaydi. Wakao va hammualliflar [31] C1–C2 darajasidagi persistirlovchi birinchi intersegmentar arteriya, fenestratsiya, yuqori joylashgan umurtqa arteriyasi va anomal PICA kabi variantlarni uch o'lchamli KT-angiografiya yordamida ko'rsatdilar. Bu anomaliyalar orqa yoyning o'zi bilan bog'liq bo'lmashligi mumkin, ammo birgalikda operativ xavfni keskin o'zgartiradi. Elgafy va hammualliflarning shu tomondagi yoysimon teshik va yuqori joylashgan umurtqa arteriyasi kombinatsiyasi haqidagi ishi [32] aynan shu kompleks xavf modelini ko'rsatadi. Klinik anatomiyaning zamonaviy konsepsiyasida “PP bor” degan xulosa yetarli emas; “PP qaysi tomonda, qaysi arteriya uning ichidan o'tadi, arteriya dominantmi, yuqori joylashgan konfiguratsiya bormi va C2 pedikulasi xavfsizmi?” degan savollar birgalikda hal qilinishi kerak. Natsis va hammualliflarning keng morfometrik klassifikatsiyasi [33] atlasning orqa yoyi va umurtqa arteriyasi egatini bir butun anatomik koridor sifatida ko'rishga imkon beradi. Ushbu yondashuv kelajakdagi klassifikatsiya faqat ponticulus shakliga emas, balki “C1 orqa neyrovaskulyar koridor fenotipi”ga asoslanishi mumkinligini ko'rsatadi.

Zhang va hammualliflar [34] va Song va hammualliflar [35] PP mavjud holatlarda C1 vinti trayektoriyasi hamda oksipitoservikal spondilodez anatomiyasini morfometrik baholab, individual rejalashtirish konsepsiyasini mustahkamladilar. Ushbu jarrohlik ishlar shuni ko'rsatadiki, Kimmerle anomaliyasi simptomatik bo'lishi shart emas, biroq operatsion anatomiyada klinik jihatdan yuqori ahamiyatga ega bo'lishi mumkin. Lukianchikov va hammualliflarning simptomatik umurtqa arteriyasi kompressiyasi holati [36] esa evolyutsiyaning boshqa tomonini aks ettiradi. Tanlangan bemorda orqa yoy va ponticulus lateralisning kombinatsiyasi V3 segmentning bosh holatiga bog'liq bukilishini yuzaga keltirgan va jarrohlik dekompressiyasi klinik yaxshilanish bilan bog'langan. Bunday ishlar morfologik variantning ayrim hollarda haqiqiy dinamik neyrovaskulyar sindrom substrati bo'lishi mumkinligini ko'rsatadi [36].

Ammo individual klinik holat bayonlarini keng populyatsiyaga ekstrapolyatsiya qilish noto'g'ri bo'ladi. Kimmerle anomaliyasi mavjud minglab simptomatsiz bemorlar borligi sababli simptomatik kasallikni aniqlashda yuqori diagnostik chegara talab qilinadi.

Zamonaviy klinik qarashda uch xil tushunchani ajratish maqsadga muvofiq.

Birinchisi — Kimmerle anatomik varianti, ya'ni tasodifiy topilgan orqa yoy.

Ikkinchisi — Kimmerlarning jarrohlik xavfi anatomiyasi, ya'ni simptom bo'lmasa ham C1–C2 instrumental jarrohlik uchun muhim bo'lgan suyak-tomir konfiguratsiyasi.

Uchinchisi — Kimmerle bilan bog'liq klinik ahamiyatli neyrovaskulyar konflikt, ya'ni morfologik tuzilma, mos simptom va vaskulyar-funksional dalil bir-biriga mos keladigan holat.

Bu semantik ajratish kelajakdagi ilmiy tadqiqotlarda ham muhimdir. “Kimmerle anomaliyasi bo'lgan bemorlar” nomi ostida faqat radiologik topilmaga ega bemorlarni haqiqiy gemodinamik sindromli bemorlar bilan bir guruhga qo'shish natijalarning katta heterogenligiga olib keladi.

4-jadval

Kelajakdagi Kimmerle anomaliyasi klassifikatsiyasiga kiritilishi maqsadga muvofiq bo'lgan komponentlar / **Table 4.** Components advisable for inclusion in a future classification of Kimmerle anomaly

Domen	Baholanadigan parametrlar
Morfologiya	To'liq, to'liq bo'lmagan, kalsifikatsiyalangan
Laterallik	O'ng, chap, ikki tomonlama
Lokalizatsiya	Orqa, lateral, kombinatsiyalangan
Morfometriya	Kanal balandligi, kengligi, maydoni, suyak ko'prigi qalinligi
Vaskulyar anatomiya	VA diametri, dominantlik, gipoplaziya, bukilish
Qo'shimcha variant	FIA, fenestratsiya, anomal PICA, yuqori joylashgan umurtqa arteriyasi
Klinik fenotip	Simptomsiz, bosh og'rig'i, vestibulyar, orqa qon aylanish havzasiga oid
Dinamik komponent	Bosh rotatsiyasida oqimning kamayishi mavjud/yo'q
Jarrohlik komponent	C1–C2 vint trayektoriyasi bilan konflikt mavjud/yo'q

Bunday ko'p domenli model klassik tasniflarni bekor qilmaydi. Aksincha, to'liq/to'liq bo'lmagan tasnif uning birinchi va eng sodda qatlami bo'lib qoladi. Maqolaning asosiy nazariy natijasi Kimmerle anomaliyasi konsepsiyasining uch bosqichli transformatsiyasidir:

morfologik variant → jarrohlik anatomik xavf → tanlangan dinamik neyrovaskulyar fenotip.

Aynan shu evolyutsiya anomaliyaga nisbatan qarama-qarshi qarashlarning nega mavjudligini tushuntiradi. Rentgenolog uchun u ko'pincha tasodifiy anatomik topilma. Umurtqa pog'onasi neyroxirurgi uchun u C1 fiksatsiyasi vaqtida potensial arterial xavf. Vaskulyar nevrolog uchun esa juda kam sonli tanlangan bemorlarda holatga bog'liq orqa qon aylanish havzasi sindromi substrati bo'lishi mumkin. Shuning uchun zamonaviy ilmiy terminologiyada “Kimmerle anomaliyasi klinik ahamiyatga ega” degan umumiy jumladan ko'ra, qaysi klinik kontekst nazarda tutilayotganini aniq ko'rsatish maqsadga muvofiq.

5. XULOSA

Conclusion

Kimmerle anomaliyasi haqidagi ilmiy qarashlar bir asrdan ortiq vaqt davomida sezilarli evolyutsiyani boshdan kechirdi. Dastlab atlas orqa yoyining anatomik varianti sifatida tasvirlangan suyak ko'prigi rentgenografiya rivojlanishi bilan klinik tasvirlash obyektiga aylandi, keyinchalik esa populyatsion, antropologik va evolyutsion nuqtai nazardan o'rganildi. Klassik to'liq va to'liq bo'lmagan tasniflari hozirgacha asosiy morfologik klassifikatsiya sifatida saqlanib qolgan bo'lsa-da, zamonaviy KT va konus-nurli KT morfometriyasi anomaliyaning kanal diametri, suyak ko'prigi qalinligi va fazoviy konfiguratsiyasini batafsil baholash imkonini yaratdi.

C1–C2 instrumental fiksatsiya texnologiyalarining rivojlanishi Kimmerle anomaliyasini spinal neyroxirurgiyada muhim umurtqa arteriyasi shikastlanishi xavfi omiliga aylantirdi. Zamonaviy KT-angiografiya va funksional gemodinamik diagnostika esa anomaliyaning klinik talqinini yanada chuqurlashtirib, morfologik topilmaning o'zi simptomlarning sababiyatini isbotlamasligini ko'rsatdi. Shuning uchun hozirgi bosqichda Kimmerle anomaliyasini uch xil klinik kontekstda baholash maqsadga muvofiq: tasodifiy anatomik variant, C1–C2 jarrohligi uchun muhim suyak-tomir anatomiyasi va juda tanlangan bemorlarda dinamik neyrovaskulyar konfliktning anatomik substrati. Kelajakdagi klassifikatsiyalar suyak ko'prigining to'liq yoki to'liq bo'lmagan ekanligi bilan cheklanmay, uning morfometriyasi, lateralligi, umurtqa arteriyasi dominantligi, qo'shimcha vaskulyar variantlar, simptomatik fenotip va dinamik gemodinamik ahamiyatini birlashtirishi kerak.

DECLARATIONS

Declarations

Author contributions *CRedit*

Conceptualization; Methodology; Investigation; Data curation; Writing – original draft; Writing – review & editing. All authors have read and agreed to the published version of the manuscript.

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Data availability statement

All data discussed in this review are taken from the publications listed in the reference list and are available from those sources.

Conflict of interest

The authors declare no conflict of interest.

Generative AI disclosure

Generative AI (Claude, Anthropic) was used in the editorial preparation of this article: for language editing, translation of the title, abstract and keywords between Uzbek, Russian and English, preparation of the extended English summary from the authors' text, and formatting of the reference list. No data, results or conclusions were generated by AI. The authors are responsible for the content of the publication.

EXTENDED SUMMARY IN ENGLISH

Kengaytirilgan inglizcha xulosa / Расширенный реферат на английском языке

Purpose and research problem

Kimmerle anomaly is an anatomical variant of the atlas in which a partial or complete bony bridge forms over the groove of the vertebral artery on the posterior arch of C1, converting the open groove into a partial or complete bony canal that contains the V3 segment of the vertebral artery, the suboccipital nerve and periarterial soft tissue. In the nineteenth and twentieth centuries the structure was studied mainly as an anatomical and radiographic finding, but its relationship with the V3 segment, the suboccipital nerve and the surgical anatomy of the craniovertebral junction later turned it into a clinically relevant entity. The literature describes the same variant under many names — ponticulus posticus, posterior bony bridge of the atlas, arcuate foramen, retroarticular canal, retroarticular vertebral artery ring and Kimmerle anomaly — which complicates comparison of studies. The aim of this review was to trace the history of the discovery of Kimmerle anomaly, the development of its classifications and the evolution of clinical concepts about its significance.

Materials and methods

The work was performed as a structured narrative review. Classical and contemporary publications on the historical anatomy, radiology, anthropology, epidemiology, clinical neurology, vertebral artery anatomy and craniovertebral surgery related to Kimmerle anomaly were analysed. The search covered the terms ponticulus posticus, arcuate foramen, Kimmerle anomaly, bony bridge of the atlas arch, vertebral artery groove, C1 lateral mass screw placement, craniovertebral junction, vertebral artery compression and related anatomical classifications. Historical anatomical and radiographic studies were compared with modern computed tomography, CT angiography, cone-beam CT, morphometric studies, systematic reviews and meta-analyses. The historical evolution was conditionally divided into the period of anatomical observation, the period of radiographic identification, the epidemiological and morphological period, the period of the surgical-risk concept and the current period of neurovascular phenotyping. Classifications were compared using three main criteria: completeness of the bony bridge, laterality and morphometry. When modern clinical approaches were evaluated, the morphological finding, its relationship with the vertebral artery, the reproducibility of symptoms and evidence of functional haemodynamic change were considered together.

Results and discussion

Scientific views of Kimmerle anomaly passed through several stages: description of the anatomical variant, radiographic identification, study of population prevalence, classification of complete and incomplete forms, recognition of the surgical risk associated with C1 instrumentation and, most recently, the concept of dynamic neurovascular conflict. With the development of CT, CT angiography and three-dimensional reconstruction, the anomaly became an object of morphometry and preoperative planning. Terminology evolved as well: the term ponticulus posticus is now considered more accurate for the bony bridge itself, whereas arcuate foramen designates the bony opening formed when the bridge is complete. The simplest and most practical classification divides the anomaly into complete and incomplete forms; later systems added unilateral and bilateral forms, posterior and lateral ponticuli, and quantitative morphometric parameters obtained with cone-beam CT and multislice CT, such as canal diameter, bridge thickness and spatial configuration. Large meta-analytic data cited in the review give an overall prevalence of 16.7%, which shows that the anomaly is common and that its presence alone cannot explain symptoms. The authors summarise the clinical evolution in a proposed set of phenotypes ranging from an asymptomatic incidental anatomical variant to a morphologically and haemodynamically confirmed symptomatic neurovascular conflict, and they stress that this model is a conceptual proposal rather than a validated international classification. The discussion shows that the development of C1–C2 instrumented fixation made the anomaly an important risk factor for vertebral artery injury during C1 lateral mass screw placement, and that individual case reports of symptomatic compression should not be extrapolated to the whole population. The authors therefore distinguish three concepts: the Kimmerle anatomical variant, the surgical-risk anatomy relevant to C1–C2 instrumentation even in the absence of symptoms, and a clinically significant Kimmerle-

related neurovascular conflict confirmed by morphology, symptoms and functional findings. A multi-domain model covering morphology, laterality, morphometry, vertebral artery anatomy and dominance, accompanying vascular variants, clinical phenotype and dynamic haemodynamic significance is proposed for future classifications.

Conclusion and contribution

Scientific concepts of Kimmerle anomaly have changed considerably over more than a century. The bony bridge, first described as an anatomical variant of the posterior arch of the atlas, became an object of clinical imaging with the development of radiography and was later studied from population, anthropological and evolutionary points of view. The classical division into complete and incomplete forms remains the basic morphological classification, while modern CT and cone-beam CT morphometry allow detailed assessment of canal diameter, bridge thickness and spatial configuration. The development of C1–C2 instrumented fixation turned the anomaly into an important risk factor for vertebral artery injury in spinal neurosurgery, and modern CT angiography and functional haemodynamic diagnostics showed that the morphological finding alone does not prove symptom causality. Kimmerle anomaly should therefore be evaluated in three clinical contexts: as an incidental anatomical variant, as bone-and-vessel anatomy important for C1–C2 surgery, and, in carefully selected patients, as the anatomical substrate of a dynamic neurovascular conflict. Future classifications should integrate morphometry, laterality, vertebral artery dominance, accompanying vascular variants, the symptomatic phenotype and dynamic haemodynamic significance.

ADABIYOTLAR RO'YXATI

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CASE REPORT • PEER-REVIEWED • OPEN ACCESS • **SERIES A** • 14.00.00 — MEDICAL SCIENCES • UDC: 616.858-089:615.84

Bilateral deep brain stimulation of the posterior ventrolateral thalamic region in stage IV tremor-rigid Parkinson disease: a case report with multimodal assessment

Parkinson kasalligining IV bosqich tremor-rigid shaklida talamusning orqa ventrolateral sohasiga ikki tomonlama miya chuqur stimulyatsiyasi: multimodal baholash bilan klinik holat

Двусторонняя глубокая стимуляция заднеventrolатеральной области таламуса при тремор-ригидной форме болезни Паркинсона IV стадии: клинический случай с мультимодальной оценкой

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Abstract. Background. Deep brain stimulation (DBS) is an established functional stereotactic neurosurgical treatment for selected patients with Parkinson disease (PD) who have disabling tremor, rigidity, bradykinesia, motor fluctuations, or insufficient symptom control despite pharmacotherapy. We report a male patient born in 1969 with symptom onset in 2016 and a tremor-rigid PD phenotype classified as Hoehn–Yahr stage IV. Case Report. At admission, the predominant manifestations included persistent upper-limb tremor, hypokinesia, muscular rigidity, hypomimia, freezing of gait, propulsion, retropulsion, lateropulsion, postural instability with falls, lower-limb weakness, and autonomic dysfunction. Despite ongoing antiparkinsonian therapy, the symptoms progressed. On August 28, 2025, bilateral frame-based DBS was performed using a Zamorano–Duchovny stereotactic system (Inomed, Germany), stereotactic multislice CT, Medtronic DICOM-based navigation, and intraoperative C-arm verification. According to the operative record, the electrodes were implanted into the posterior ventrolateral thalamic region. The implantable pulse generator was positioned in the right upper chest. Conclusion. This case illustrates the value of individualized stereotactic planning in advanced tremor-rigid PD and the importance of separately quantifying tremor suppression, rigidity, bradykinesia, gait, balance, and functional independence. Missing standardized scale and programming values in this working manuscript are explicitly marked as simulated and must be replaced with actual patient measurements before scientific submission.

Keywords: Parkinson disease; deep brain stimulation; DBS; thalamus; tremor; rigidity; stereotactic neurosurgery; neuromodulation; MDS-UPDRS; neurorehabilitation

O‘ZBEKCHA

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Annotatsiya. Kirish. Miyaning chuqur stimulyatsiyasi (DBS) Parkinson kasalligida dori vositalari bilan yetarli nazorat qilinmaydigan tremor, rigidlik, bradikineziya va rivojlangan motor buzilishlarda qo‘llaniladigan funksional stereotaktik neyroxirurgik usuldir. Ushbu maqolada 1969-yilda tug‘ilgan, kasallik belgilari 2016-yilda boshlangan va Hoehn–Yahr bo‘yicha IV bosqich tremor-rigid shakldagi

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Parkinson kasalligi bo'lgan erkak bemor holati keltiriladi. Klinik holat. Gospitalizatsiya vaqtida qo'llarning doimiy titrashi, gipokineziya, mushak rigidligi, gipomimiya, freezing of gait, propulsiya, retropulsiya, lateropulsiya, yiqilishlar bilan kechuvchi postural beqarorlik, oyoqlardagi kuchsizlik va vegetativ buzilishlar ustun bo'lgan. Konservativ davoga qaramay simptomlar kuchaygan. 2025-yil 28-avgustda Zamorano–Duchovny stereotaktik tizimi (Inomed, Germany), stereotaktik MSKT, Medtronic DICOM-navigatsiyasi va C-arm nazorati ostida ikki tomonlama DBS implantatsiyasi bajarilgan. Operatsion protokolga ko'ra elektrodlar talamusning orqa ventrolateral yadrolari proyeksiyasiga o'rnatilgan. Impuls generatori o'ng ko'krakning yuqori qismiga joylashtirilgan. Xulosa. Mazkur holat rivojlangan tremor-rigid Parkinson kasalligida individual stereotaktik rejalashtirishning ahamiyatini va tremor, rigidlik, bradikineziya, yurish, muvozanat hamda funksional mustaqillikni alohida baholash zarurligini ko'rsatadi. Ishchi qo'lyozmada hujjatlarda mavjud bo'lmagan standart shkala va dasturlash ko'rsatkichlari modellashtirilgan bo'lib, ilmiy nashrdan oldin haqiqiy ma'lumotlar bilan almashtirilishi kerak.

Kalit so'zlar: Parkinson kasalligi; DBS; miyaning chuqur stimulyatsiyasi; talamus; tremor; rigidlik; stereotaksiya; neyromodulyatsiya; MDS-UPDRS; neyroeabilitatsiya

РУССКИЙ

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Аннотация. Введение. Глубокая стимуляция мозга (DBS) является методом функциональной стереотаксической нейрохирургии, применяемым у тщательно отобранных пациентов с болезнью Паркинсона при инвалидизирующем треморе, выраженной ригидности, брадикинезии, моторных флуктуациях и недостаточном контроле симптомов на фоне фармакотерапии. Представлен клинический случай мужчины 1969 года рождения с дебютом заболевания в 2016 году и тремор-ригидным фенотипом болезни Паркинсона IV стадии по Hoehn–Yahr. Клинический случай. К моменту госпитализации доминировали постоянный тремор рук, гипокинезия, мышечная ригидность, гипомимия, freezing of gait, пропульсия, ретропульсия и латеропульсия, постуральная неустойчивость с эпизодами падений, слабость в нижних конечностях и вегетативные нарушения. Несмотря на постоянный прием противопаркинсонических препаратов, симптоматика прогрессировала. 28 августа 2025 года выполнена двусторонняя рамочная DBS с использованием стереотаксической системы Zamorano–Duchovny (Inomed, Germany), стереотаксической МСКТ, DICOM-навигации Medtronic и интраоперационного C-arm контроля. Согласно операционному протоколу, электроды имплантированы в проекцию задне-вентролатеральных ядер таламуса. Генератор импульсов размещен в правой верхней грудной области. Заключение. Клиническое наблюдение демонстрирует практическое значение индивидуализированного стереотаксического планирования при выраженном тремор-ригидном фенотипе болезни Паркинсона и необходимость отдельной оценки эффекта на тремор, ригидность, брадикинезию, походку, равновесие и функциональную самостоятельность. Для рабочей версии рукописи отсутствующие стандартизированные шкальные и программирующие параметры представлены как моделированные значения и должны быть заменены фактическими данными перед научной публикацией.

Ключевые слова: болезнь Паркинсона; глубокая стимуляция мозга; DBS; таламус; тремор; ригидность; стереотаксия; нейромодуляция; MDS-UPDRS; нейрореабилитация

1. ВВЕДЕНИЕ

Introduction

Болезнь Паркинсона (БП) представляет собой хроническое прогрессирующее нейродегенеративное заболевание, ключевыми патоморфологическими особенностями которого являются дегенерация дофаминергических нейронов substantia nigra pars compacta и последующее нарушение функциональной организации базально-ганглионарно-таламо-кортикальных сетей [1,2]. Наряду с брадикинезией, тремором покоя и мышечной ригидностью, по мере прогрессирования заболевания возрастают выраженность постуральной неустойчивости, нарушений ходьбы, freezing of gait, вегетативной дисфункции и нейropsychологических проявлений [1–3].

Фармакотерапия, прежде всего леводопа-содержащие режимы, остается основой симптоматического лечения БП. Однако у части пациентов с длительно текущим заболеванием формируется недостаточный контроль тремора, моторные флуктуации, лекарственные дискинезии или неприемлемая функциональная зависимость. В таких ситуациях у тщательно

отобранных пациентов рассматривается хирургическая нейромодуляция [4–7].

Deep brain stimulation (DBS) представляет собой регулируемую и частично обратимую нейромодуляционную технологию, основанную на хронической электрической стимуляции глубоких мозговых структур. Наиболее широко при БП используются субталамическое ядро (STN) и внутренний сегмент бледного шара (GPi). Вентральные моторные отделы таламуса, включая ventral intermediate и прилежащую ventrolateral thalamic region, исторически применялись преимущественно для контроля выраженного тремора [8–10].

Выбор мишени должен определяться клиническим фенотипом, преобладанием тремора или дискинезий, степенью леводопа-чувствительности, когнитивно-психиатрическим профилем и индивидуальной нейроанатомией. Таламическая стимуляция способна обеспечивать выраженное подавление тремора, однако ее влияние на брадикинезию, ригидность и аксиальные симптомы, как правило, менее комплексно, чем

при STN- или GPi-DBS [8–10]. Поэтому клинический исход необходимо оценивать многомерно, а не только по субъективному уменьшению тремора.

2. КЛИНИЧЕСКИЙ СЛУЧАЙ

Case report

Пациент мужского пола, 1969 года рождения, был госпитализирован в нейрохирургическое отделение многопрофильной клиники Самаркандского государственного медицинского университета в августе 2025 года. По данным анамнеза, первые проявления заболевания появились в 2016 году. Сам пациент субъективно связывал дебют симптомов с перенесенным ранее ожогом кисти, однако причинная связь данного события с развитием нейродегенеративного заболевания не устанавливалась. Начальными проявлениями были слабость и тремор правой руки; в последующем присоединились слабость в конечностях, нарушение равновесия и прогрессирующее ограничение ходьбы.

К моменту госпитализации пациент предъявлял жалобы на головную боль и головокружение, постоянное дрожание рук, слабость в нижних конечностях, значительное затруднение поддержания равновесия в положении стоя и при ходьбе, эпизоды непроизвольных движений плечевого пояса, невозможность своевременно остановить начатое движение, падения и общую слабость. Вегетативная дисфункция проявлялась запорами и эпизодами задержки мочеиспускания. До хирургического вмешательства пациент постоянно принимал Konfundus по 1 таблетке 3 раза в сутки и циклодол (trihexyphenidyl) по 1/2 таблетки 2 раза в сутки. Несмотря на проводимую терапию, в последние месяцы отмечалось прогрессирование двигательной симптоматики, что стало основанием для госпитализации и рассмотрения вопроса о хирургическом лечении.

При соматическом осмотре общее состояние оценивалось как средней тяжести. Сознание ясное. Пульс - 80 уд/мин, артериальное давление - 120/80 мм рт. ст. Дыхание самостоятельное, над легкими выслушивалось везикулярное дыхание. Живот мягкий и безболезненный. Аппетит был снижен. Менингеальные симптомы отсутствовали.

В неврологическом статусе определялись выраженная гипокинезия, мышечная ригидность, тремор покоя, гипомимия и пластическое повышение мышечного тонуса. Походка была мелкошаговой, с феноменом «прилипания стоп к полу» (freezing of gait) и выраженным нарушением автоматизированных постуральных реакций. При внешнем толчке выявлялись пропульсия, латеропульсия и ретропульсия. Координаторные пробы выполнялись с грубой интенцией. Функции черепных нервов I–XII существенно не нарушены, сухожильные рефлексы вызывались симметрично. Состояние соответствовало IV стадии по Hoehn–Yahr; Karnofsky Performance Status составлял 70 баллов.

Таблица 1

Основные клиничко-анамнестические характеристики пациента / Table 1. Main clinical and anamnestic characteristics of the patient

Показатель	Характеристика
Пол	Мужской
Год рождения	1969
Дебют заболевания	2016
Длительность болезни к моменту DBS	Около 9 лет
Начальный симптом	Слабость и тремор правой руки
Клиническая форма	Тремор-ригидная, с выраженным постурально-кинети́ческим компонентом
Hoehn–Yahr	IV стадия
Karnofsky Performance Status	70 баллов
Основные моторные симптомы	Тремор покоя, гипокинезия, ригидность, гипомимия
Аксиальные нарушения	Freezing of gait, пропульсия, латеропульсия, ретропульсия, падения
Вегетативные нарушения	Запоры, эпизоды задержки мочеиспускания
Предоперационная терапия	Konfundus 1 таб. 3 раза/сут; trihexyphenidyl 1/2 таб. 2 раза/сут

2.1. Предоперационная диагностика и клиническая оценка

Высокопольная МРТ головного мозга с контрастированием в предоперационной документации описывалась как соответствующая клиническому синдрому паркинсонизма; дополнительно указывались признаки церебральной микроангиопатии и особенности сигнала в проекции substantia nigra, обозначенные в протоколе как «симптом ласточкиного хвоста». Значимой объемной патологии, которая могла бы объяснить симптомы вторичным паркинсонизмом, в представленных документах не отмечено.

В предоперационных лабораторных исследованиях гемоглобин составлял 118 г/л, эритроциты - $4,92 \times 10^{12}/л$, лейкоциты - $6,56 \times 10^9/л$, СОЭ - 15 мм/ч. Билирубин составлял 13,5 мкмоль/л, креатинин - 102,8 мкмоль/л, мочеви́на - 10,5 ммоль/л. Протромбиновый индекс - 94%, INR - 1,12. Группа крови B(III) Rh-positive; скрининговые тесты на HBsAg и HCV были отрицательными.

Таблица 2

Предоперационные лабораторные показатели / Table 2. Preoperative laboratory parameters

Показатель	Значение
Гемоглобин	118 г/л
Эритроциты	$4,92 \times 10^{12}/л$
Лейкоциты	$6,56 \times 10^9/л$
СОЭ	15 мм/ч
Билирубин	13,5 мкмоль/л
Креатинин	102,8 мкмоль/л
Мочевина	10,5 ммоль/л
Протромбиновое время	17 с
Протромбиновый индекс	94%
INR	1,12
Группа крови	B (III) Rh+
HBsAg / HCV	Отрицательные

2.2. Нейровизуализация и стереотаксическое планирование

Предоперационная МРТ использовалась для оценки структурной анатомии и исключения грубой внутричерепной

патологии. При DBS планирование мишени должно учитывать не только атласные координаты, но и индивидуальную конфигурацию желудочковой системы, глубинных ядер и сосудисто-сулькальной анатомии [11, 12]. В день операции после установки рамочной стереотаксической системы выполнена МСКТ головного мозга. DICOM-данные были загружены в нейронавигационную систему, после чего стереотаксические target points уточнялись при помощи программного обеспечения Medtronic DBS. В операционном протоколе анатомическая мишень обозначена как проекция задневролатеральных ядер таламуса. Эта формулировка сохранена без автоматического переименования в Vim,

поскольку окончательная международная номенклатурная корреляция требует просмотра исходного стереотаксического плана и послеоперационной fusion-реконструкции. Параметры А–Е, приведенные в операционном протоколе, являются настройками дуг системы Zamorano–Duchovny и не должны без специального преобразования представляться как стандартные декартовы координаты X/Y/Z относительно AC–PC или midcommissural point. Для научной публикации предпочтительно дополнительно показать исходные planning screenshots с нанесенными entry point, target, AC, PC и запланированной траекторией.

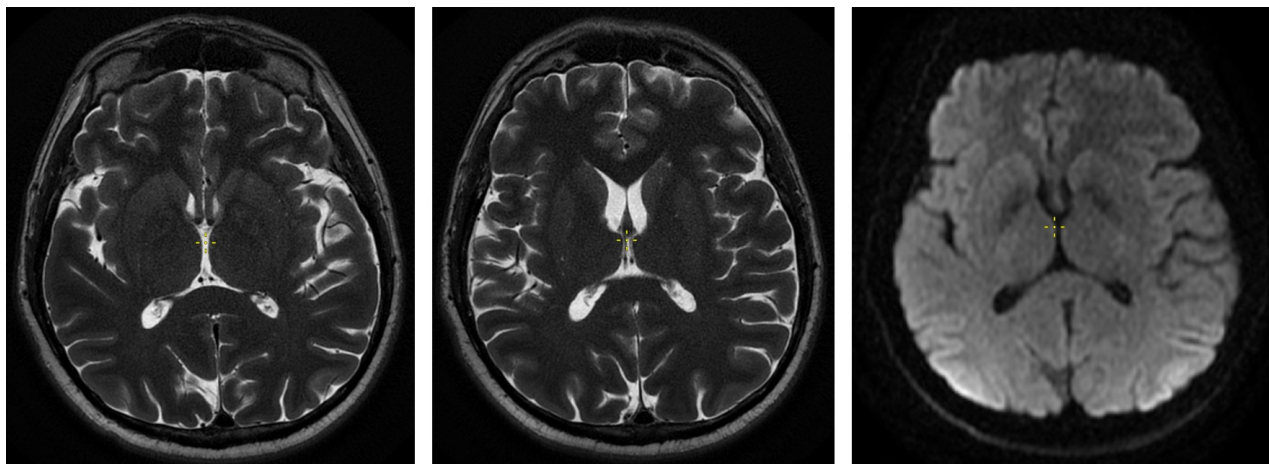


Рис. 1. Предоперационная МРТ головного мозга с визуализацией глубинной анатомии, использованной при планировании DBS / **Fig. 1.** Preoperative brain MRI showing the deep anatomy used for DBS planning

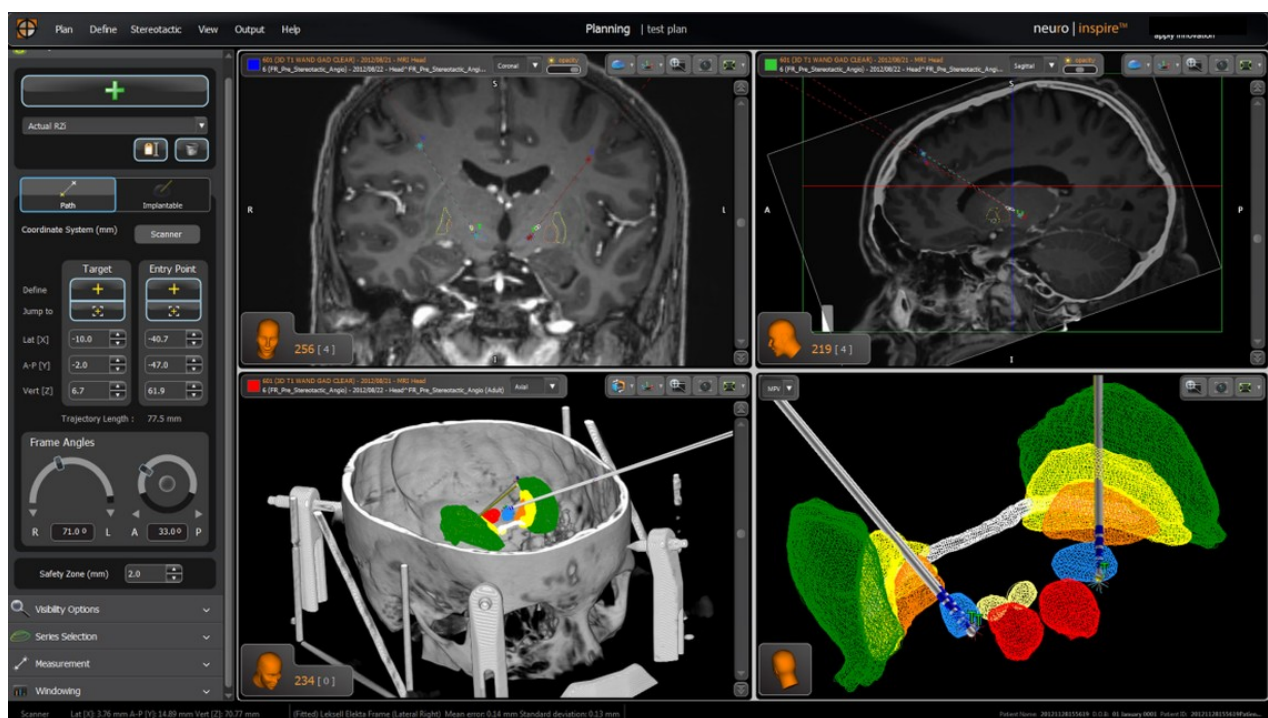


Рис. 2. Стереотаксическое планирование двусторонних траекторий на основе MRI/MSCT fusion / **Fig. 2.** Stereotactic planning of bilateral trajectories based on MRI/MSCT fusion

2.3. Хирургическое лечение

28 августа 2025 года пациенту выполнена операция глубокой стимуляции мозга. Вмешательство началось в 11:00 и завершилось в 14:00; продолжительность операции составила 3 часа. На этапе установки стереотаксической рамы точки введения фиксаторов инфильтровали 0,5% раствором новокаина. Zamorano–Duchovny stereotactic frame (Inomed, Germany) фиксировали к голове четырьмя штифтами в

двусторонних лобных и затылочных областях. После рамочной фиксации выполнена стереотаксическая МСКТ. DICOM-данные были перенесены в нейронавигационную систему, где с применением Medtronic DBS navigation уточнялись целевые точки. Основной этап операции проводили под эндотрахеальной общей анестезией в полусидячем положении. После обработки операционного поля выполнены двусторонние лобные кожные разрезы

длиной около 4 см. В правой, затем левой лобно-теменной области сформированы фрезевые отверстия диаметром 14 мм. После крестообразного вскрытия твердой мозговой оболочки на краях отверстий установлены специальные круговые фиксаторы электродов. Первым был имплантирован правый внутримозговой электрод Medtronic в запланированную проекцию заднеventrolатеральной таламической области. Положение контролировалось C-arm fluoroscopy, после чего электрод фиксировали к burr-hole anchoring system. Затем аналогичная процедура выполнена слева. В операционном протоколе зарегистрированы параметры дуг ZD-системы, приведенные в таблице 3. После двусторонней имплантации стереотаксической рама была снята. В правой верхней грудной области сформирован подкожный карман для генератора импульсов; через отдельный разрез в правой затылочно-шейной области extension leads были проведены подкожно от грудной области к краниальным компонентам. Правый и левый электроды соединены с соответствующими удлинителями, а генератор зафиксирован в грудном кармане. После завершения соединения система активирована посредством Medtronic DBS software, и корректная работа обоих каналов была подтверждена. Интраоперационных технических осложнений в представленном протоколе не зафиксировано.

Таблица 3

Стереотаксические параметры, зарегистрированные в операционном протоколе / **Table 3.** Stereotactic parameters recorded in the operative protocol

Параметр ZD-системы	Правая сторона	Левая сторона
Анатомическая мишень	Заднеventrolатеральная область таламуса	Заднеventrolатеральная область таламуса
A	A1 = 16,2	A2 = 10,0
B	B2 = 5,8	B2 = 7,4
C	31,5	33,5
D	D1 = 68,7	D1 = 70,9
E	65,6	105,1
Производитель электрода	Medtronic	Medtronic
Интраоперационный контроль	C-arm	C-arm

2.4. Послеоперационный период и программирование DBS

В раннем послеоперационном периоде обязательными задачами контроля являются оценка уровня сознания, нового очагового неврологического дефицита, судорог, головной боли, раневых осложнений и технического состояния DBS-системы. Послеоперационная КТ/МСКТ должна оценивать фактическую траекторию электродов, исключать клинически значимое внутричерепное кровоизлияние, выраженный пневмоцефал, трансвентрикулярное прохождение и грубое смещение электродов. В демонстрационной модели первичное программирование проводилось через 12–14 суток после операции путем монополярного обзора контактов. Наиболее выраженным ожидаемым эффектом была супрессия контралатерального тремора, тогда как влияние на ригидность, брадикинезию и аксиальные симптомы предполагалось более умеренным. При повышении амплитуды возможными ограничивающими явлениями считались парестезии, дизартрия и сокращения контралатеральной мимической мускулатуры.

Таблица 4

Моделированные параметры программирования DBS / **Table 4.** Simulated DBS programming parameters

Параметр	Правая сторона	Левая сторона
Мишень	Posterior ventrolateral thalamic region	Posterior ventrolateral thalamic region
Активный контакт	1–	2–
Конфигурация	C+ / 1–, monopolar	C+ / 2–, monopolar
Амплитуда	2,5 mA	2,3 mA
Ширина импульса	60 µs	60 µs
Частота	145 Hz	145 Hz
Порог клинического эффекта	1,4 mA	1,3 mA
Порог побочных эффектов	3,7 mA	3,5 mA
Терапевтическое окно	1,4–3,6 mA	1,3–3,4 mA
Преобладающий эффект	Выраженное уменьшение левого тремора	Выраженное уменьшение правого тремора
Ограничивающий эффект	Легкая дизартрия/парестезия	Легкая парестезия

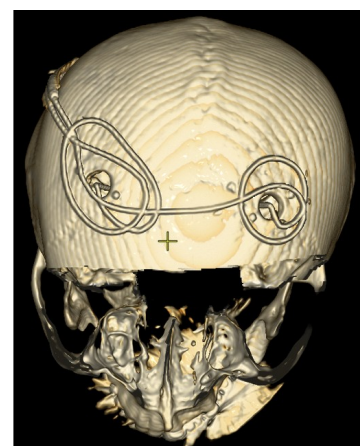
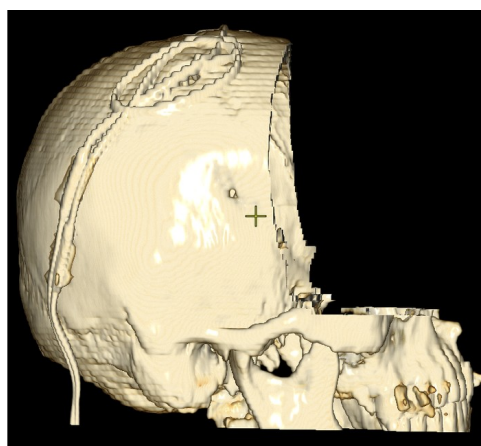
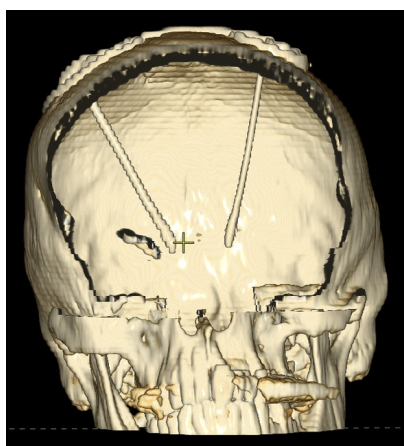


Рис. 3. Послеоперационная МСКТ/3D-реконструкция после двусторонней имплантации DBS / **Fig. 3.** Postoperative MSCT/3D reconstruction after bilateral DBS implantation

2.5. Нейрореабилитация

Даже при технически успешной DBS уменьшение тремора не означает автоматического восстановления ранее сформированных патологических двигательных стереотипов. У пациентов с исходной IV стадией по Hoehn–Yahr часто сохраняются укороченный шаг, недостаточный перенос массы

тела, freezing, нарушение поворотов, сниженные реактивные постуральные ответы и страх падения [13,14].

Для данного клинического фенотипа рациональная программа нейрореабилитации должна быть направлена на тренировку initiation of gait, увеличение длины шага, повторные переходы sit-to-stand, безопасную остановку

движения, повороты, реактивный постуральный контроль, внешние visual/auditory cueing strategies, динамический баланс и dual-task walking. Ferriero et al. показали возможность сочетания DBS с интенсивной кинезитерапией, тренировкой мышечной силы, стабилизацией туловища, координационными упражнениями и функциональным переобучением [15]. В рабочей модели наблюдения реабилитация начиналась после стабилизации послеоперационного состояния и синхронизировалась с последовательным подбором параметров стимуляции. Особое внимание уделялось профилактике падений, так как исходно у

пациента имелись пропульсия, ретропульсия, латеропульсия и эпизоды невозможности остановить движение.

2.6. Оценка результатов

Для case report клинический эффект целесообразно оценивать по нескольким независимым доменам. MDS-UPDRS III отражает выраженность моторного синдрома; отдельный tremor subscore позволяет показать специфический эффект таламической стимуляции. PDQ-39 отражает качество жизни, Berg Balance Scale и Timed Up and Go - постуральный контроль и функциональную мобильность, а Schwab and England - повседневную независимость [4,16–18].

Таблица 5

Моделированная динамика клинических показателей после DBS / **Table 5.** Simulated changes in clinical scores after DBS

Показатель	До DBS	1 месяц	3 месяца	6 месяцев
MDS-UPDRS III, Med-OFF	63	49	44	40
Tremor subscore	20	8	6	5
Rigidity subscore	13	11	10	10
Bradykinesia subscore	18	16	15	15
Hoehn–Yahr	4,0	4,0	3,5	3,5
Schwab & England ADL, %	50	60	70	75
PDQ-39 Summary Index, %	58,9	49,2	43,7	40,8
MoCA, баллы	25	25	25	25
Berg Balance Scale, баллы	29	33	37	40
Timed Up and Go, с	23,8	21,4	19,3	18,1
Freezing of Gait Questionnaire	17	15	13	11

Таблица 6

Моделированная итоговая оценка эффекта DBS через 6 месяцев / **Table 6.** Simulated overall assessment of the DBS effect at 6 months

Домен	До операции	6 месяцев	Изменение
MDS-UPDRS III OFF	63	40	↓ 36,5%
Tremor subscore	20	5	↓ 75,0%
Rigidity subscore	13	10	↓ 23,1%
Bradykinesia subscore	18	15	↓ 16,7%
PDQ-39 Summary Index	58,9%	40,8%	↓ 30,7%
Berg Balance Scale	29	40	↑ 11 баллов
Timed Up and Go	23,8 с	18,1 с	↓ 23,9%
Schwab & England	50%	75%	↑ 25 п.п.

3. ОБСУЖДЕНИЕ

Discussion

Представленный клинический случай характеризуется сочетанием выраженного тремор-ригидного синдрома и далеко зашедших аксиальных нарушений. К моменту хирургического лечения у пациента имелись freezing of gait, пропульсия, латеропульсия, ретропульсия и падения, что соответствует значительному нарушению постуральных автоматизмов. Именно такие симптомы часто определяют функциональную зависимость пациента даже при относительно хорошем контроле отдельных конечностных проявлений паркинсонизма [3,13].

Важной особенностью случая является формулировка хирургической мишени. В операционном протоколе она обозначена как «проекция задневентролатеральных ядер таламуса». В современной международной литературе для хирургического лечения тремора чаще обсуждается ventral intermediate nucleus (Vim) и прилежащие motor thalamic

territories [8–10]. Однако без исходного planning dataset и послеоперационной MRI/CT fusion некорректно автоматически приравнивать документированную задневентролатеральную область к конкретному ядру. В окончательной статье желательно показать точную локализацию электродов и активных контактов относительно индивидуальной анатомии пациента.

Таламическая DBS наиболее предсказуемо воздействует на тремор за счет модуляции cerebello-thalamo-cortical network. Исторические и современные данные показывают возможность выраженного и устойчивого уменьшения тремора при стимуляции Vim и прилежащих таламических областей [8–10]. В то же время эта стратегия обычно не обеспечивает столь же комплексного воздействия на брадикинезию, ригидность и моторные флуктуации, как STN-или GPi-DBS [6, 7, 10]. Поэтому для данного пациента было бы методологически неверно оценивать успех только по исчезновению тремора.

Эта особенность объясняет структуру моделированной динамики в таблицах 5 и 6: наибольшее улучшение предусмотрено для tremor subscore, тогда как общий MDS-UPDRS III, ригидность и брадикинезия уменьшаются умеренно. Такой профиль более физиологичен для таламической стимуляции, чем глобальное снижение всех паркинсонических проявлений на 60–70%. Однако сами цифровые значения не являются наблюдаемыми данными и включены исключительно для рабочего макета статьи.

Не менее важна исходная аксиальная симптоматика. Freezing, постуральная нестабильность и падения при поздней БП могут быть лишь частично допамин- и DBS-чувствительными. Даже после хорошего тремор-контроля пациент может сохранять нарушения initiation of gait, поворотов и реактивного равновесия [13, 16]. Это является основанием для интеграции DBS с целенаправленной нейрореабилитацией.

С технической точки зрения случай иллюстрирует классический frame-based stereotactic workflow. Zamorano–Duchovny frame обеспечивал жесткую фиксацию и воспроизводимое координатное пространство; стереотаксическая МСКТ позволила зарегистрировать геометрию рамы, а DICOM-данные были интегрированы в Medtronic navigation environment. Последовательная имплантация правого и левого электродов с C-arm verification дополняла контроль траекторий.

Следует подчеркнуть различие между параметрами дуг ZD-системы и стандартными X/Y/Z-координатами. В первичном протоколе зарегистрированы параметры A, B, C, D и E. До получения planning report их следует публиковать именно в такой форме или преобразовать с использованием документации конкретной стереотаксической системы.

Клинический отбор пациента на DBS также заслуживает обсуждения. К моменту операции продолжительность заболевания составляла около девяти лет, а стадия по Hoehn–Yahr – IV. Несмотря на относительно меньшую длительность заболевания по сравнению со многими классическими DBS-сериями, инвалидизирующий тремор, ригидность, аксиальные нарушения и прогрессирование симптомов на фоне медикаментозного лечения стали основанием для хирургического рассмотрения. Международный опыт подтверждает, что решение о DBS должно основываться не на одном временном критерии, а на сочетании клинического фенотипа, медикаментозного ответа, функциональной инвалидизации, когнитивного статуса и хирургического риска [5–7].

Когнитивное и нейропсихологическое состояние имеет принципиальное значение при оценке кандидатов на DBS. В исходном осмотре пациент был в ясном сознании и ориентирован во времени и месте.

4. ЗАКЛЮЧЕНИЕ

Conclusion

Представлен клинический случай мужчины 1969 года рождения с тремор-ригидной формой болезни Паркинсона, дебютировавшей в 2016 году и достигшей IV стадии по Hoehn–Yahr. Клинический фенотип включал выраженный тремор, гипокинезию, мышечную ригидность, freezing of gait, постуральную неустойчивость, пропульсию, латеропульсию и ретропульсию. 28 августа 2025 года пациенту выполнена двусторонняя frame-based DBS с применением Zamorano–Duchovny stereotactic system, стереотаксической МСКТ, Medtronic DBS navigation и C-arm verification; согласно операционному протоколу, электроды имплантированы в задневрололатеральную таламическую область. Данный случай подчеркивает необходимость индивидуального стереотаксического планирования и мультимодальной оценки результата, особенно раздельного анализа тремора и аксиальных нарушений. Для окончательной научной публикации моделированные параметры программирования и функциональные шкальные значения должны быть заменены фактическими данными пациента.

DECLARATIONS

Declarations

Author contributions CRediT

Conceptualization; Methodology; Investigation; Data curation; Writing – original draft; Writing – review & editing. All authors have read and agreed to the published version of the manuscript.

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Ethics approval

The case report was prepared in accordance with the principles of the Declaration of Helsinki; publication of the anonymised clinical data was approved by the local ethics committee of the Specialized Scientific and Practical Center for Neurosurgery and Neurorehabilitation at the Samarkand State Medical University.

Informed consent

Written informed consent was obtained from the patient for publication of this case report and the accompanying anonymised images.

Data availability statement

The data supporting this case report are presented in the tables and figures of this article; further anonymised clinical records are available from the authors on reasonable request.

Conflict of interest

The authors declare no conflict of interest.

Generative AI disclosure

Generative AI (Claude, Anthropic) was used in the editorial preparation of this article: for language editing, translation of the title, abstract and keywords between Uzbek, Russian and English, preparation of the extended English summary from the authors' text, and formatting of the reference list. No data, results or conclusions were generated by AI. The authors are responsible for the content of the publication.

EXTENDED SUMMARY IN ENGLISH

Kengaytirilgan inglizcha xulosa / Расширенный реферат на английском языке

Purpose and research problem

Parkinson disease (PD) is a chronic progressive neurodegenerative disorder in which degeneration of the dopaminergic neurons of the substantia nigra pars compacta disrupts the functional organisation of basal ganglia–thalamo-cortical networks. As the disease advances, postural instability, gait disorders, freezing of gait, autonomic dysfunction and neuropsychological manifestations increase alongside bradykinesia, rest tremor and rigidity. Levodopa-based pharmacotherapy remains the basis of symptomatic treatment, but in some patients with long-standing disease tremor control becomes insufficient and motor fluctuations, drug-induced dyskinesias or unacceptable functional dependence develop; in carefully selected patients surgical neuromodulation is then considered. Deep brain stimulation (DBS) most often targets the subthalamic nucleus (STN) or the internal globus pallidus (GPi), whereas the ventral motor thalamus has historically been used mainly for the control of severe tremor. The aim of the article is to present a case of bilateral thalamic DBS in stage IV tremor-rigid PD and to show why the outcome has to be assessed in several independent domains rather than by tremor reduction alone.

Materials and methods

A male patient born in 1969 was admitted to the neurosurgical department of the multidisciplinary clinic of Samarkand State Medical University in August 2025. The first symptoms, weakness and tremor of the right hand, appeared in 2016 and were later followed by limb weakness, imbalance and progressive limitation of walking. On admission the patient complained of headache and dizziness, constant hand tremor, leg weakness, marked difficulty in keeping balance when standing and walking, involuntary movements of the shoulder girdle, inability to stop a movement once started, falls and general weakness; autonomic dysfunction presented with constipation and episodes of urinary retention. Despite continuous treatment with Konfundus (one tablet three times a day) and trihexyphenidyl (half a tablet twice a day), the motor symptoms progressed. Neurological examination revealed marked hypokinesia, rigidity, rest tremor, hypomimia and small-step gait with freezing, together with propulsion, lateropulsion and retropulsion on external push; the condition corresponded to Hoehn–Yahr stage IV with a Karnofsky Performance Status of 70. Contrast-enhanced high-field MRI was described as consistent with parkinsonism, with signs of cerebral microangiopathy and the "swallow tail" sign, and without a mass lesion that could explain secondary parkinsonism. On 28 August 2025 bilateral frame-based DBS was performed under general endotracheal anaesthesia in the semi-sitting

position using a Zamorano–Duchovny stereotactic frame (Inomed, Germany), stereotactic multislice CT, Medtronic DICOM-based navigation and intraoperative C-arm control. Medtronic electrodes were implanted through 14-mm burr holes, first on the right and then on the left, into the posterior ventrolateral thalamic region documented in the operative protocol; the arc settings of the ZD system (A–E) are reported in the form in which they were recorded. The pulse generator was placed in a subcutaneous pocket in the right upper chest and the system was activated with Medtronic DBS software. The outcome domains proposed for assessment were MDS-UPDRS III with a separate tremor subscore, PDQ-39, the Berg Balance Scale, the Timed Up and Go test and the Schwab and England scale.

Results and discussion

The operation lasted three hours, and no intraoperative technical complications were recorded in the protocol; correct function of both channels was confirmed after activation. The stereotactic arc parameters recorded for the right and left trajectories are given in Table 3. The authors state explicitly that the DBS programming parameters (Table 4) and the changes in clinical scales at 1, 3 and 6 months (Tables 5 and 6) are simulated values included only for the working layout of the article and are not observed patient data. In this demonstration model, initial programming was performed 12–14 days after surgery by monopolar review of the contacts; the expected predominant effect was suppression of contralateral tremor, with a more moderate influence on rigidity, bradykinesia and axial symptoms, and paraesthesia, dysarthria and contractions of the contralateral facial muscles were regarded as possible limiting effects at higher amplitudes. Accordingly, the simulated profile assumes the greatest improvement in the tremor subscore and only moderate changes in total MDS-UPDRS III, rigidity and bradykinesia, which the authors consider more physiological for thalamic stimulation than a global reduction of all parkinsonian signs. In the working model, rehabilitation began after postoperative stabilisation and was synchronised with stepwise adjustment of the stimulation parameters; it addressed gait initiation, step length, repeated sit-to-stand transfers, safe stopping, turning, reactive postural control, visual and auditory cueing, dynamic balance and dual-task walking, with particular attention to fall prevention.

Conclusion and contribution

The case describes bilateral frame-based thalamic DBS in a man born in 1969 with tremor-rigid PD of Hoehn–Yahr stage IV, in whom severe tremor was combined with advanced axial disturbances. Thalamic stimulation acts most predictably on tremor through modulation of the cerebello-thalamo-cortical network but has a less comprehensive effect on bradykinesia, rigidity and motor fluctuations than STN or GPi stimulation, so the success of surgery cannot be judged by tremor suppression alone. Freezing, postural instability and falls in advanced PD are only partly responsive to dopamine and DBS, which justifies integrating DBS with targeted neurorehabilitation. The authors stress that the documented target should not be equated automatically with a specific nucleus such as Vim without the original planning dataset and postoperative MRI/CT fusion, and that the ZD arc settings should not be presented as standard X/Y/Z coordinates without conversion. According to the authors, the simulated programming parameters and functional scale values should be replaced with the patient's actual data in the final scientific publication.

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CASE REPORT • PEER-REVIEWED • OPEN ACCESS • **SERIES A** • 14.00.00 — MEDICAL SCIENCES • UDC: 616.858-089:615.84

Bilateral posterior ventrolateral thalamic deep brain stimulation in stage IV tremor-rigid Parkinson disease with prominent axial dysfunction: a case report

Parkinson kasalligining IV bosqichdagi tremor-rigid shaklida aksial buzilishlar yaqqol ifodalanganda talamusning orqa ventrolateral sohasini ikki tomonlama chuqur stimulyatsiya qilish: klinik holat

Двусторонняя глубокая стимуляция заднеventrolатеральной области таламуса при тремор-ригидной форме болезни Паркинсона IV стадии с выраженными аксиальными нарушениями: клинический случай

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Abstract. Background. Deep brain stimulation (DBS) is an established functional neurosurgical treatment for carefully selected patients with advanced Parkinson disease (PD). Clinical outcome depends on target selection, electrode localization, stimulation parameters, phenotype, and the severity of axial manifestations. Case Report. We describe a 44-year-old man with an approximately 17-year history of tremor-rigid PD with a prominent postural-kinetic component. His neurological phenotype included severe limb tremor, hypokinesia, muscular rigidity, hypomimia, freezing of gait, propulsion, retropulsion, lateropulsion, impaired balance, and recurrent falls. Disease severity corresponded to Hoehn–Yahr stage IV, with a Karnofsky Performance Status of 70. On August 28, 2025, bilateral frame-based DBS of the posterior ventrolateral thalamic region was performed using a Zamorano–Duchovny stereotactic system, MSCT-based registration, Medtronic DBS navigation, and intraoperative C-arm verification. The intracranial leads were connected to a subcutaneous implantable pulse generator placed in the right upper chest. Postoperative management included individualized stimulation programming, pharmacological adjustment, gait and balance rehabilitation, and longitudinal assessment using MDS-UPDRS, PDQ-39, MoCA, Berg Balance Scale, Timed Up and Go, and the Freezing of Gait Questionnaire. Conclusion. Bilateral motor thalamic DBS may provide substantial tremor suppression in advanced tremor-rigid PD. In patients with prominent axial dysfunction, however, optimal outcome requires a multimodal strategy integrating stereotactic accuracy, individualized programming, medication adjustment, and structured neurorehabilitation.

Keywords: Parkinson disease; deep brain stimulation; DBS; motor thalamus; ventrolateral thalamus; tremor; rigidity; freezing of gait; stereotactic neurosurgery; neurorehabilitation

O‘ZBEKCHA

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Annotatsiya. Kirish. Miyaning chuqur stimulyatsiyasi (DBS) Parkinson kasalligining rivojlangan bosqichlarida to‘g‘ri tanlangan bemorlar uchun samarali funksional neyroxirurgik davolash usuli hisoblanadi. Davolash natijasi stimulyatsiya nishoni, elektrodning anatomik joylashuvi,

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stimulyatsiya parametrlari va aksial motor buzilishlarning og'irligiga bog'liq. Klinik holat. 44 yoshli erkak bemorda Parkinson kasalligi taxminan 17 yil davom etgan. Klinik ko'rinish tremor-rigid shakl va yaqqol postural-kinetik komponent bilan xarakterlangan. Bemorda qo'l-oyoqlarda kuchli tremor, gipokineziya, mushak rigidligi, gipomimiya, freezing of gait, propulsiya, retropulsiya, lateropulsiya, muvozanat buzilishi va takroriy yiqilishlar kuzatilgan. Hoehn–Yahr bo'yicha IV bosqich, Karnofsky shkalasi bo'yicha 70 ball qayd etilgan. 2025-yil 28-avgust kuni Zamorano–Duchovny stereotaktik tizimi, MSKT asosidagi ro'yxatga olish, Medtronic DBS navigatsiyasi va C-arm nazorati yordamida talamusning orqa ventrolateral sohasiga ikki tomonlama DBS bajarilgan. Keyingi davrda stimulyator individual dasturlangan, farmakoterapiya moslashtirilgan va strukturaviy neyroeabilitatsiya o'tkazilgan. Xulosa. Rivojlangan tremor-rigid Parkinson kasalligida ikki tomonlama talamik DBS yaqqol tremorni sezilarli kamaytirishi mumkin. Aksial simptomlar mavjud bemorlarda optimal natijaga erishish uchun DBS, dori terapiyasi va neyroeabilitatsiyani kompleks ravishda olib borish zarur.

Kalit so'zlar: Parkinson kasalligi; DBS; miyaning chuqur stimulyatsiyasi; talamus; tremor; rigidlik; yurish muzlashi; stereotaksiya; neyroeabilitatsiya

РУССКИЙ

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Аннотация. Введение. Глубокая стимуляция мозга (deep brain stimulation, DBS) является одним из наиболее эффективных методов функциональной нейрохирургии у тщательно отобранных пациентов с продвинутой болезнью Паркинсона. Клинический эффект DBS определяется не только выраженностью исходного паркинсонического синдрома, но и выбором мишени, анатомическим положением электродов, параметрами стимуляции и характером аксиальной симптоматики. Клинический случай. Представлен мужчина 44 лет с болезнью Паркинсона длительностью около 17 лет, тремор-ригидной формой с выраженным постурально-кинетическим компонентом. В клинической картине преобладали постоянный тремор конечностей, гипокинезия, мышечная ригидность, гипомимия, freezing of gait, пропульсия, ретропульсия, латеропульсия, нарушение равновесия и повторные падения. Заболевание соответствовало IV стадии по Hoehn–Yahr, функциональный статус по Karnofsky составлял 70 баллов. 28 августа 2025 года пациенту выполнена двусторонняя frame-based DBS заднеventrolateral таламической области с использованием стереотаксической системы Zamorano–Duchovny, MSCT-based registration, Medtronic DBS navigation и C-arm контроля. После имплантации выполнено программирование нейростимулятора и структурированная нейрореабилитация. Динамическая оценка включала MDS-UPDRS, PDQ-39, MoCA, Berg Balance Scale, Timed Up and Go и Freezing of Gait Questionnaire. Заключение. Двусторонняя таламическая DBS может обеспечивать выраженное подавление инвалидизирующего тремора при продвинутой тремор-ригидной форме болезни Паркинсона, однако контроль брадикинезии, ригидности и особенно аксиальных нарушений требует комплексного программирования и нейрореабилитации.

Ключевые слова: болезнь Паркинсона; глубокая стимуляция мозга; DBS; таламус; вентролатеральное ядро; тремор; ригидность; freezing of gait; стереотаксия; нейрореабилитация

1. ВВЕДЕНИЕ

Introduction

Болезнь Паркинсона представляет собой хроническое прогрессирующее нейродегенеративное заболевание, при котором дегенерация дофаминергических нейронов substantia nigra pars compacta и последующая перестройка базально-ганглионарно-таламо-кортикальных сетей приводят к формированию брадикинезии, ригидности, тремора покоя и постуральной неустойчивости. По мере прогрессирования заболевания к моторным проявлениям присоединяются нарушения ходьбы, freezing, дисфункция вегетативной нервной системы, расстройства сна, когнитивные и аффективные нарушения, существенно ухудшающие функциональную независимость и качество жизни [1–3]. Леводопа остаётся наиболее эффективным фармакологическим средством контроля двигательной симптоматики, однако длительное течение заболевания сопровождается сокращением продолжительности стабильного ON-состояния, появлением wearing-off, непредсказуемых OFF-периодов, лекарственных дискинезий и усложнением схемы медикаментозного лечения. Современная

концепция отбора кандидатов на DBS поэтому основывается не только на длительности заболевания, но и на индивидуальном моторном фенотипе, леводопачувствительности, выраженности тремора и дискинезий, аксиальных симптомах, когнитивно-психиатрическом профиле и ожиданиях пациента [3, 8]. Современный обзор 2025 года подчёркивает необходимость перехода от универсального подхода к precision DBS, включающему индивидуальный выбор пациента, мишени, устройства и параметров программирования. DBS является регулируемой и в значительной степени обратимой формой хронической нейромодуляции. Классическими мишенями при болезни Паркинсона являются nucleus subthalamicus и globus pallidus internus.

Рандомизированные исследования продемонстрировали значимое улучшение моторной функции и повседневной активности после DBS у правильно отобранных больных [5–7]. Вместе с тем современная систематическая оценка подчёркивает необходимость учитывать не только пользу, но и риски: в метаанализе Petersen et al. хирургическое лечение ассоциировалось с большей частотой серьёзных нежелательных явлений,

преимущественно периперационных и hardware-related, а достоверность ряда сравнительных результатов была ограничена методологией исходных исследований [4].

Выбор мишени имеет принципиальное значение. STN-DBS позволяет эффективно воздействовать на леводопамочувствительную брадикинезию, ригидность и тремор и часто позволяет уменьшить медикаментозную нагрузку. GPi-DBS обеспечивает выраженный антидискинетический эффект и может быть предпочтительным в отдельных клинических ситуациях. Вентральные моторные отделы таламуса, прежде всего Vim и соседние вентролатеральные территории, традиционно рассматриваются как высокоэффективная мишень для фармакорезистентного тремора. В долгосрочном исследовании Cury et al. у пациентов с болезнью Паркинсона после Vim-DBS снижение тремора составляло около 70% через год и оставалось выраженным даже при длительном наблюдении [9]. Однако выраженное подавление тремора не эквивалентно полному восстановлению двигательной функции. Особенно сложными остаются gait freezing, нарушения равновесия и постуральные реакции. Метаанализ 17 рандомизированных исследований, включивший 333 пациента, не выявил устойчивого значимого улучшения Berg Balance Scale, Timed Up and Go или частоты падений после DBS [10]. Это обстоятельство особенно важно при оценке пациентов с исходной тяжёлой аксиальной симптоматикой.

В 2025–2026 гг. концепция DBS ещё больше сместилась в сторону symptom-specific и network-based neuromodulation. Современные исследования рассматривают связь результата не только с названием анатомического ядра, но и с расположением активного контакта, стимулируемыми волоконными путями, индивидуальной коннектомикой и параметрами volume of tissue activated [8, 14, 15]. Недавний сетевой метаанализ рандомизированных исследований также показал, что влияние разных вариантов DBS на freezing of gait и скорость ходьбы неодинаково, что подтверждает необходимость индивидуального выбора стратегии [15].

2. КЛИНИЧЕСКИЙ СЛУЧАЙ

Case report

Пациент мужского пола, 44 лет. Первые проявления заболевания появились в 2008 году, приблизительно за 17 лет до хирургического вмешательства. Дебют характеризовался слабостью в руках и тремором. В дальнейшем постепенно нарастали тремор верхних и нижних конечностей, слабость в ногах, нарушение равновесия и трудности самостоятельной ходьбы. К августу 2025 года пациента беспокоили постоянный тремор конечностей, головокружение, ощущение слабости в ногах, выраженная неустойчивость в положении стоя и при ходьбе, эпизоды невозможности своевременно остановить начатое движение, произвольные движения плечевого пояса, периодические падения и общая слабость. До госпитализации пациент нерегулярно принимал Konfundus по 1 таблетке 3–5 раз в сутки. Объективно общее состояние было

средней тяжести. Артериальное давление 120/80 мм рт.ст., пульс 80 уд/мин. Дыхание самостоятельное, над лёгкими выслушивалось везикулярное дыхание. При рентгенографии органов грудной клетки были выявлены признаки хронического бронхита.

Сознание ясное, пациент полностью ориентирован во времени, месте и собственной личности. Менингеальных знаков не определялось. Черепные нервы без клинически значимого очагового дефицита. Выявлялись гипомимия, выраженная гипокинезия, тремор покоя, пластическое повышение мышечного тонуса и ригидность. Ходьба была мелкошаговой, с эпизодами «прилипания» стоп к полу. При постуральных пробах определялись пропульсия, латеропульсия и ретропульсия. Координаторные пробы выполнялись с выраженной интенцией. Сухожильные рефлексы симметричные. Имелись вегетативные нарушения в виде запора и эпизодов задержки мочеиспускания. Тяжесть заболевания соответствовала Hoehn–Yahr IV стадии; Karnofsky Performance Status – 70 баллов.

Таблица 1

Исходная клиническая характеристика / **Table 1.** Baseline clinical characteristics

Параметр	Значение
Возраст на момент DBS	44 года
Пол	Мужской
Начало болезни	2008
Продолжительность болезни	≈17 лет
Фенотип	Тремор-ригидный, постурально-кинети́ческий компонент
Hoehn–Yahr	IV
Karnofsky	70
Тремор	Выраженный, верхние и нижние конечности
Брадикинезия/ гипокинезия	Выраженная
Ригидность	Выраженная
Freezing of gait	Выраженный
Постуральная неустойчивость	Propulsia, lateropulsia, retropulsia
Падения	Периодические
Вегетативные нарушения	Запор, эпизоды задержки мочеиспускания
Предоперационная терапия	Konfundus 1 таб. 3–5 раз/сут

2.1. Предоперационная нейровизуализация

При высокопольной МРТ головного мозга были описаны признаки болезни Паркинсона, церебральной микроангиопатии и изменения сигнала в области substantia nigra с визуализацией феномена «ласточки хвоста» (Рис. 1).

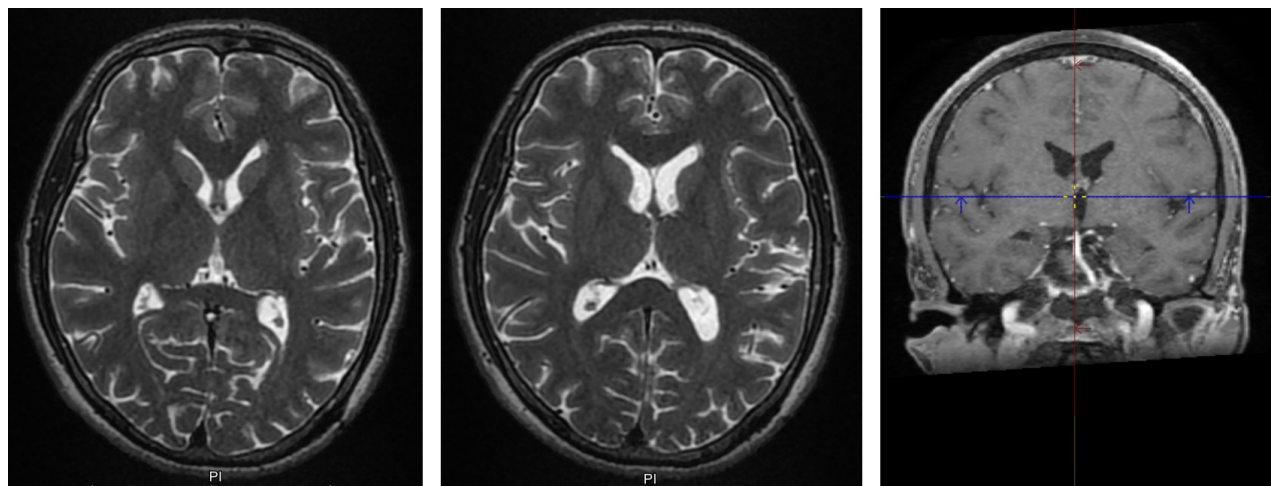


Рис. 1. Предоперационная МРТ головного мозга. Аксиальный срез с визуализацией предполагаемой DBS-мишени / **Fig. 1.** Preoperative brain MRI. Axial section showing the intended DBS target

Структурных объёмных процессов, способных вызвать вторичный паркинсонический синдром, клинически не выявлено. В предоперационной лабораторной оценке гемоглобин составлял 121 г/л, креатинин 100,8 мкмоль/л, мочевины 7,9 ммоль/л, билирубин 20,8 мкмоль/л. HBsAg и

HCV-Ab были отрицательными. Сахар крови составлял 5,39 ммоль/л. В коагулограмме перед вмешательством регистрировались протромбиновое время 22 с, протромбиновый индекс 73%, INR 1,4 и фибриноген 2,08 г/л.

2.2. Предоперационная количественная оценка

Таблица 2

Мультимодальная динамика клинических показателей / **Table 2.** Multimodal changes in clinical scores

Показатель	Pre-DBS OFF	Pre-DBS ON	1 мес.	3 мес.	6 мес.	12 мес.
MDS-UPDRS I	13	13	12	11	10	10
MDS-UPDRS II	31	31	27	24	22	21
MDS-UPDRS III	64	45	48	44	41	39
MDS-UPDRS IV	11	11	9	8	7	6
Hoehn–Yahr	4.0	3.0	3.5	3.0	3.0	3.0
Schwab & England, %	50	65	65	70	75	75
PDQ-39 SI, %	57.8	57.8	48.5	43.2	39.1	36.4
MoCA	25	25	25	25	26	26
Berg Balance Scale	29	35	35	38	40	41
Timed Up and Go, s	24.2	19.0	19.2	17.8	16.5	15.8
FOG-Q	18	14	15	13	12	11
LEDD, mg/day	850	850	800	800	750	750

2.3. Хирургическое лечение

28 августа 2025 года пациенту выполнена двусторонняя имплантация системы глубокой стимуляции мозга. Операция началась в 15:00 и завершилась в 18:00. Общая продолжительность составила 3 часа. Первым этапом под

местной инфильтрационной анестезией 0,5% раствором новокаина выполнена установка стереотаксической системы Zamorano–Duchovny (ZD; Inomed, Germany). Рама фиксирована четырьмя специальными штифтами в двух лобных и двух затылочных областях. После установки системы выполнена МСКТ головного мозга (Рис. 2).

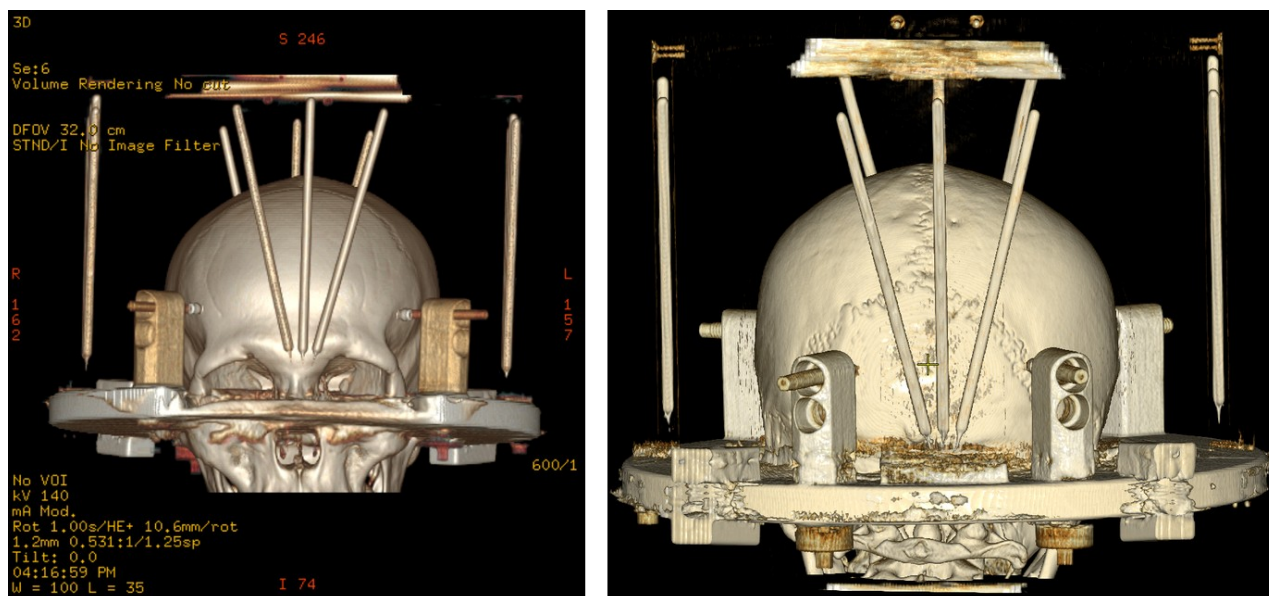


Рис. 2. Стереотаксическая система Zamorano–Duchovny / **Fig. 2.** Zamorano–Duchovny stereotactic system

DICOM-данные перенесены в нейронавигационную рабочую станцию, где осуществлялось стереотаксическое планирование с использованием программного обеспечения Medtronic DBS navigation. Основной этап операции проводился под эндотрахеальной общей анестезией в полусидячем положении. В правой и левой лобно-теменных областях выполнены кожные разрезы около 4 см и сформированы 14-мм фрезевые отверстия. В соответствии с операционным протоколом целевой анатомической областью являлась проекция задних вентролатеральных ядер таламуса. Последовательно справа и слева имплантированы интрацеребральные электроды Medtronic. Положение электродов контролировалось интраоперационной C-arm флюороскопией.

Таблица 3

Реальные параметры ZD-стереотаксической системы / **Table 3.**
Actual parameters of the ZD stereotactic system

Параметр	Правая сторона	Левая сторона
A	A2 = 16.8	A2 = 10.0
B	B2 = 2.3	B2 = 7.4
C	41.1	33.5
D	D1 = 60.6	D1 = 70.9
E	104.5	105.1
Target	Posterior ventrolateral thalamic region	Posterior ventrolateral thalamic region
Manufacturer	Medtronic	Medtronic
Intraoperative control	C-arm	C-arm

После окончательной фиксации электродов стереотаксическая рама была удалена. Через отдельный разрез в верхнем отделе правой грудной клетки сформирован подкожный карман для имплантируемого генератора импульсов. Электродные удлинители проведены подкожно через правую затылочно-шейную область и соединены с внутримозговыми электродами. После подключения системы её функционирование проверено с помощью Medtronic DBS software.

2.4. Послеоперационный период

Послеоперационный период протекал без клинически значимого нового очагового неврологического дефицита. Контрольная МСКТ демонстрировала двустороннее симметричное расположение интракраниальных электродов с дистальными отделами в пределах запланированной таламической области (Рис. 3).

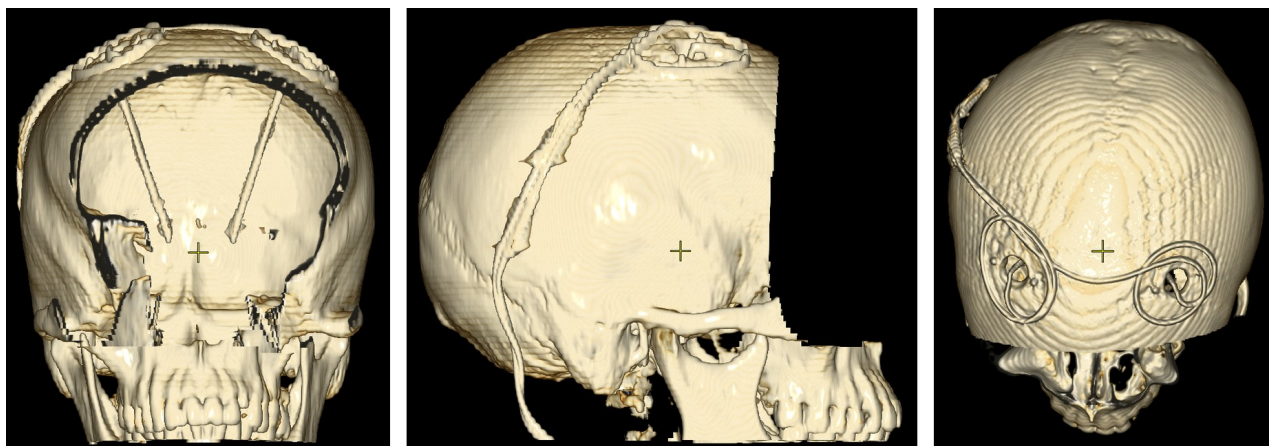


Рис. 3. 3D-реконструкция черепа после глубокой стимуляции головного мозга / Fig. 3. 3D reconstruction of the skull after deep brain stimulation

Признаков внутримозгового кровоизлияния не выявлено; определялся небольшой остаточный фронтальный пневмоцефал без масс-эффекта. Пациент был выписан 30 августа 2025 года. Было рекомендовано продолжить противопаркинсоническую терапию, наблюдение невролога и хирурга по месту жительства. Повторный визит для активации и настройки системы был назначен на 12 сентября 2025 года, что соответствует фактическим рекомендациям в выписке.

2.5. Программирование DBS

Первичная активация системы выполнена приблизительно через две недели после имплантации. Использовался последовательный monopolar review с постепенным повышением амплитуды и оценкой ответа тремора, ригидности, брадикинезии, походки и появления нежелательных эффектов.

Таблица 4

Параметры DBS / Table 4. DBS parameters

Параметр	Правая сторона	Левая сторона
Мишень	Posterior ventrolateral motor thalamus	Posterior ventrolateral motor thalamus
Электрод	Medtronic 3389	Medtronic 3389
Тип	Conventional quadripolar	Conventional quadripolar
Активный контакт	1–	1–
Конфигурация	C+ / 1–	C+ / 1–
Амплитуда	2.4 mA	2.2 mA
Pulse width	60 μ s	60 μ s
Frequency	150 Hz	150 Hz
Порог клинического эффекта	1.3 mA	1.4 mA
Порог побочного эффекта	3.6 mA	3.5 mA
Терапевтическое окно	1.3–3.5 mA	1.4–3.4 mA
Tremor response	≈85% reduction	≈80% reduction
Rigidity response	Умеренное уменьшение	Умеренное уменьшение
Bradykinesia response	Частичное улучшение	Частичное улучшение
Высокоамплитудный побочный эффект	Контралатеральная парестезия, лёгкая дизартрия	Парестезия, лёгкая дизартрия

Наиболее выраженный клинический ответ наблюдался в отношении тремора. Ригидность и брадикинезия уменьшались менее значительно, тогда как freezing и постратуральная неустойчивость сохранялись частично.

2.6. Нейрореабилитация

Реабилитационная программа была ориентирована прежде всего на аксиальные симптомы. В неё включались повторные sit-to-stand transitions, упражнения на увеличение амплитуды движений, тренировку длины шага, перенос центра тяжести, изменение площади опоры, реактивные постратуральные реакции, безопасные повороты, преодоление узких проходов и внешние visual/auditory cueing strategies. Особое внимание уделялось freezing of gait. Пациент выполнял упражнения с визуальными ориентирами, ритмической слуховой стимуляцией и тренировкой последовательного переноса веса с одной конечности на другую. Дополнительно выполнялись упражнения на статический и динамический баланс, координацию, укрепление мышц туловища и конечностей и dual-task walking.

2.7. Результаты

Через 12 месяцев после операции наиболее выраженное изменение отмечалось в треморном компоненте моторного синдрома.

Таблица 5

Итоговая оценка эффекта DBS / Table 5. Overall assessment of the DBS effect

Домен	До DBS	12 мес.	Изменение
MDS-UPDRS III OFF	64	39	↓39.1%
Tremor subscore	20	4	↓80.0%
Rigidity subscore	12	9	↓25.0%
Bradykinesia subscore	18	14	↓22.2%
MDS-UPDRS IV	11	6	↓45.5%
PDQ-39 SI	57.8	36.4	↓37.0%
Berg Balance Scale	29	41	↑12 points
Timed Up and Go	24.2 s	15.8 s	↓34.7%
FOG-Q	18	11	↓38.9%
Schwab & England	50%	75%	↑25 percentage points
MoCA	25	26	+1 point
LEDD	850 mg/day	750 mg/day	↓11.8%

Полученный профиль ответа соответствовал преимущественно тремор-супрессивному действию таламической стимуляции. При этом улучшение походки, постратурального контроля и самостоятельности было более постепенным и менее выраженным, чем контроль тремора.

3. ОБСУЖДЕНИЕ

Discussion

Представленный клинический случай интересен сочетанием сравнительно молодого возраста пациента, длительного - около 17 лет - течения болезни Паркинсона, Hoehn–Yahr IV стадии и тяжёлой аксиальной дисфункции. В отличие от пациентов, направляемых на DBS главным образом из-за моторных флуктуаций или дискинезий, у данного больного одним из центральных инвалидирующих проявлений являлся постоянный тремор в сочетании с freezing, постуральной неустойчивостью и падениями.

Современный подход к DBS всё меньше основывается на единой стратегии для всех пациентов. Wagle Shukla et al. в обзоре 2025 года подчёркивают, что результат определяется взаимодействием четырёх факторов - patient, target, device and program. Выбор мишени должен соответствовать клиническому приоритету пациента, а программирование необходимо рассматривать как динамический процесс precision neuromodulation [8]. В рассматриваемом случае операционный протокол определяет мишень как задние вентролатеральные ядра таламуса. Это позволяет интерпретировать вмешательство как стимуляцию motor thalamic territory, функционально связанную с cerebello-thalamo-cortical tremor network. Именно эта сеть является одной из основных анатомо-функциональных мишеней хирургического контроля тремора. Наиболее убедительные долговременные данные относительно таламической стимуляции были получены Cury et al. У пациентов с болезнью Паркинсона VIM-DBS обеспечивала примерно 70% уменьшение тремора через год; клинический эффект сохранялся и при наблюдении более 10 лет, что подтверждает устойчивость тремор-супрессивного действия моторной таламической DBS [9]. Это хорошо соответствует профилю настоящего случая, в котором наиболее выраженная динамика наблюдалась именно по треморному компоненту.

В то же время таламическая стимуляция не должна рассматриваться как функциональный эквивалент STN- или GPi-DBS. STN и GPi входят непосредственно в патологически изменённые basal ganglia loops и способны оказывать более широкое влияние на брадикинезию, ригидность, дискинезию и моторные флуктуации. Современный метаанализ Xu et al., включивший 35 исследований и 1082 пациента, подтвердил значимое улучшение общего UPDRS-III и ряда основных моторных доменов после DBS, но отметил значительно большую вариабельность результатов для походки и речи [14]. Именно аксиальная симптоматика представляет наиболее сложную часть интерпретации настоящего случая. До операции у пациента наблюдались freezing, propulsia, retropulsia, lateropulsia и падения. Систематический обзор Morton et al. 2024 года, включивший 17 рандомизированных исследований и 333 пациента, не выявил последовательного значимого улучшения Timed Up and Go, Berg Balance Scale или частоты падений после DBS [10]. Следовательно, умеренное восстановление равновесия в данном случае более физиологично, чем ожидание полной нормализации походки после устранения тремора.

Более того, Janssen Daalen et al. в систематическом обзоре 2025 года показали, что после двусторонней STN-DBS у части пациентов могут возникать или усиливаться freezing и нарушения равновесия; в контролируемых выборках частота таких явлений составляла 15,9% против 5,8% при best medical treatment. Хотя настоящее наблюдение касается другой мишени, эти результаты подчёркивают общую концепцию: appendicular motor improvement не гарантирует эквивалентного восстановления axial motor control [11]. Сетевой метаанализ Guo et al., опубликованный в 2026 году, дополнительно показал, что результат в отношении MDS-UPDRS III, FOG-Q и

скорости ходьбы зависит от используемой мишени и режима стимуляции. Таким образом, современная DBS должна оцениваться не единым показателем «успех/неуспех», а по отдельным symptom-specific domains [15]. Отдельное значение имеет качество жизни. Тремор, ограничение самостоятельности и страх падения способны существенно ухудшать PDQ-39 даже при сохранённой когнитивной функции. В обновлённом метаанализе Nogueira et al. 2025 года были включены 42 исследования и 2767 пациентов после двусторонней STN-DBS. Улучшение качества жизни сохранялось приблизительно до 36 месяцев, тогда как к пятилетнему сроку средние значения приближались к исходным, вероятно вследствие прогрессирования немоторных и аксиальных проявлений заболевания [12]. Когнитивный статус также должен входить в обязательную оценку DBS. Метаанализ Ning et al. 2026 года, включивший 10 рандомизированных исследований и 1274 пациента, не выявил генерализованного ухудшения общего когнитивного или нейропсихиатрического статуса по сравнению с медикаментозной терапией, однако показал небольшое специфическое ухудшение verbal fluency и Stroop interference performance [13]. Поэтому сохранение MoCA в динамике не исключает необходимости более детального нейропсихологического мониторинга.

Ещё одним определяющим компонентом является программирование. Современная парадигма больше не ограничивается выбором фиксированных значений amplitude, pulse width и frequency. Image-guided programming, physiology-guided contact selection и adaptive DBS позволяют постепенно приближаться к индивидуальной «оптимальной дозе» стимуляции, при которой therapeutic window максимизируется при минимальной активации соседних структур [8]. Для таламической стимуляции это особенно актуально, поскольку латеральное или заднее распространение тока может вызывать парестезии, а распространение в сторону corticospinal/corticobulbar fibers - мышечные сокращения или дизартрию. Не менее важна нейрореабилитация. DBS меняет патологическую активность нейрональных сетей, но не устраняет автоматически сформировавшиеся за годы болезни патологические двигательные стереотипы. Cochrane review Ernst et al. подтверждает положительное влияние различных вариантов физических упражнений на моторную функцию и качество жизни при болезни Паркинсона, причём gait/balance/functional training относится к клинически значимым направлениям [18].

Практическая модель сочетания DBS и интенсивной реабилитации была представлена Ferriero et al. в 2025 году. Авторы применяли укрепление мышц плечевого и тазового пояса, стабилизацию туловища, координационную тренировку, упражнения на статическое и динамическое равновесие, gait training и функциональное переобучение [19]. Этот принцип особенно актуален для настоящего пациента, поскольку исходные freezing и постуральная нестабильность формировали самостоятельную реабилитационную проблему независимо от степени подавления тремора. Наконец, результат DBS необходимо сопоставлять с риском вмешательства. Современная доказательная база подтверждает существенный клинический потенциал метода, одновременно демонстрируя вероятность геморрагических, инфекционных, аппаратных, когнитивных и stimulation-related осложнений [4,13]. Именно поэтому наиболее обоснованной является модель непрерывного ведения пациента: patient selection → stereotactic planning → implantation → imaging verification → programming → medication optimization → rehabilitation → longitudinal reassessment.

Представленный случай демонстрирует, что при выраженном тремор-ригидном фенотипе таламическая DBS

может обеспечить значительное уменьшение наиболее инвалидизирующего тремора, но аксиальная дисфункция требует отдельной терапевтической стратегии. Это делает мультимодальную оценку значительно более информативной, чем простое заключение о «положительном результате DBS».

4. ЗАКЛЮЧЕНИЕ

Conclusion

Двусторонняя глубокая стимуляция задневрололateralной таламической области представляет собой возможную нейромодуляционную стратегию при выраженном фармакорезистентном треморном компоненте болезни Паркинсона. Представленный пациент характеризовался длительным течением заболевания, Hoehn–Yahr IV стадией, выраженным тремор-ригидным синдромом и тяжёлыми аксиальными нарушениями. Применение frame-based стереотаксии Zamorano–Duchovny, MSCT-навигации, двусторонней имплантации Medtronic DBS-электродов и последующего индивидуального программирования позволило сформировать комплексную нейрохирургическую стратегию. Клинический профиль ответа характеризовался преимущественным уменьшением тремора, тогда как брадикинезия, ригидность, freezing и постртуральная неустойчивость изменялись более умеренно. Поэтому оптимальное ведение подобных пациентов должно объединять нейростимуляцию, фармакотерапию и длительную целенаправленную нейрореабилитацию.

DECLARATIONS

Declarations

Author contributions CRediT

Conceptualization; Methodology; Investigation; Data curation; Writing – original draft; Writing – review & editing. All authors have read and agreed to the published version of the manuscript.

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Ethics approval

The case report was prepared in accordance with the principles of the Declaration of Helsinki; publication of the anonymised clinical data was approved by the local ethics committee of the Specialized Scientific and Practical Center for Neurosurgery and Neurorehabilitation at the Samarkand State Medical University.

Informed consent

Written informed consent was obtained from the patient for publication of this case report and the accompanying anonymised images.

Data availability statement

The data supporting this case report are presented in the tables and figures of this article; further anonymised clinical records are available from the authors on reasonable request.

Conflict of interest

The authors declare no conflict of interest.

Generative AI disclosure

Generative AI (Claude, Anthropic) was used in the editorial preparation of this article: for language editing, translation of the title, abstract and keywords between Uzbek, Russian and English, preparation of the extended English summary from the authors' text, and formatting of the reference list. No data, results or conclusions were generated by AI. The authors are responsible for the content of the publication.

EXTENDED SUMMARY IN ENGLISH

Kengaytirilgan inglizcha xulosa / Расширенный реферат на английском языке

Purpose and research problem

Parkinson disease (PD) is a chronic progressive neurodegenerative disorder in which degeneration of the dopaminergic neurons of the substantia nigra pars compacta and remodelling of basal ganglia–thalamo-cortical networks produce bradykinesia, rigidity, rest tremor and postural instability; with progression, gait disorders, freezing and autonomic, sleep, cognitive and affective disturbances further reduce independence and quality of life. Long-term levodopa therapy is complicated by wearing-off, unpredictable OFF periods and dyskinesias, so the selection of candidates for deep brain stimulation (DBS) now relies on the individual motor phenotype, levodopa responsiveness, the severity of tremor and dyskinesias, axial symptoms, the cognitive and psychiatric profile and the patient's expectations rather than on disease duration alone. The subthalamic nucleus and the internal globus pallidus are the classical DBS targets in PD, whereas the ventral motor thalamus (Vim) and the adjacent ventrolateral territories) is traditionally regarded as a highly effective target for drug-resistant tremor. Marked tremor suppression, however, is not equivalent to full motor recovery, and freezing of gait, balance and postural responses remain the most difficult domains. The article presents a case of bilateral thalamic DBS in advanced tremor-rigid PD with severe axial dysfunction and describes a multimodal assessment of its outcomes.

Materials and methods

The patient was a 44-year-old man whose disease began in 2008, about 17 years before surgery, with weakness and tremor of the hands, followed by progressive tremor of the upper and lower limbs, leg weakness, imbalance and difficulty in walking independently. By August 2025 he had constant limb tremor, dizziness, marked instability when standing and walking, episodes of inability to stop a movement once started, involuntary movements of the shoulder girdle, periodic falls and general weakness; before admission he had irregularly taken Konfundus, one tablet three to five times a day. Examination revealed hypomimia, marked hypokinesia, rest tremor, plastic hypertonia and rigidity, small-step gait with freezing, and propulsion, lateropulsion and retropulsion; autonomic disturbances included constipation and episodes of urinary retention. The disease corresponded to Hoehn–Yahr stage IV, with a Karnofsky Performance Status of 70. High-field MRI showed signs of PD, cerebral microangiopathy and signal changes in the substantia nigra with the "swallow tail" phenomenon, without structural lesions that could cause secondary parkinsonism. On 28 August 2025 bilateral DBS was performed. The Zamorano–Duchovny frame (Inomed, Germany) was fixed under local anaesthesia, stereotactic MSCT was acquired and the DICOM data were planned with Medtronic DBS navigation software; under general endotracheal anaesthesia in the semi-sitting position, Medtronic electrodes were implanted sequentially on the right and on the left through 14-mm burr holes into the posterior ventrolateral thalamic nuclei documented in the operative protocol, under intraoperative C-arm fluoroscopy. The pulse generator was placed in a subcutaneous pocket in the right upper chest. Programming began about two weeks after implantation with a sequential monopolar review. Outcomes were assessed before surgery (OFF and ON medication) and at 1, 3, 6 and 12 months with MDS-UPDRS parts I–IV, the Hoehn–Yahr stage, the Schwab and England scale, PDQ-39, MoCA, the Berg Balance Scale, the Timed Up and Go test, the Freezing of Gait Questionnaire (FOG-Q) and the levodopa equivalent daily dose (LEDD).

Results and discussion

The postoperative course was free of new clinically significant focal deficit. Control MSCT showed symmetrical bilateral electrodes with their distal parts within the planned thalamic region, no intracerebral haemorrhage and a small residual frontal pneumocephalus without mass effect, and the patient was discharged on 30 August 2025. Stimulation used contact 1– on both sides (C+/1–) at 2.4 and 2.2 mA, 60 µs and 150 Hz, with therapeutic windows of 1.3–3.5 and 1.4–3.4 mA; paraesthesia and mild dysarthria appeared at high amplitudes. The most pronounced response concerned tremor, with a reduction of approximately 85% and 80% for the right- and left-sided stimulation, whereas rigidity and bradykinesia decreased less and freezing and postural instability persisted in part. At 12 months, MDS-UPDRS III in the OFF state decreased from 64 to 39 (by 39.1%), the tremor subscore from 20 to 4 (by 80.0%), the rigidity subscore by 25.0% and the

bradykinesia subscore by 22.2%; MDS-UPDRS IV decreased by 45.5% and the PDQ-39 summary index by 37.0%. The Berg Balance Scale score improved by 12 points, the Timed Up and Go time by 34.7% and FOG-Q by 38.9%; the Schwab and England score rose from 50% to 75%, MoCA changed from 25 to 26 points and LEDD fell from 850 to 750 mg/day. Neurorehabilitation focused on axial symptoms and included repeated sit-to-stand transitions, movement amplitude and step-length training, weight shifting, reactive postural responses, safe turning, passing through narrow spaces, visual and auditory cueing with rhythmic auditory stimulation, static and dynamic balance, trunk and limb strengthening and dual-task walking. The response profile corresponded mainly to the tremor-suppressive effect of thalamic stimulation, while gains in gait, postural control and independence were slower and smaller.

Conclusion and contribution

Bilateral DBS of the posterior ventrolateral thalamic region is a possible neuromodulation strategy when a drug-resistant tremor component dominates the clinical picture of PD. In this patient with long disease duration, Hoehn–Yahr stage IV, a severe tremor-rigid syndrome and marked axial disturbances, frame-based Zamorano–Duchovny stereotaxy, MSCT navigation, bilateral implantation of Medtronic electrodes and individual programming formed a comprehensive neurosurgical strategy. The response was dominated by tremor reduction, whereas bradykinesia, rigidity, freezing and postural instability changed more moderately, in line with published evidence that thalamic stimulation is not the functional equivalent of STN or GPi stimulation and that DBS does not consistently improve balance, gait or falls. DBS outcomes should therefore be assessed by separate symptom-specific domains, including quality of life and cognition, and the optimal management of such patients should combine neurostimulation, pharmacotherapy and long-term targeted neurorehabilitation within a continuous pathway from patient selection to longitudinal reassessment.

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CASE REPORT • PEER-REVIEWED • OPEN ACCESS • **SERIES A** • 14.00.00 — MEDICAL SCIENCES • UDC: 616.831-006.328-089

Anterior cranial fossa tumors: a clinical case of a large olfactory groove meningioma with bifrontal compression and peritumoral edema

Oldingi kalla chuqurchasi o'smalari: bifrontal kompressiya va perifokal shish bilan kechgan yirik hid bilish egati meningiomasining klinik holati

Опухоли передней черепной ямки: клинический случай крупной менингиомы обонятельной борозды с бифронтальной компрессией и перифокальным отёком

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Abstract. Olfactory groove meningiomas are anterior cranial fossa tumors characterized by an indolent clinical course and may therefore reach a considerable size before diagnosis, producing frontal lobe compression and peritumoral vasogenic edema. Clinical manifestations may include olfactory dysfunction, headache, visual impairment, emotional and behavioral abnormalities, cognitive dysfunction, and signs of intracranial hypertension. We report the case of a 59-year-old woman with a large extra-axial anterior cranial fossa mass located in the olfactory groove region, causing bilateral frontobasal compression, vasogenic edema, hyposmia, cerebral symptoms, and frontal behavioral dysfunction. Contrast-enhanced magnetic resonance imaging demonstrated a lesion with a maximum dimension of approximately 42 mm. Due to the symptomatic course, marked mass effect, and frontal lobe compression, microsurgical treatment was undertaken. A right frontolateral craniotomy was performed, achieving total tumor removal corresponding to Simpson grade II. Postoperatively, cerebral and frontal behavioral symptoms regressed, Karnofsky performance status improved from 70 to 80, no new motor deficit developed, and the surgical wound healed primarily. This case emphasizes the diagnostic significance of subtle olfactory and neurobehavioral manifestations, individualized selection of the surgical corridor, and the principle of maximal safe resection in anterior cranial fossa tumors.

Keywords: anterior cranial fossa; olfactory groove meningioma; frontolateral approach; microsurgery; Simpson grade II; peritumoral edema; hyposmia; frontal lobe; skull base

O'ZBEKCHA

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Annotatsiya. Hid bilish egati meningiomalari oldingi kalla chuqurchasi o'smalari guruhiga kirib, uzoq vaqt davomida kam simptomli kechishi mumkin. Shu sababli ular ko'pincha o'sma katta hajmga yetib, peshona bo'laklarini kompressiya qilgan va perifokal vazogen shish shakllangan bosqichda aniqlanadi. Klinik belgilari hid bilishning pasayishi, bosh og'rig'i, ko'rish buzilishi, emotsional-xulqiy o'zgarishlar, kognitiv disfunktsiya hamda intrakranial gipertenziya belgilari bilan namoyon bo'lishi mumkin. Ushbu maqolada 59 yoshli bemorda oldingi kalla chuqurchasi va hid bilish egati sohasida joylashgan, ikki tomonlama peshona-bazal tuzilmalarni kompressiya qilgan, perifokal shish,

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giposmiya, umumiy miya simptomlari hamda frontal ruhiy disfunktsiya bilan kechgan yirik ekstraserebral o'smaning klinik holati bayon etilgan. Kontrastli magnit-rezonans tomografiyada o'smaning maksimal o'lchami taxminan 42 mm bo'lgan. Klinik simptomlar va mass-effekt mavjudligi sabab mikroxirurgik davolash tanlangan. O'ng tomonlama frontolateral kraniotomiya orqali o'sma Simpson II darajasida total rezeksiya qilingan. Operatsiyadan keyin umumiy miya va frontal-ruhiy simptomlar regressiyasi, Karnovskiy indeksining 70 dan 80 ballgacha yaxshilanishi va yangi harakat defitsitining yo'qligi kuzatilgan. Klinik holat individual jarrohlik yondashuvini tanlash va maksimal xavfsiz rezeksiya tamoyilining ahamiyatini ko'rsatadi.

Kalit so'zlar: oldingi kalla chuqurchasi; hid bilish egati meningiomas; frontolateral kirish; mikroxirurgiya; Simpson II; perifokal shish; giposmiya; peshona bo'lgi

РУССКИЙ

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Аннотация. Менингиомы обонятельной борозды относятся к опухолям передней черепной ямки и характеризуются длительным клинически малосимптомным течением, вследствие чего нередко диагностируются уже при значительном объеме опухолевой массы, компрессии лобных долей и формировании перифокального вазогенного отека. Клиническая картина может включать нарушение обоняния, головную боль, зрительные расстройства, изменения эмоционально-поведенческой сферы, когнитивную дисфункцию и признаки внутричерепной гипертензии. Представлен клинический случай 59-летней пациентки с крупным экстрацеребральным новообразованием передней черепной ямки, локализованным в области обонятельной борозды и сопровождавшимся двусторонней лобно-базальной компрессией, вазогенным отеком, гипосмией, общемозговой симптоматикой и эмоционально-лобной дисфункцией. По данным контрастной магнитно-резонансной томографии максимальный размер образования составлял около 42 мм. С учетом симптомности, выраженного масс-эффекта и компрессии лобных долей принято решение о микрохирургическом лечении. Выполнена правосторонняя фронтолатеральная крааниотомия с тотальным удалением опухоли по Simpson II. В послеоперационном периоде отмечены регресс общемозговой симптоматики и лобно-психических нарушений, улучшение функционального статуса по шкале Карновского с 70 до 80 баллов, отсутствие нового двигательного дефицита и удовлетворительное заживление раны. Клинический случай демонстрирует значение раннего распознавания малоспецифичных нейropsychологических и обонятельных симптомов, индивидуального выбора хирургического коридора и соблюдения принципа максимально безопасной резекции при опухолях передней черепной ямки.

Ключевые слова: передняя черепная ямка; менингиома обонятельной борозды; менингиома; фронтолатеральный доступ; микрохирургия; Simpson II; перифокальный отек; гипосмия; лобная доля; основание черепа

1. ВВЕДЕНИЕ

Introduction

Менингиомы являются одними из наиболее распространенных первичных внутричерепных новообразований и представляют собой гетерогенную группу опухолей менинготелиального происхождения. Согласно современной классификации опухолей центральной нервной системы Всемирной организации здравоохранения, менингиома рассматривается как единый тип опухоли с различными морфологическими подтипами и степенями злокачественности CNS WHO grade 1–3, при этом всё большее прогностическое значение приобретают молекулярно-генетические характеристики опухолевой ткани [1, 2]. Мутация промотора TERT и гомозиготная делеция CDKN2A/B могут определять более агрессивный биологический профиль и учитываются в современной классификационной системе независимо от классической морфологической картины [2].

Клиническая тактика при менингиомах определяется сочетанием симптомности, динамики роста, нейроанатомической локализации, возраста и функционального состояния пациента. При симптомной или растущей опухоли хирургическая резекция остаётся базовым методом лечения, однако современная концепция нейроонкологической хирургии предполагает не максимальную анатомическую радикальность любой ценой, а максимально безопасное удаление с сохранением

неврологических и нейрокогнитивных функций [1, 24, 25]. Менингиомы обонятельной борозды представляют специфическую группу опухолей переднего основания черепа, исходящих преимущественно из арахноидальных клеток области решётчатой пластинки, фронтотенториального шва и прилежащей твёрдой мозговой оболочки. По данным различных хирургических серий, они составляют приблизительно 8–13% внутричерепных менингиом [5–7]. Их анатомическое положение определяет характерное направление роста: опухоль постепенно распространяется кзади и вверх, приподнимая и компримируя базальные отделы обеих лобных долей, способна смещать передние мозговые артерии, вовлекать комплекс передней соединительной артерии, зрительные нервы и хиазму, а при значительном распространении – решётчатую кость и околоносовые пазухи [5, 6, 12].

Клиническая диагностика нередко запаздывает. Обонятельная дисфункция может прогрессировать постепенно и оставаться незамеченной пациентом. Компрессия вентромедиальной и орбитофронтальной коры приводит к нарушениям мотивации, эмоциональной лабильности, апатии, снижению критики, изменению поведения и исполнительных функций. В крупной серии Bassiouni и соавт. нарушения психики выявлялись более чем у половины пациентов, нарушения обоняния – более чем у 70%, а снижение зрения – приблизительно у одной пятой [7]. Современные

нейропсихологические исследования подтверждают, что особенно уязвимыми функциями являются когнитивная гибкость, внимание и исполнительный контроль [13, 14].

Систематический обзор Pashkov и соавт. показал, что когнитивные, аффективные и поведенческие нарушения при менингиомах обонятельной борозды встречаются значительно чаще, чем предполагает обычное неврологическое обследование. Депрессия, апатия, изменения личности, нарушения внимания и памяти нередко предшествуют выраженному очаговому неврологическому дефициту [14]. Эти особенности имеют принципиальное диагностическое значение: пациент с постепенно формирующимся изменением поведения и нарушением обоняния может первоначально обращаться не к нейрохирургу, а к неврологу, психиатру, оториноларингологу или офтальмологу. Перифокальный вазогенный отёк является ещё одной важной характеристикой крупных менингиом передней черепной ямки. Его выраженность может существенно превосходить ожидаемую исходя только из размеров опухоли и обуславливать внутричерепную гипертензию, когнитивно-поведенческие нарушения и повышенный риск послеоперационной дисфункции лобных долей. В серии из 129 больных размер опухоли, выраженность прилежащего отёка, вовлечение комплекса передних мозговых артерий и экстракраниальное распространение являлись факторами, существенно влиявшими на сложность хирургического вмешательства и исход [12]. Хирургические доступы к менингиомам обонятельной борозды эволюционировали от широких двусторонних субфронтальных краниотомий к односторонним фронтолатеральным, птериональным, латеральным супраорбитальным и эндоскопическим эндоназальным коридорам [5–10, 16–20]. Исторически двусторонний субфронтальный доступ обеспечивал широкую экспозицию передней черепной ямки, но был связан с двусторонней ретракцией лобных долей, риском повреждения мостовых вен, вскрытия лобной пазухи и нарушений обоняния. Односторонние доступы позволяют уменьшить объём экспозиции мозга при сохранении возможности раннего контроля заднего нейроваскулярного комплекса [5, 8–10].

Nakamura и соавт. при сравнении фронтолатерального и бифронтального доступов показали возможность достижения резекции Simpson I–II более чем у 90% пациентов при обоих вариантах, при этом фронтолатеральный доступ характеризовался меньшей хирургической травматичностью [5]. El-Bahy продемонстрировал, что фронтолатеральный коридор особенно эффективен при опухолях менее 4 см и может применяться при более крупных образованиях при отсутствии выраженного охвата комплекса передней мозговой артерии [10]. Результаты современной метааналитической литературы также поддерживают индивидуализированный выбор доступа. Feng и соавт. не обнаружили значимого снижения радикальности резекции при односторонних доступах по сравнению с двусторонними, тогда как частота ряда осложнений и периоперационной летальности была ниже при односторонних краниотомиях [16]. Пул-анализ более чем 1000 пациентов показал, что Simpson I–II может быть достигнут приблизительно в 90% случаев открытого микрохирургического лечения, однако общая хирургическая морбидность остаётся клинически значимой [17]. Эндоскопический эндоназальный доступ создаёт прямой вентральный путь к месту прикрепления опухоли и обеспечивает раннюю деваскуляризацию, но сопряжён с риском послеоперационной ликвореи и фатически неизбежным повреждением обонятельного аппарата при классическом расширенном трансэмоидальном доступе [18–20]. В метаанализе 2026 года не выявлено достоверной разницы между эндоназальным и транскраниальным подходами по частоте полной резекции и рецидива, однако

вероятность ликвореи после эндоназальной операции была значительно выше [20]. Поэтому крупные латерально распространяющиеся образования с компрессией лобных долей и сложными отношениями с сосудами передней циркуляции продолжают рассматриваться как сильная область применения транскраниальных доступов. Функция обоняния в современной хирургии больше не должна рассматриваться как второстепенный исход. Систематический обзор Candy и соавт. продемонстрировал возможность объективного сохранения обоняния у части пациентов после различных транскраниальных вмешательств и подчеркнул необходимость до- и послеоперационного применения стандартизированных тестов обоняния [21]. Особенно это актуально у пациентов с гипосмией, но не полной аносмией.

Степень радикальности традиционно оценивается классификацией Simpson, предложенной в 1957 году [22]. При Simpson II выполняется макроскопически полное удаление опухоли с коагуляцией её дурального основания. Несмотря на продолжающуюся дискуссию о прогностическом значении данной шкалы, объём резекции остаётся одним из ключевых факторов локального контроля [23–27]. Современные исследования одновременно подчёркивают необходимость сопоставлять интраоперационную оценку Simpson с ранней контрастной МРТ и молекулярно-гистологической характеристикой опухоли [24–27].

2. МАТЕРИАЛЫ И МЕТОДЫ

Materials and methods

Работа выполнена в формате клинического случая с аналитическим обзором современной литературы и адаптирована к структуре IMRAD. При подготовке описания использованы данные выписного эпикриза, результаты клинического и неврологического обследования, магнитно-резонансной томографии, лабораторно-инструментальных исследований и сведения о хирургическом лечении. Структура клинического сообщения формировалась с учётом основных принципов рекомендаций CARE для клинических случаев [3]. Из публикации исключены имя, точный адрес и другие идентифицирующие сведения пациентки. Перед подачей рукописи в журнал необходимо документально подтвердить наличие письменного информированного согласия пациентки на публикацию обезличенных клинических данных и диагностических, интраоперационных и послеоперационных изображений. В предоставленном выписном эпикризе информация о таком согласии отсутствует. Литературный анализ включал международные рекомендации по менингиомам, классификацию WHO CNS5, хирургические серии менингиом обонятельной борозды, систематические обзоры и метаанализы, посвящённые транскраниальным и эндоскопическим доступам, сохранению обоняния, нейропсихологическим исходам и прогностическому значению объёма резекции [1–35]. В клинической документации обнаружена разница между двумя вариантами измерения образования. В основном диагнозе приведены размеры 42×31×26 мм, тогда как в заключении контрастной МРТ указаны размеры приблизительно 42×37×32 мм. В клиническом анализе данные приведены с указанием этого расхождения; окончательная рукопись должна использовать размеры, подтверждённые повторным просмотром исходных DICOM-изображений. Кроме того, дата операции в выписном эпикризе обозначена как 11.09.2024, несмотря на период данной госпитализации в сентябре 2026 года. Поскольку документ не позволяет достоверно устранить это противоречие, календарная дата хирургического вмешательства в настоящем варианте статьи не конкретизируется и должна быть уточнена по операционному журналу.

3. РЕЗУЛЬТАТЫ

Results

3.1. Клинический случай

Пациентка 59 лет была госпитализирована в нейрохирургическое отделение с жалобами на головную боль, головокружение, эпизод потери сознания, снижение обоняния, ухудшение зрения, чувство онемения в верхних и нижних конечностях и общую слабость. Из анамнеза известно, что приблизительно в течение месяца до госпитализации отмечалось постепенное ухудшение состояния. Примерно за две недели до обращения в специализированный нейрохирургический стационар произошёл эпизод кратковременной потери сознания во время бытовой активности, после чего пациентка была обследована неврологом. По результатам нейровизуализации рекомендована консультация нейрохирурга.

При поступлении общее состояние оценивалось как средней тяжести. Сознание ясное, 15 баллов по шкале комы Глазго. Исходный функциональный статус по шкале Карновского составлял 70 баллов. Определялись общемозговые проявления в виде цефалгического и вестибулярного синдрома, расценённые в совокупности с нейровизуализацией как проявления внутричерепной гипертензии.

В неврологическом статусе обращала на себя внимание дисфункция I пары черепных нервов в виде гипосмии. Со стороны психоэмоциональной сферы отмечались снижение настроения, тревожность и эмоциональная лабильность, что клинически соответствовало дисфункции фронтальных

отделов. В медицинской документации со стороны II пары черепных нервов отмечено снижение остроты зрения обоих глаз, обозначенное как амблиопия. Движения глазных яблок сохранялись в полном объёме, лицо было симметричным, слух сохранён, бульбарных нарушений не выявлено. Парезов конечностей не было. В позе Ромберга отмечалось пошатывание; координаторные пробы выполнялись с лёгкой интенцией. Нарушений тазовых функций не зарегистрировано.

Офтальмологическое обследование выявило ангиоспазм сосудов сетчатки обоих глаз. При осмотре оториноларингологом патологических изменений при риноскопии не обнаружено. Электроэнцефалография выявила эпилептиформную активность, что в контексте эпизода потери сознания представляло дополнительное основание для последующего противосудорожного контроля. По данным первичной магнитно-резонансной томографии головного мозга определялось крупное объёмное образование лобно-базальной области, сопровождавшееся перифокальным отёком и масс-эффектом. В заключении образование расценено как менингиома обонятельной борозды. В одном разделе медицинской документации размеры составляли 4,2×3,1×2,6 см.

Контрастная МРТ выявила немозговое объёмное образование передней черепной ямки и передней трети серпа большого мозга размерами приблизительно 36×31×31 мм, сопровождавшееся выраженной компрессией правой лобной доли, перифокальным вазогенным отёком и нейровизуализационными признаками внутричерепной гипертензии (Рис. 1).

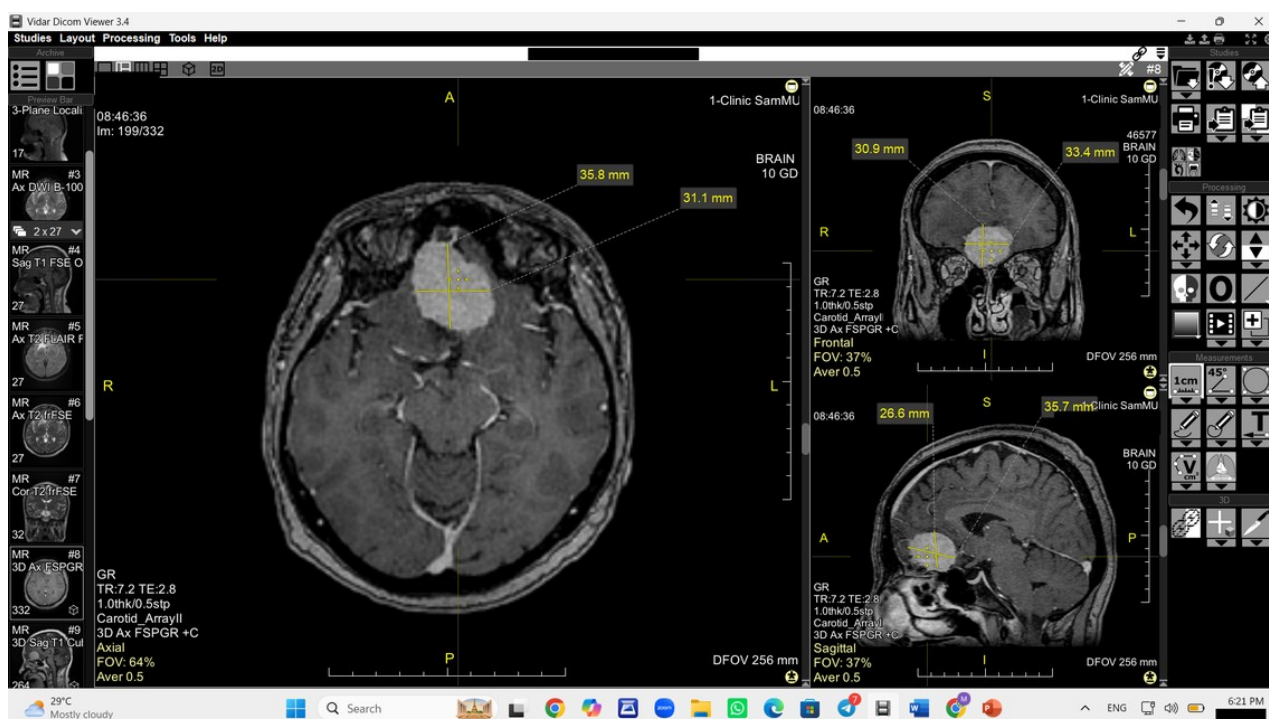


Рис. 1. Предоперационная МРТ головного мозга. Аксиальные, корональные и сагиттальные изображения после внутривенного контрастирования / **Fig. 1.** Preoperative brain MRI. Axial, coronal and sagittal images after intravenous contrast enhancement

Дифференциально-диагностический ряд опухолей передней черепной ямки включал менингиому обонятельной борозды, менингиому площадки основной кости, эстезионейробластому с интракраниальным распространением, солитарную фиброзную опухоль, метастатическое экстрааксиальное образование и другие более редкие опухоли переднего основания черепа. Однако немозговой характер роста, топографическая связь с передним основанием черепа и характерная клинко-рентгенологическая картина позволяли в первую очередь предполагать менингиому обонятельной борозды.

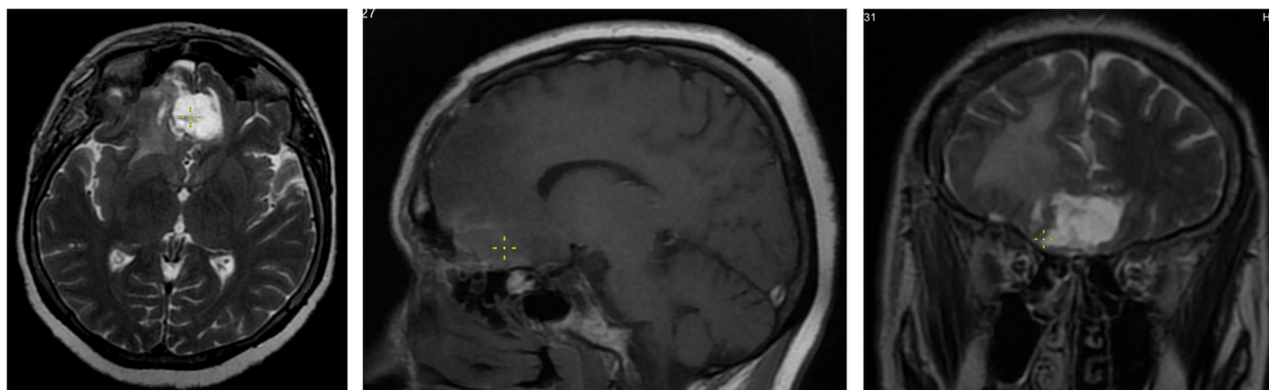
Таблица 1Клинико-нейровизуализационные особенности представленного случая / **Table 1.** Clinical and neuroimaging features of the presented case

Параметр	Данные пациентки	Клиническое значение
Возраст	59 лет	Типичный возрастной диапазон для спорадических менингиом
Основные жалобы	Головная боль, головокружение, потеря сознания, гипосмия, ухудшение зрения	Сочетание общемозговой и фронтобазальной симптоматики
GCS	15 баллов	Сознание сохранено
Karnofsky до операции	70 баллов	Симптомная опухоль с ограничением обычной активности
Обоняние	Гипосмия	Характерный локализационный симптом
Психоэмоциональный статус	Тревожность, снижение настроения, эмоциональная лабильность	Фронтобазальная дисфункция
Размер опухоли	36×31×31 мм	Крупное объёмное образование; требуется сверка DICOM
Локализация	Передняя черепная ямка, обонятельная борозда	Соответствует клиническому синдрому
Перифокальный отёк	Выраженный	Дополнительный фактор масс-эффекта
EEG	Эпилептиформная активность	Обосновывает дальнейший судорожный контроль
Хирургический доступ	Правосторонний фронтолатеральный	Односторонний транскраниальный коридор
Радикальность	Simpson II	Макроскопически полная резекция с обработкой дурального основания
Карновский при выписке	80 баллов	Раннее функциональное улучшение

С учётом симптомного течения, крупного размера образования, выраженной компрессии лобных долей, перифокального вазогенного отёка и признаков внутричерепной гипертензии принято решение о хирургическом лечении. Был выбран правосторонний фронтолатеральный транскраниальный доступ. Согласно выписной документации выполнена краниотомия с микрохирургическим удалением экспансивно растущего образования передней черепной ямки, компримировавшего базальные отделы обеих лобных долей. Операционная радикальность определена хирургами как Simpson II, то есть макроскопически полное удаление опухолевой ткани с коагуляцией её дурального прикрепления. Подробности интраоперационного этапа, включая последовательность деваскуляризации, отношение опухолевой капсулы к передним мозговым артериям, передней соединительной артерии, обонятельным трактам и зрительным нервам, а также кровопотерю и продолжительность операции, в представленном выписном эпикризе отсутствуют. Эти данные

необходимо дополнить из полного операционного протокола, не заменяя их предполагаемым стандартным описанием.

В раннем послеоперационном периоде состояние пациентки характеризовалось положительной клинической динамикой. К моменту выписки активных жалоб она не предъявляла. Сознание оставалось ясным, 15 баллов по шкале комы Глазго. Функциональный статус по шкале Карновского улучшился с 70 до 80 баллов. Общемозговые симптомы регрессировали. Отмечалась положительная динамика гипосмии и фронтальной психоэмоциональной дисфункции. Нового пареза или дисфункции каудальной группы черепных нервов не возникло. Движения глазных яблок сохранялись в полном объёме, лицо оставалось симметричным, слух сохранён. Снижение остроты зрения, ранее обозначенное как амблиопия, сохранялось. В позе Ромберга сохранялось пошатывание, координаторные пробы выполнялись с лёгкой интенцией. Послеоперационная рана заживала первичным натяжением, повязка была сухой и чистой.

**Рис. 2.** МРТ головного мозга: аксиальная, сагиттальная и корональная проекции / **Fig. 2.** Brain MRI: axial, sagittal and coronal views

Пациентке рекомендовано динамическое наблюдение нейрохирурга и невролога, контрольная МРТ и электроэнцефалография через один месяц. С учётом эпилептиформной активности назначена противосудорожная терапия карбамазепином.

Таблица 2Динамика клинического состояния / **Table 2.** Changes in clinical status

Показатель	До операции	При выписке
Сознание	Ясное, GCS 15	Ясное, GCS 15
Karnofsky	70	80
Головная боль/головозвонение	Выражены	Регрессировали

Показатель	До операции	При выписке
Обоняние	Гипосмия	Положительная динамика, остаточная дисфункция
Фронтально-психические нарушения	Эмоциональная лабильность, тревожность, снижение настроения	Регрессируют
Двигательный дефицит	Нет	Нет
Нарушение координации	Лёгкая интенция, неустойчивость в Ромберге	Незначительные проявления сохраняются
Зрение	Снижено	Снижение сохраняется
Рана	-	Первичное заживление

4. ОБСУЖДЕНИЕ

Discussion

Представленный случай иллюстрирует несколько характерных особенностей опухолей передней черепной ямки и, в частности, менингиом обонятельной борозды.

Первая из них заключается в несоответствии относительно короткого анамнеза, сообщаемого пациентом, и значительного объёма опухоли на момент диагностики. Менингиомы данной локализации способны долго расти клинически скрыто, поскольку лобные доли постепенно адаптируются к хронической компрессии, а нарушение обоняния нередко не воспринимается пациентом как симптом, требующий срочного обследования [5–7, 11, 12]. У пациентки опухоль уже достигала приблизительно 4,2 см по максимальному измерению и сопровождалась двусторонней лобно-базальной компрессией и выраженным перифокальным отёком. Подобная комбинация способна объяснить головную боль, головокружение, эмоциональную лабильность и эпизод потери сознания. Наличие эпилептиформной активности на электроэнцефалограмме дополнительно указывает на функциональную кортикальную раздражимость, вероятно связанную с масс-эффектом и отёком прилежащей лобной ткани.

Вторая важная особенность - наличие гипосмии и относительно мягких психоэмоциональных изменений при отсутствии грубого двигательного дефицита. Именно такая клиническая картина характерна для медленно растущих лобно-базальных образований. Bassiouni и соавт. выявили психические нарушения более чем у половины пациентов и объективные нарушения обоняния приблизительно у 72% больных [7]. Fountas и соавт. также подчёркивали высокую частоту изменений личности и когнитивных нарушений при крупных опухолях [11].

Современные данные заставляют оценивать нейropsychологическую функцию при менингиомах обонятельной борозды значительно глубже. Constanthin и соавт. продемонстрировали дооперационный дефицит прежде всего когнитивной гибкости и внимания, причём непосредственно после хирургии возможно транзитное ухудшение, а затем постепенное восстановление в течение последующего года [13]. Систематический обзор 2025 года показал, что аффективные и поведенческие нарушения остаются недооценёнными и редко исследуются стандартизированными шкалами [14]. Поэтому в подобных случаях целесообразно включать в протокол MoCA, Frontal Assessment Battery, тесты внимания, исполнительной функции и эмоционального состояния. Третьей особенностью является выраженный перифокальный вазогенный отёк. Goel и соавт. показали, что сочетание большого размера опухоли, отёка и

вовлечения комплекса передней мозговой артерии повышает хирургическую сложность и влияет на исход [12]. При значительном отёке особенно важно минимизировать механическую ретракцию лобной доли, поскольку дополнительная хирургическая травма может увеличивать риск послеоперационной когнитивной дисфункции, венозного инфаркта и отёка. Выбор правостороннего фронтолатерального доступа в представленном случае соответствует современной тенденции к использованию односторонних транскраниальных коридоров для большинства доступных через них менингиом обонятельной борозды. Hassler и Zentner ещё в ранней серии подчёркивали преимущества одностороннего птерионального подхода, связанные с сохранением лобной доли и ранним контролем сосудистых структур [9]. Spektor и соавт. показали, что выбор хирургического коридора должен определяться не догматической приверженностью одному доступу, а размерами опухоли, её латеральным распространением, отношением к передним мозговым артериям и основанию черепа [6].

Nakamura и соавт. непосредственно сравнили фронтолатеральный и бифронтальный доступы. Радикальность удаления была сопоставима, однако односторонний фронтолатеральный подход позволял уменьшить экспозицию нормальной мозговой ткани [5]. В представленном случае образование компримировало обе лобные доли, но было удалено через односторонний коридор, что подтверждает возможность достижения достаточной хирургической экспозиции без обязательного выполнения широкой бифронтальной краниотомии.

El-Bahy рассматривал размер более 4 см и охват комплекса передней мозговой артерии как факторы, способные ограничивать удобство фронтолатерального доступа [10]. Размер настоящей опухоли находится как раз в пограничной категории более 4 см. Поэтому для полноценного анализа хирургической тактики особенно важны отсутствующие пока сведения о взаимоотношении капсулы с A2-сегментами передних мозговых артерий и передней соединительной артерией. Если интраоперационные изображения демонстрируют сохранность и чёткую диссекцию этих структур, их следует обязательно включить в окончательную публикацию. Латеральный супраорбитальный подход также позволяет работать с опухолями этой области с ограниченной экспозицией мозга. Romani и соавт. на серии из 66 последовательных пациентов показали возможность эффективного удаления менингиом обонятельной борозды через латеральный супраорбитальный коридор [8]. Птериональный доступ, напротив, обеспечивает ранний доступ к заднему полюсу опухоли, зрительному нерву, внутренней сонной и передней мозговой артериям, что особенно ценно при опухолях с выраженным задним распространением. Современные метаанализы дают дополнительные аргументы в пользу односторонних транскраниальных доступов. Feng и соавт. проанализировали более 1000 пациентов и обнаружили сходную частоту тотального удаления при односторонних и двусторонних операциях - около 95 и 91% соответственно, при более высокой летальности и частоте менингита в двусторонней группе [16]. Необходимо учитывать возможное смещение отбора: для бифронтальной операции могли изначально направляться более крупные и сложные опухоли. Пул-анализ 1016 операций также показал, что полное удаление Simpson I–II может быть достигнуто у подавляющего большинства больных, однако приблизительно четверть пациентов испытывает те или иные послеоперационные осложнения [17]. Таким образом, техническая радикальность не должна быть единственным критерием качества хирургии.

Особого обсуждения заслуживает эндоскопический эндоназальный доступ. Его достоинством является работа по срединному вентральному направлению с возможностью ранней обработки дуральной матрицы опухоли. Однако при менингиомах обонятельной борозды доступ проходит через структуры основания передней черепной ямки и сопряжён с высокой вероятностью утраты обоняния. Purohit и соавт. в систематическом обзоре выявили более высокую частоту полного удаления в транскраниальной группе и существенно меньшую частоту ликвореи [18]. В более раннем анализе Komotar и последующих авторов также обсуждались ограничения эндоназальной хирургии крупных латерально распространяющихся опухолей, особенно при охвате сосудов и выраженном фронтальном компоненте [19]. Вместе с тем современные технологии реконструкции основания черепа улучшили результаты эндоскопической хирургии, и прямое противопоставление двух методов становится менее корректным. В наиболее свежем метаанализе Hafiz и соавт., опубликованном в 2026 году, частота полной резекции и рецидива статистически значимо не отличалась между эндоскопическим эндоназальным и транскраниальным подходами, однако эндоназальная хирургия сопровождалась более чем пятикратным увеличением шансов послеоперационной ликвореи [20]. Это поддерживает концепцию индивидуального выбора: небольшие срединные опухоли с выраженным зрительным компонентом могут быть кандидатами для эндоназального удаления, тогда как крупная опухоль с лобной компрессией, как в представленном случае, остаётся сильным аргументом в пользу транскраниального доступа.

Современный сравнительный метаанализ Brown и соавт. также показал отсутствие убедительной универсальной хирургической техники, превосходящей остальные по всем исходам; односторонние доступы в целом характеризовались более благоприятным профилем осложнений и сохранения обоняния по сравнению с двусторонними [28]. Это ещё раз подчёркивает, что анатомия конкретной опухоли должна определять хирургический доступ, а не наоборот. Функция обоняния у нашей пациентки представляет отдельный интерес. До операции имелась гипосмия, то есть обонятельная функция была снижена, но не полностью утрачена. Candy и соавт. показали, что сохранение объективно измеряемого обоняния после транскраниальной хирургии возможно [21]. Поэтому при наличии предоперационной гипосмии потенциальное сохранение обонятельного тракта следует рассматривать как функциональную цель операции наряду с тотальной резекцией.

При подготовке окончательной статьи целесообразно не ограничиваться субъективной записью «гипосмия», а при возможности добавить формализованное исследование обоняния. Даже если дооперационное тестирование не проводилось, объективное послеоперационное исследование может быть полезно для последующего наблюдения. Радикальность Simpson II в представленном случае означает визуальное полное удаление опухоли с коагуляцией её дурального основания. Классическая система Simpson была предложена почти семь десятилетий назад [22], однако до настоящего времени широко используется в нейрохирургических публикациях.

Вопрос о различии между Simpson I и II остаётся дискуссионным. Brokinkel и соавт. показали сохраняющуюся связь степени резекции с риском прогрессирования [23]. Voß и соавт., напротив, продемонстрировали, что прогностическая ценность Simpson существенно зависит от локализации менингиомы и может быть меньше при опухолях основания черепа [25]. Chotai и Schwartz справедливо отмечают, что субъективной хирургической оценки уже недостаточно:

современная оценка радикальности должна включать послеоперационную контрастную МРТ, остаточный объём и биологические характеристики опухоли [24]. Spille и соавт. обнаружили остаточную опухолевую ткань на послеоперационной МРТ у части пациентов, которым интраоперационно была выставлена макроскопически полная резекция [26]. В то же время опубликованные в 2026 году международные данные более чем 4000 больных вновь показали статистическую связь более высокой степени Simpson с риском рецидива даже среди пациентов после макроскопически тотального удаления, хотя сила этой связи зависела от WHO grade, Ki-67 и локализации опухоли [27]. Следовательно, наиболее рациональный подход состоит не в отказе от Simpson, а в её интеграции с послеоперационной МР-волнометрией и молекулярно-гистологическим профилем.

По классификации WHO CNS5 наличие инвазии мозга, митотической активности и некоторых морфологических признаков может переводить опухоль в grade 2, тогда как мутация промотора TERT или гомозиготная делеция CDKN2A/B определяют grade 3 независимо от ряда классических признаков [2, 29]. Послеоперационное улучшение состояния пациентки соответствует закономерной декомпрессии фронтобазальных отделов. Функциональный статус по Карновскому вырос с 70 до 80 баллов, общемозговая симптоматика уменьшилась, эмоционально-лобная дисфункция и нарушение обоняния продемонстрировали регресс. Это согласуется с наблюдениями Bassiouni и Fountas, согласно которым зрительные и психические симптомы после адекватной декомпрессии могут существенно улучшаться [7, 11].

Однако ранний клинический результат не отражает окончательного нейрокогнитивного исхода. Constanthin и соавт. показали, что часть исполнительных функций восстанавливается постепенно на протяжении месяцев, а внимание и когнитивная гибкость могут оставаться снижены через год после операции [13]. Pashkov и соавт. также подчёркивают необходимость длительного нейropsychологического наблюдения [14]. Послеоперационная МРТ имеет принципиальное значение. У данной пациентки рекомендован контроль через месяц, что позволяет оценить состояние ложа опухоли, регресс отёка и возможный остаточный контрастирующий компонент. В дальнейшем периодичность наблюдения следует определять с учётом окончательного WHO grade, Simpson II и послеоперационной нейровизуализации в соответствии с рекомендациями EANO [1]. Для менингиомы CNS WHO grade 1 после тотальной резекции требуется длительное МР-наблюдение, поскольку даже доброкачественная опухоль может рецидивировать спустя годы. Более высокая степень WHO требует существенно более плотного контроля и рассмотрения вопроса о лучевой терапии в зависимости от радикальности, рецидива и других факторов риска [1, 2].

Исследование Nakamura продемонстрировало низкую частоту рецидивов после радикальной хирургии менингиом обонятельной борозды [5]. В то же время Bassiouni сообщил рецидивы примерно у 9% пациентов при среднем наблюдении более пяти лет [7], а Fountas - пятилетнюю частоту рецидива около 12% [11]. Различия отражают неодинаковую биологию опухолей, степень резекции, длительность наблюдения и хирургические серии.

Отдельного внимания заслуживает профилактика и наблюдение за эпилептическими приступами. У пациентки был эпизод потери сознания, а электроэнцефалография выявила эпилептиформную активность. Назначение противосудорожной терапии в конкретном случае следует рассматривать в контексте клинической вероятности эпилептического приступа и дальнейших результатов ЭЭГ. В

окончательной публикации желательнo уточнить семиологию эпизода потери сознания, наличие или отсутствие судорог, прикуса языка, амнезии, постиктальной спутанности и других

признаков, позволяющих дифференцировать эпилептический приступ от синкопального состояния.

Таблица 3

Сравнительная характеристика основных хирургических доступов при менингиоме обонятельной борозды / **Table 3.** Comparison of the main surgical approaches to olfactory groove meningioma

Доступ	Основные преимущества	Основные ограничения	Потенциально оптимальная ситуация
Бифронтальный субфронтальный	Широкий двусторонний обзор, удобен при массивном латеральном распространении	Двусторонняя ретракция лобных долей, венозный риск, лобная пазуха, обонятельные пути	Очень крупная двусторонняя опухоль со сложной латеральной анатомией
Фронтолатеральный	Ограниченная экспозиция мозга, ранний доступ к опухоли, возможность Simpson I–II	Сложнее при массивном сосудистом охвате и крайнем контралатеральном распространении	Средние и крупные опухоли без критического охвата АСА
Птериональный	Ранний контроль зрительного нерва, ICA, АСА и заднего полюса опухоли	Латеральный угол обзора к противоположной стороне	Заднее распространение, сосудистые взаимоотношения
Латеральный супраорбитальный	Малый костный доступ, хороший базальный коридор	Ограниченная манёвренность при очень крупных опухолях	Выбранные средние опухоли
Эндоскопический эндоназальный	Ранняя деваскуляризация основания, прямой срединный доступ, отсутствие ретракции мозга	Ликворея, потеря обоняния, ограничения при выраженном латеральном распространении	Отдельные срединные опухоли, особенно при зрительной компрессии

С клинической точки зрения оригинальность представленного наблюдения заключается не в редкости самой менингиомы обонятельной борозды, а в сочетании крупного срединного образования с двусторонней лобно-базальной компрессией и выраженным отёком, при котором тотальная резекция Simpson II была достигнута через односторонний правый фронтолатеральный доступ с ранним улучшением нейропсихологических и общемозговых симптомов.

Таблица 4

Практические особенности представленного случая в контексте современной литературы / **Table 4.** Practical features of the presented case in the context of current literature

Особенность случая	Значение
Опухоль более 4 см	Погранично крупный размер для ограниченного одностороннего доступа
Бифронтальная компрессия	Может провоцировать эмоционально-поведенческие и исполнительные нарушения
Выраженный вазогенный отёк	Повышает клиническую симптоматику и требует минимизации ретракции мозга
Сохранённая частичная функция обоняния	Создаёт функциональную цель сохранения оставшегося обонятельного пути
Односторонний фронтолатеральный доступ	Снижает объём хирургической экспозиции при достаточной радикальности
Simpson II	Макроскопически полное удаление с коагуляцией дурального основания
KPS 70 → 80	Раннее объективное функциональное улучшение
Регресс фронтальных симптомов	Подтверждает роль масс-эффекта в психоэмоциональной симптоматике
Отсутствие гистологии в имеющемся документе	Не позволяет окончательно установить CNS WHO grade
Необходимость послеоперационной МРТ	Верификация отсутствия резидуальной опухоли и создание исходной точки наблюдения

Ограничением настоящего клинического сообщения является отсутствие в представленном материале полного операционного протокола, патоморфологического заключения, ранней послеоперационной МРТ и отдалённого катамнеза. Кроме того, расхождение размеров опухоли между двумя разделами медицинской документации и техническое противоречие в календарной дате операции требуют обязательной сверки с первичными источниками перед

отправкой рукописи. После добавления имеющихся у авторов предоперационных, интраоперационных и послеоперационных изображений, патоморфологии и хотя бы 1–3-месячного контрольного исхода клиническая ценность сообщения существенно возрастёт.

5. ЗАКЛЮЧЕНИЕ

Conclusion

Менингиомы обонятельной борозды представляют собой сложную категорию опухолей передней черепной ямки, клиническая диагностика которых может запаздывать из-за медленного роста, постепенного нарушения обоняния и малозаметных изменений эмоционально-поведенческой и когнитивной сферы. Представленный клинический случай демонстрирует крупное экстрааксиальное образование передней черепной ямки с двусторонней лобно-базальной компрессией, перифокальным вазогенным отёком, внутрочерепной гипертензией, гипосмией и фронтальной психоэмоциональной дисфункцией. Правосторонний фронтолатеральный транскраниальный доступ позволил выполнить тотальное микрохирургическое удаление опухоли по Simpson II без формирования нового двигательного или выраженного краниального неврологического дефицита. В раннем послеоперационном периоде зарегистрированы регресс общемозговой и фронтальной симптоматики и повышение функционального статуса по шкале Карновского. Клинический случай подчёркивает целесообразность индивидуального выбора доступа с учётом размера, направления роста, перифокального отёка, состояния обонятельной функции и взаимоотношений опухоли с нейроваскулярными структурами. Современная хирургия менингиом передней черепной ямки должна быть ориентирована не только на анатомическую радикальность, но и на минимизацию ретракционной травмы, сохранение функции зрительных и обонятельных путей и восстановление когнитивно-поведенческого статуса пациента. Для окончательной онкологической стратификации данного случая необходимо включение патоморфологического заключения, CNS WHO grade, пролиферативного индекса и результатов послеоперационной контрастной МРТ.

DECLARATIONS

Declarations

Author contributions *CRedit*

Conceptualization; Methodology; Investigation; Data curation; Writing – original draft; Writing – review & editing. All authors have read and agreed to the published version of the manuscript.

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Ethics approval

The case report was prepared in accordance with the principles of the Declaration of Helsinki and the CARE guidelines; publication of the anonymised clinical data was approved by the local ethics committee of the Specialized Scientific and Practical Center for Neurosurgery and Neurorehabilitation at the Samarkand State Medical University.

Informed consent

Written informed consent was obtained from the patient for publication of this case report and the accompanying anonymised images.

Data availability statement

The data supporting this case report are presented in the tables and figures of this article; further anonymised clinical records are available from the authors on reasonable request.

Conflict of interest

The authors declare no conflict of interest.

Generative AI disclosure

Generative AI (Claude, Anthropic) was used in the editorial preparation of this article: for language editing, translation of the title, abstract and keywords between Uzbek, Russian and English, preparation of the extended English summary from the authors' text, and formatting of the reference list. No data, results or conclusions were generated by AI. The authors are responsible for the content of the publication.

EXTENDED SUMMARY IN ENGLISH

Kengaytirilgan inglizcha xulosa / Расширенный реферат на английском языке

Purpose and research problem

Meningiomas are among the most common primary intracranial tumours. According to the 2021 WHO classification of central nervous system tumours they form a single tumour type with several morphological subtypes and CNS WHO grades 1–3, and molecular markers such as TERT promoter mutation and homozygous CDKN2A/B deletion increasingly determine their biological behaviour. Olfactory groove meningiomas arise mainly from the arachnoid cells of the cribriform plate, the frontoethmoidal suture and the adjacent dura and account for about 8–13% of intracranial meningiomas. Because they grow slowly and cause gradual olfactory and neurobehavioural changes, they are often diagnosed late, when they already compress both frontal lobes, displace the anterior cerebral arteries and produce peritumoral oedema. Surgical approaches have evolved from wide bifrontal subfrontal craniotomies to unilateral frontolateral, pterional, lateral supraorbital and endoscopic endonasal corridors, and the modern aim of surgery is maximal safe resection with preservation of neurological and neurocognitive function. The article presents a large olfactory groove meningioma with bifrontal compression and peritumoral oedema removed through a unilateral frontolateral approach, together with an analytical review of current literature.

Materials and methods

The work was designed as a clinical case report with an analytical review of the literature, structured according to IMRAD and the main principles of the CARE guidelines for case reports. Data from the discharge summary, clinical and neurological examination, magnetic resonance imaging, laboratory and instrumental studies and information on the surgical treatment were used, and the patient's name, address and other identifying details were excluded. The literature analysis covered international guidelines on meningiomas, the WHO CNS5 classification, surgical series of olfactory groove meningiomas, and systematic reviews and meta-analyses of transcranial and endoscopic approaches, olfaction preservation, neuropsychological outcomes and the prognostic value of the extent of resection. The authors point out

discrepancies in the source documentation: the tumour dimensions were recorded as 42×31×26 mm in the main diagnosis and as approximately 42×37×32 mm in the contrast-enhanced MRI report, and the date of surgery in the discharge summary was inconsistent with the period of hospitalisation, so the calendar date of the operation is not specified in the article.

Results and discussion

A 59-year-old woman was admitted with headache, dizziness, an episode of loss of consciousness, reduced sense of smell, impaired vision, numbness of the limbs and general weakness that had progressed over about a month. On admission she was fully conscious (Glasgow Coma Scale 15) with a Karnofsky score of 70, and cephalgic and vestibular syndromes were regarded as signs of intracranial hypertension. Neurological examination revealed hyposmia, low mood, anxiety and emotional lability consistent with frontobasal dysfunction, a bilateral reduction of visual acuity recorded as amblyopia, unsteadiness in the Romberg position and mild intention on coordination tests, without limb paresis. Ophthalmological examination showed retinal angiospasm, rhinoscopy was normal and electroencephalography revealed epileptiform activity. Contrast-enhanced MRI showed an extra-axial mass of the anterior cranial fossa and the anterior third of the falx with marked compression of the right frontal lobe, peritumoral vasogenic oedema and signs of intracranial hypertension, interpreted as an olfactory groove meningioma; the differential diagnosis included planum sphenoidale meningioma, esthesioneuroblastoma with intracranial extension, solitary fibrous tumour and extra-axial metastasis. Through a right frontolateral transcranial approach the tumour compressing the basal parts of both frontal lobes was removed microsurgically, and the extent of resection was graded by the surgeons as Simpson II. In the early postoperative period general cerebral symptoms regressed, hyposmia and frontal psycho-emotional dysfunction improved, the Karnofsky score rose from 70 to 80, no new paresis or caudal cranial nerve dysfunction appeared and the wound healed by primary intention, whereas reduced visual acuity and mild coordination disturbances persisted. Carbamazepine was prescribed because of the epileptiform activity, and follow-up MRI and electroencephalography were recommended after one month.

Conclusion and contribution

The case illustrates typical features of olfactory groove meningiomas: a short reported history despite a large tumour, hyposmia and relatively mild psycho-emotional changes without gross motor deficit, and the contribution of peritumoral oedema and bifrontal compression to general cerebral symptoms. Published series and meta-analyses show that Simpson I–II resection is achieved in about 90% of open microsurgical operations, that unilateral approaches do not reduce radicality compared with bilateral ones while some complications are less frequent, and that the endoscopic endonasal route carries a higher risk of cerebrospinal fluid leakage and loss of olfaction. In this patient, total Simpson II removal of a large midline tumour with bifrontal compression and marked oedema was achieved through a unilateral right frontolateral approach, with early improvement of neuropsychological and general cerebral symptoms. The authors acknowledge that the full operative protocol, the histopathological report, early postoperative MRI and long-term follow-up were not available, and that final oncological stratification requires the histological diagnosis, CNS WHO grade, proliferative index and postoperative contrast-enhanced MRI. Modern surgery for anterior skull base meningiomas should aim not only at anatomical radicality but also at minimising retraction injury and preserving visual, olfactory and cognitive-behavioural function.

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A model of a unified bibliographic metadata layer with embedded quality control for a national scientific publications platform

Milliy ilmiy nashrlar platformasi uchun sifat nazorati o'rnatilgan yagona bibliografik metama'lumotlar qatlami modeli

Модель единого слоя библиографических метаданных со встроенным контролем качества для национальной платформы научных изданий

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Abstract. The article proposes a model of a unified bibliographic metadata layer for the National Scientific Publications Platform of Uzbekistan, with quality control embedded at every processing stage. Each field value is stored as an assertion with its source, method, time and confidence; the canonical value is selected by source rank. Quality is assessed along six dimensions; completeness, correctness and consistency are combined into a metadata quality index guiding recommendations to journals.

Keywords: bibliographic metadata; data quality; data provenance; assertion model; metadata quality index; national scientific publications platform

O'ZBEKCHA

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Annotatsiya. Maqolada O'zbekiston Milliy ilmiy nashrlar platformasi uchun yagona bibliografik metama'lumotlar qatlami modeli taklif etilgan; ushbu modelda sifat nazorati yozuvga ishlov berishning barcha bosqichlariga o'rnatilgan. Har bir maydon qiymati manbasi, usuli, vaqti va ishonchiligi ko'rsatilgan tasdiq (assertion) sifatida saqlanadi, kanonik qiymat esa manbalar darajasi bo'yicha tanlanadi. Sifat oltita o'lchov bo'yicha baholanadi; to'liqlik, to'g'rilik va muvofiqlik ko'rsatkichlari jurnallarga manzilli tavsiyalar berishda qo'llaniladigan metama'lumotlar sifati indeksiga jamlanadi.

Kalit so'zlar: bibliografik metama'lumotlar; ma'lumotlar sifati; ma'lumotlar kelib chiqishi; tasdiqlar modeli; metama'lumotlar sifati indeksi; milliy ilmiy nashrlar platformasi

РУССКИЙ

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HAC / OAK: On the HAC list of national scientific publications (Academy of Sciences of the Republic of Uzbekistan) for 06.00.00 Agricultural Sciences and 16.00.00 Veterinary Sciences. В перечне ВАК при АН РУз: 06.00.00 – Сельскохозяйственные науки; 16.00.00 – Ветеринарные науки.

Аннотация. В статье предложена модель единого слоя библиографических метаданных для Национальной платформы научных изданий Узбекистана; в этой модели контроль качества встроен во все этапы обработки записи. Каждое значение поля хранится как утверждение с указанием источника, метода, времени и достоверности, а каноническое значение выбирается по рангам источников. Качество оценивается по шести измерениям; показатели полноты, корректности и согласованности сводятся в индекс качества метаданных, используемый для адресных рекомендаций журналам.

Ключевые слова: библиографические метаданные; качество данных; происхождение данных; модель утверждений; индекс качества метаданных; национальная платформа научных изданий

1. ВВЕДЕНИЕ

Introduction

В Узбекистане издается более 200 научных журналов, но сведения о статьях рассредоточены по сайтам редакций, а данные о публикациях ученых для аттестации и отчетности собираются вручную. Между тем национальные библиографические базы данных с полным охватом научной продукции страны могут лучше подходить для библиометрического анализа, чем коммерческие международные индексы, особенно в социально-гуманитарных науках [1].

Любой агрегатор неизбежно наследует дефекты источников: пропуски аффилиаций и списков литературы, разночтения в написании имен и значениях полей. Отклонение неполных записей сокращает охват, а их некритическое принятие снижает достоверность. Если качество данных – это пригодность для использования потребителями [2], контроль должен сопровождать запись на всем пути от источника до сервиса. Цель статьи – обосновать модель единого слоя библиографических метаданных, в которой происхождение значений и результаты проверок качества – свойства самих данных.

2. МАТЕРИАЛЫ И МЕТОДЫ

Materials and methods

Материалом исследования послужили концепция и техническое задание первого этапа Национальной платформы

научных изданий. Методами документального и системного анализа выделены механизмы контроля на каждом этапе жизненного цикла записи; они сопоставлены с общепринятыми измерениями качества данных и метаданных [2; 3].

3. РЕЗУЛЬТАТЫ И ОБСУЖДЕНИЕ

Results and discussion

Сведения о статьях поступают только от журналов: автоматически (по протоколу OAI-PMH или сканированием страниц с метатегами citation_*) либо вручную в кабинете журнала с предзаполнением полей из PDF-файла и по DOI; внешние источники (Crossref, ORCID, ISSN Portal) записей не создают, а проверяют и дополняют их. Запись сохраняется в неизменном исходном слое (RAW) с хеш-суммой SHA-256, временем и адресом получения; запись, удаленная в источнике, не стирается, а помечается, как и в OAI-PMH [4].

Ключевой элемент модели – переход от записи как целого к утверждениям (assertions) о значениях отдельных полей. Утверждение фиксирует поле, значение, источник, метод, достоверность, время и ссылку на исходную запись (рис. 1) и тем самым связывает значение с породившим его действием и ответственным агентом в терминах онтологии происхождения PROV-O [5].

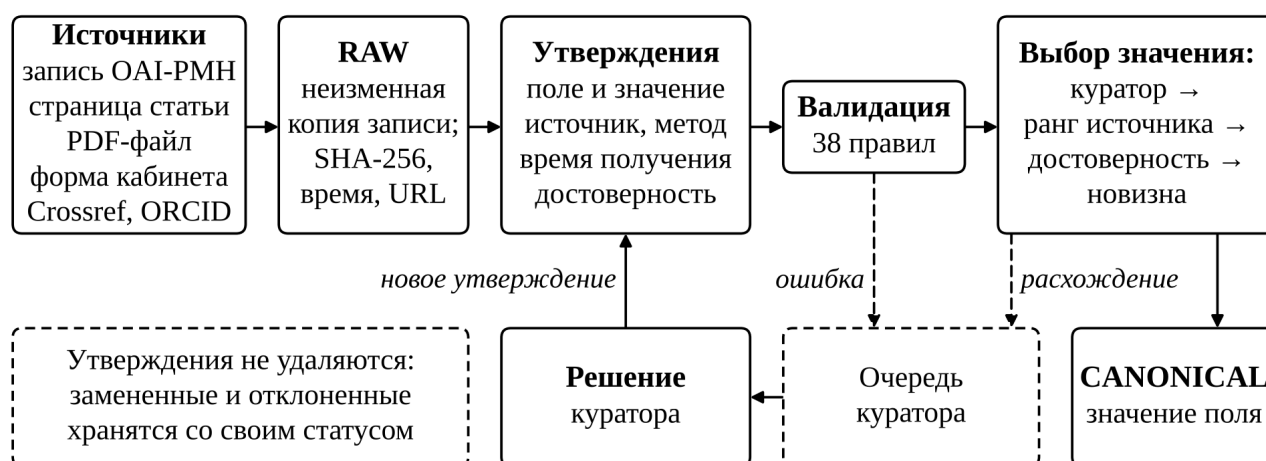


Рис. 1. Модель утверждений и выбора канонического значения поля / Fig. 1. Model of assertions and selection of the canonical field value

Каноническое значение (CANONICAL) выбирается среди утверждений, прошедших валидацию: приоритет имеет решение куратора, затем ранг источника, достоверность и новизна. Ранги задаются по полям: для DOI старший источник – Crossref, где идентификатор и метаданные регистрирует издатель [6], а для заглавия и аннотации – журнал, отвечающий за содержание. Если два старших утверждения по ключевому полю (DOI, заглавие, авторы, год)

существенно расходятся, запись получает статус «требуется рассмотрение».

Нарушения правил валидации (в техническом задании их 38) делятся в основном на ошибки и предупреждения. Ошибки – неверный контрольный символ ISSN или ORCID, недопустимый синтаксис DOI, совпадение DOI у разных работ, расхождение года публикации и года выпуска – в ручном

канале блокируют размещение записи, а в автоматическом переводят ее в статус «требуется рассмотрения»; предупреждения запись не блокируют, но учитываются в индексе качества метаданных (ИКМ). Для автоматически собранных записей так реализуется принцип «не отклонять, а маркировать»: дефект остается видимым, а журналу направляется запрос на исправление конкретного поля.

Таблица 1

Измерения качества метаданных и механизмы их контроля / **Table 1.** Metadata quality dimensions and their control mechanisms

Измерение	Механизм контроля	Показатель
Полнота	Профиль обязательных и рекомендуемых полей; данные со страницы статьи и из PDF	Составляющие C ₁ , C ₂ , R индекса (1)
Корректность	Правила валидации: контрольные символы ISSN и ORCID, синтаксис DOI, даты, страницы	Составляющая V индекса (1)
Согласованность	Сопоставление утверждений, сверка с Crossref, ORCID и ISSN Portal	Составляющая A индекса (1)
Уникальность	Правила дедупликации, очередь куратора, эталонные выборки	Точность ≥ 99,5 %; полнота ≥ 95 %
Своевременность	Ежедневный инкрементальный сбор, статусы источников	Задержка: автосбор ≤ 24 ч, кабинет ≤ 15 мин
Прослеживаемость	Утверждения со ссылкой на RAW, версии записей, журнал аудита	100 % значений выборки связаны с RAW

Полнота, корректность и согласованность сводятся в ИКМ (0–100):

$$\text{ИКМ} = 40 \cdot C_1 + 20 \cdot C_2 + 15 \cdot V + 15 \cdot A + 10 \cdot R, \quad (1)$$

где C₁ и C₂ – доли заполненных обязательных и рекомендуемых полей; V – доля полей без ошибок валидации; A – доля имеющихся идентификаторов (DOI, ORCID, ISSN), подтвержденных внешним источником; R – доля разобранных позиций списка литературы. Все составляющие вычисляются без экспертного просмотра записей, что соответствует подходам к автоматической оценке качества метаданных [7]. ИКМ не является рейтингом: он служит для адресных рекомендаций редакциям и упорядочения кураторских очередей.

Своевременность контролируется по источникам: статус сбора по протоколу OAI-PMH – «зеленый» при успешном последнем сеансе и доле ошибочных записей не более 5 %, «желтый» – при большей доле ошибок или частично выполненном сеансе, «красный» – после трех неудачных сеансов подряд или при отсутствии обновлений более 7 дней. При подключении журнала пробный сбор 100 записей дает отчет о соответствии – какие поля извлекаются и откуда дополнить недостающие; сбои следует отделять от пробелов в данных.

Уникальность обеспечивается консервативной дедупликацией: записи объединяются автоматически лишь в двух случаях – при совпадении DOI, если журнал и год не расходятся, и при совпадении журнала, года и первой страницы (номера статьи), если сходство заголовков не ниже 0,95, а совпадение авторов – не ниже 0,8. Пары с интегральной оценкой 0,80–0,97 передаются куратору, с меньшей – не связываются. Такое разбиение на зоны автоматического связывания, ручной проверки и отказа восходит к модели Феллеги – Сантера [8]; точность объединения (≥ 99,5 %) и полнота выявления дубликатов (≥ 95 %) ежеквартально проверяются на эталонных выборках.

4. ЗАКЛЮЧЕНИЕ

Conclusion

Таким образом, в предложенной модели качество метаданных – не итоговый фильтр, а свойство единого слоя данных: неизменный исходный слой, утверждения с указанием

качества оценивается по шести измерениям (табл. 1), включающим классические характеристики качества – полноту, корректность (точность) и своевременность [2]; набор близок к параметрам качества метаданных Т. Брюса и Д. Хиллманн, где происхождение – отдельный параметр [3].

происхождения, ранги источников, маркирующая валидация, индекс качества и консервативная дедупликация сохраняют охват и обеспечивают проверяемость каждого значения. Практическая ценность модели – в адресных рекомендациях журналам и проверяемом происхождении данных; хранение исходных записей и PDF-файлов вместе с версионированием алгоритмов позволяет пересчитывать показатели без повторных запросов к журналам. Дальнейшая работа – калибровка весов индекса и порогов сопоставления по данным пилотного подключения 20–30 журналов.

DECLARATIONS

Declarations

Author contributions CRediT

Conceptualization; Methodology; Investigation; Data curation; Writing – original draft; Writing – review & editing. All authors have read and agreed to the published version of the manuscript.

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Ethics approval

The study is a documentary and system analysis of the design documents of an information platform; it involved no human participants or animals and required no ethics committee approval.

Informed consent

All authors have read and approved the final version of the manuscript and have given their consent to its submission and publication. The study involved no human participants and no personal data.

Data availability statement

The data analysed in the study are presented in the text, figure and table of this article; further details are available from the authors on reasonable request.

Conflict of interest

The authors declare no conflict of interest.

Generative AI disclosure

Generative AI (Claude, Anthropic) was used in the editorial preparation of this article: for language editing, translation of the title, abstract and keywords between Uzbek, Russian and English, preparation of the extended English summary from the authors' text, and formatting of the

reference list. No data, results or conclusions were generated by AI. The authors are responsible for the content of the publication.

EXTENDED SUMMARY IN ENGLISH

Kengaytirilgan inglizcha xulosa / Расширенный реферат на английском языке

Purpose and research problem

More than 200 scientific journals are published in Uzbekistan, but information about their articles is scattered across editorial websites, and data on researchers' publications for attestation and reporting are still collected manually. National bibliographic databases with full coverage of a country's scientific output may be better suited for bibliometric analysis than commercial international indexes, especially in the social sciences and humanities. Any aggregator inevitably inherits the defects of its sources — missing affiliations and reference lists, variant spellings of names and inconsistent field values. Rejecting incomplete records reduces coverage, whereas accepting them uncritically lowers reliability. If data quality is understood as fitness for use by data consumers, quality control has to accompany a record along its whole path from the source to the service. The aim of the article is to substantiate a model of a unified bibliographic metadata layer for the National Scientific Publications Platform of Uzbekistan in which the provenance of values and the results of quality checks are properties of the data themselves.

Materials and methods

The material of the study was the concept and the technical specification of the first stage of the National Scientific Publications Platform. Using documentary and system analysis, the authors identified the quality control mechanisms applied at each stage of the record life cycle and compared them with generally accepted dimensions of data quality (Wang and Strong) and metadata quality (Bruce and Hillmann). The model was described in terms of record intake channels, storage of source records, field-level assertions with provenance, selection of canonical values, validation rules, quality dimensions and indicators, monitoring of harvesting sources and deduplication.

Results and discussion

Article records come only from journals: automatically, via the OAI-PMH protocol or by crawling article pages with citation_* meta tags, or manually in the journal's account, with fields pre-filled from the PDF file and by DOI. External sources (Crossref, ORCID, ISSN Portal) do not create records but verify and enrich them. Each record is kept in an immutable source layer (RAW) with a SHA-256 hash and the time and address of retrieval, and a record deleted at the source is marked rather than erased, as in OAI-PMH. The key element of the model is the shift from the record as a whole to assertions about the values of individual fields: an assertion fixes the field, value, source, method, confidence, time and a link to the source record, which links each value to the activity and agent that produced it in terms of the PROV-O provenance ontology. The canonical value is selected among validated assertions by curator decision, then by source rank, confidence and recency; ranks are defined per field (Crossref for the DOI, the journal for the title and abstract), and a substantial disagreement between two senior assertions on a key field sends the record for review. The 38 validation rules of the technical specification are divided mainly into errors — invalid ISSN or ORCID check digits, invalid DOI syntax, the same DOI for different works, a mismatch between the publication year and the issue year — which block manually entered records and flag automatically harvested ones, and warnings, which do not block a record but are counted in the metadata quality index, following the principle "mark, do not reject". Quality is assessed in six dimensions — completeness, correctness, consistency, uniqueness, timeliness and traceability — each with its own control mechanism and indicator (Table 1). Completeness, correctness and consistency are combined into a metadata quality index (MQI, 0–100): $MQI = 40 \cdot C1 + 20 \cdot C2 + 15 \cdot V + 15 \cdot A + 10 \cdot R$, where C1 and C2 are the shares of filled mandatory and recommended fields, V is the share of fields without validation errors, A is the share of identifiers confirmed by an external source and R is the share of parsed reference list items. All components are calculated without expert review of records, and the index serves for targeted recommendations to editors

and for ordering curator queues rather than as a rating. Timeliness is monitored by source status (green, yellow or red depending on the success of the last harvesting session, the share of erroneous records and the time since the last update), and a trial harvest of 100 records when a journal is connected produces a compliance report. Uniqueness is ensured by conservative deduplication: records are merged automatically only when DOIs match and the journal and year agree, or when the journal, year and first page match with a title similarity of at least 0.95 and an author match of at least 0.8; pairs with a combined score of 0.80–0.97 are passed to a curator, following the Fellegi–Sunter model, and merge precision ($\geq 99.5\%$) and duplicate recall ($\geq 95\%$) are checked quarterly on reference samples.

Conclusion and contribution

In the proposed model, metadata quality is not a final filter but a property of the unified data layer: the immutable source layer, assertions with provenance, source ranks, marking validation, the quality index and conservative deduplication preserve coverage and make every value verifiable. The practical value of the model lies in targeted recommendations to journals and in verifiable data provenance; storing source records and PDF files together with versioned algorithms allows the indicators to be recalculated without repeated requests to journals. Further work will calibrate the index weights and matching thresholds using data from a pilot connection of 20–30 journals.

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RESEARCH ARTICLE • PEER-REVIEWED • OPEN ACCESS • **SERIES B** • 05.00.00 — TECHNICAL SCIENCES
• UDC: 635.615:631.531.027

Experimental research results on the treatment of watermelon seeds with ultraviolet light

Tarvuz urug'lariga ultrabinafsha nur bilan ishlov berish bo'yicha eksperimental tadqiqot natijalari**Результаты экспериментальных исследований по обработке семян арбуза ультрафиолетовым светом****USMONOV Inomjon Isroilovich^{1*}**, **ABDULLAJONOV Sirojiddin Sadirdin ugli¹**¹ Kokand State University, Kokand, Uzbekistan* Corresponding author: mr.usmonov.ksu@mail.ru**ARTICLE INFO****ARTICLE TYPE**

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AUTHOR, TITLE AND ABSTRACT METADATA (EN / UZ / RU)**ENGLISH****USMONOV Inomjon Isroilovich^{1*}**, **ABDULLAJONOV Sirojiddin Sadirdin ugli¹**¹ Kokand State University, Kokand, Uzbekistan

Abstract. In increasing watermelon yield, improving the laboratory and field germination of the seeds to be sown and disinfecting them against various diseases are of great practical importance in agriculture. In this regard, developing a special device for ultraviolet (UV) irradiation of watermelon seeds and increasing the efficiency of its use is a pressing issue. The aim of the research is to conduct experimental studies on a laboratory prototype of a device for UV irradiation of watermelon seeds and to determine the most rational irradiation modes. The experiments were carried out on a laboratory stand of the UV device, in four replications, using bactericidal lamps with a power of 120–180 W and wavelengths of 253.7 nm and 300 nm. Different modes, varying in the distance between the seeds and the irradiator and in the treatment time, were compared with one another, and the results of the analysis are presented.

Keywords: watermelon seed; germination; ultraviolet light; irradiation; wavelength; lamp; watermelon; method; stand; bactericidal; power; fungus

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Annotatsiya. Maqolada tarvuz hosildorligini oshirishda ekanligini oshirishda ekiladigan urug'larning laboratoriya hamda dala unuvchanligini yaxshilash va ularni turli kasalliklardan zararsizlantirish qishloq xo'jaligida muhim amaliy ahamiyatga ega. Shu munosabat bilan tarvuz urug'lariga ultrabinafsha nur (UBN) beruvchi maxsus qurilmani ishlab chiqish va undan foydalanish samaradorligini oshirish dolzarb masala hisoblanadi. Tadqiqotning maqsadi tarvuz urug'iga ultrabinafsha nur berish qurilmasining laboratoriya nusxasida eksperimental tadqiqotlar o'tkazish hamda nurlatishning eng ratsional rejimlarini aniqlashdan iborat. Tajribalar UBN qurilmasining laboratoriya stendida to'rt qaytariqda, to'liq uzunliklari 253,7 nm va 300 nm bo'lgan 120 – 180 Vt quvvatli bakteritsid lampalarda o'tkazildi. Urug'lar va nurlatgich orasidagi masofa hamda ishlov berish vaqti bo'yicha turli rejimlar o'zaro solishtirilib, tahlillar natijalari keltirilgan.

Kalit so'zlar: tarvuz urug'i; unuvchanlik; ultrabinafsha nuri; nurlanish; to'liq uzunligi; lampa; tarvuz; usul; stend; bakteritsid; quvvat; zamburug'

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Аннотация. В деле повышения урожайности арбуза повышение лабораторной и полевой всхожести высеваемых семян и их дезинфекция против различных болезней имеют важное

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практическое значение в сельском хозяйстве. В связи с этим разработка специального устройства для ультрафиолетового (УФ) облучения семян арбуза и повышение эффективности его использования является актуальной задачей. Целью исследования является проведение экспериментальных исследований на лабораторном макете устройства для УФ-облучения семян арбуза и определение наиболее рациональных режимов облучения. Эксперименты проводились на лабораторном стенде УФ-установки в четырехкратной повторности с использованием бактерицидных ламп мощностью 120–180 Вт и длиной волны 253,7 нм и 300 нм. Сопоставлены различные режимы, различающиеся расстоянием между семенами и облучателем, а также временем обработки, и представлены результаты анализа.

Ключевые слова: семена арбуза; всхожесть; ультрафиолетовый свет; облучение; длина волны; лампа; арбуз; метод; стенд; бактерицидный; мощность; грибок

1. INTRODUCTION

Producing and using high-quality seed material is of great importance for obtaining high and stable yields from cucurbit crops. Seed production differs from ordinary crop production technology and includes a number of special agrotechnical measures, such as preserving the biological characteristics of the variety, ensuring the quality indicators of the seeds, harvesting on time, and separating, drying, sorting and storing the seeds. In particular, seed production of cucurbit crops is labor-intensive to a certain degree and requires the use of technical means adapted to the efficient performance of technological processes [1-2].

Studies note that an insufficient level of mechanization in the cultivation of cucurbit crops and the production of seed material increases labor costs and reduces production efficiency. In particular, because special implements and machines for treating cucurbit crops are produced in limited quantities, farms sometimes adapt the technical equipment they already have. Therefore, improving seed production and cultivation technology for cucurbit crops, reducing labor costs, and using modern, resource-saving mechanization tools are among the important scientific and practical tasks [3-4].

Not many works have been devoted to studying the effect of ultraviolet light on biological objects; the published works note its environmental cleanliness, low cost and convenience. Using ultraviolet light for pre-sowing seed treatment improves seed health and increases the yield of agricultural crops by 35% to 45% [5-6].

Seed emergence is one of the important stages of the seedling-growing process. In watermelon, delayed and uneven seed emergence are frequently encountered problems. Therefore, it is important to use stimulating technologies aimed at ensuring fast, uniform and high-quality seed emergence.

A number of factors affect the seed emergence process. In particular, seed germination energy, ambient temperature, the moisture level required for emergence, and other external and internal factors are important for the speed and uniformity of seed emergence and development.

It is known that ultraviolet radiation is a part of the natural solar spectrum. Because of its diverse effects, it has attracted the attention of physicians, biologists and scientists in other fields. In Uzbekistan, increasing crop yields is considered one of the important factors for boosting the production of agricultural products. At present, in addition to improving traditional agrotechnical measures, the rational use of new resources is

required. Among these is the regulation of physiological processes in plants through methods of exposing plants to UV light and the use of growth stimulators [7-8].

In obtaining a high yield from agricultural crops, including watermelon, one of the cucurbit crops, the quality indicators of the seeds prepared for sowing play an important role alongside other agrotechnical measures. This is because using select seeds that are close to one another in biological properties, with high laboratory and field germination and high potential yield, is the guarantee of an abundant harvest. Taking this into account, experimental studies were conducted on irradiating watermelon seeds with ultraviolet light [8-9].

For this purpose, the laboratory germination of “Dilnoz” variety watermelon seeds in the control variant was first determined in four replications.

2. METHODS

Experimental studies on irradiation on the stand for UV treatment of watermelon seeds were developed, and the experiments were carried out in four replications [9-10].

3. RESULTS

In recent years, as a result of scientific research, an irradiation stand for UV treatment of watermelon seeds has been developed. Based on the analysis of the results, the following conclusion can be drawn: the experiment was conducted at heights of 6, 9 and 12 cm, at time intervals of 3, 5 and 7 minutes, at wavelengths of 253.7 nm and 300 nm, using bactericidal lamps with a total power of 180 W. With a distance of 9 cm from the irradiator to the seeds, a seed irradiation time of 5 minutes, and bactericidal lamps of 253.7 nm wavelength and 60 W power together with 300 nm wavelength and 90 W power, germination was 98.3% (Table 2). Compared with the other UV parameters and modes, the best sprout emergence was observed in this mode.

This research consists in creating a technology for disinfecting and stimulating watermelon seeds before sowing by means of electrotechnological methods. Therefore, we conducted studies to determine the microflora of watermelon seeds before and after treatment by electrotechnological methods.

Figure 1 shows the experimental samples used to determine fungal infection in watermelon seeds. The experiments were carried out in the laboratory of the Department of Chemical Technologies of Kokand State University.

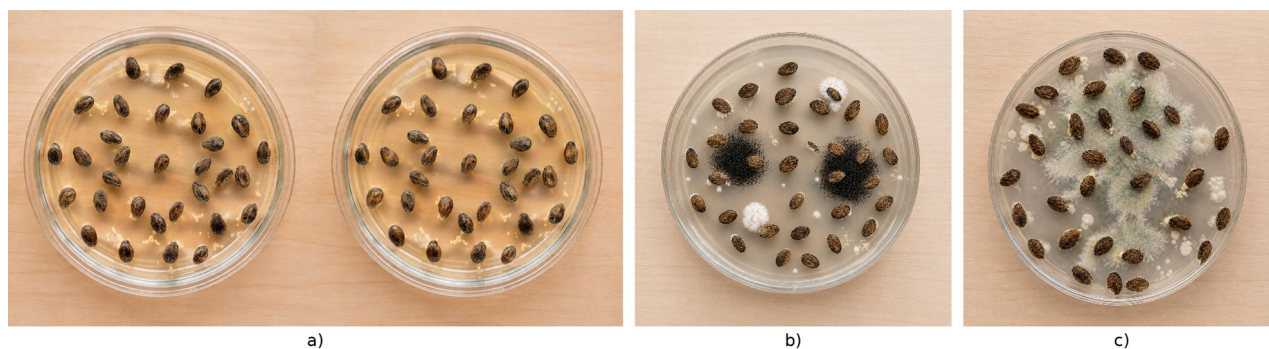


Fig. 1. “Dilnoz” variety watermelon seeds: infection by (a) *Bacillus* spp., (b) *Streptomyces* spp. and *Actinomyces* spp., (c) *Micrococcus* spp. and *Fusarium* spp. fungi

As a result of the research, when seeds of the “Dilnoz” watermelon variety were studied microbiologically, microorganisms were found to occur in relatively high amounts. The isolated microorganisms were identified taxonomically as belonging to the groups *Bacillus* spp., *Micrococcus* spp., *Fusarium* spp., *Streptomyces* spp. and *Actinomyces* spp. fungi.

The laboratory germination of “Dilnoz” variety watermelon seeds was 84% in the control variant and 98.3% after irradiation, which is 14.3% higher than the control.

The UV treatment of the seeds was carried out in the laboratory of the Department of “Electrical Technologies” of Kokand State University.

A lighting stand fitted with bactericidal lamps of 253.7 nm and 300 nm wavelengths, with a total power of $P = 180$ W, was used as the ultraviolet light source. For each variant, 30 watermelon seeds were selected.

The selected seeds were irradiated using the stand shown in Figure 2.



Fig. 2. General view of the UV treatment stand

After irradiation, the seeds were placed on moist filter paper in laboratory Petri dishes and left in a dark place at a temperature of 21–23 °C. The germination of the watermelon seeds was assessed visually and by counting. Sprouts began to appear within the first two days. After six days, seed emergence stabilized, and on the eighth day all viable seeds were identified [10-11].



Fig. 3. Appearance of watermelon seeds when irradiated with ultraviolet light

As can be seen from Figure 3, it was found that *Bacillus* spp., *Micrococcus* spp., *Fusarium* spp., *Streptomyces* spp., *Actinomyces* spp. and other fungi died in the seeds treated with UV light.

The tables present the results of determining the germination of watermelon seeds treated with ultraviolet light. In the tables, H_{UV} is the distance from the UV lamp to the seeds (cm), t is the irradiation time (min), and germination is given in %.

Table 1

Germination of watermelon seeds irradiated with 253.7 nm lamps of 120–180 W power

$\lambda=253.7$ nm, $P=120$ W			$\lambda=253.7$ nm, $P=150$ W			$\lambda=253.7$ nm, $P=180$ W		
H_{UV} , cm	t , min	Germination, %	H_{UV} , cm	t , min	Germination, %	H_{UV} , cm	t , min	Germination, %
6	3	75.2	6	3	77.5	6	3	74.9
	5	79.1		5	84.1		5	78.7
	7	79.2		7	82.5		7	78.6
9	3	78.4	9	3	79.2	9	3	78.2
	5	76.5		5	84.1		5	76.2
	7	74.7		7	69.2		7	74.3
12	3	74.6	12	3	71.7	12	3	74.0
	5	76.8		5	80.8		5	76.4

$\lambda=253.7$ nm, P=120 W			$\lambda=253.7$ nm, P=150 W			$\lambda=253.7$ nm, P=180 W		
H_{UV} , cm	t, min	Germination, %	H_{UV} , cm	t, min	Germination, %	H_{UV} , cm	t, min	Germination, %
	7	75.7		7	65.8		7	75.4

Table 1 presents the results of the experiments carried out with lamps of 253.7 nm wavelength and 120–180 W power. According to it, the best germination rate, 84.1%, was obtained with a 150 W irradiator at a distance of 6 cm from the seeds and an irradiation duration of 5 minutes.

Table 2

Germination of watermelon seeds irradiated simultaneously with 253.7 nm lamps (30–90 W) and 300 nm lamps (90 W)

$\lambda=253.7$ nm, P=30 W $\lambda=300$ nm, P=90 W			$\lambda=253.7$ nm, P=60 W $\lambda=300$ nm, P=90 W			$\lambda=253.7$ nm, P=90 W $\lambda=300$ nm, P=90 W		
H_{UV} , cm	t, min	Germination, %	H_{UV} , cm	t, min	Germination, %	H_{UV} , cm	t, min	Germination, %
6	3	82.1	6	3	87.5	6	3	83.9
	5	92.0		5	94.1		5	88.0
	7	76.3		7	84.2		7	82.4
9	3	82.1	9	3	95.7	9	3	88.1
	5	91.1		5	98.3		5	88.2
	7	83.8		7	92.4		7	86.7
12	3	74.5	12	3	87.5	12	3	84.1
	5	86.1		5	94.1		5	86.6
	7	84.5		7	84.1		7	82.2

Table 2 presents the results of the experiments carried out with lamps of 253.7 nm wavelength and 30–90 W power, together with lamps of 300 nm wavelength and 90 W power. The best germination rate, 98.3%, was obtained with the 253.7 nm lamp at 60 W and the 300 nm lamp at 90 W, at a distance of 9 cm from the irradiator to the seeds and an irradiation duration of 5 minutes

Table 3

Germination of watermelon seeds irradiated simultaneously with 253.7 nm lamps (60–120 W) and 300 nm lamps (60 W)

$\lambda=253.7$ nm, P=60 W $\lambda=300$ nm, P=60 W			$\lambda=253.7$ nm, P=90 W $\lambda=300$ nm, P=60 W			$\lambda=253.7$ nm, P=120 W $\lambda=300$ nm, P=60 W		
H_{UV} , cm	t, min	Germination, %	H_{UV} , cm	t, min	Germination, %	H_{UV} , cm	t, min	Germination, %
6	3	85.0	6	3	85.8	6	3	81.9
	5	88.9		5	91.2		5	87.3
	7	75.2		7	74.1		7	74.5
9	3	84.3	9	3	85.7	9	3	83.9
	5	93.8		5	94.9		5	89.8
	7	80.3		7	80.8		7	78.1
12	3	78.8	12	3	78.2	12	3	77.5
	5	83.5		5	84.2		5	81.8
	7	75.8		7	74.9		7	74.7

Table 3 presents the results of the experiments carried out with lamps of 253.7 nm wavelength and 60–120 W power, together with lamps of 300 nm wavelength and 60 W power. The best germination rate, 94.9%, was obtained with the 253.7 nm lamp at 90 W and the 300 nm lamp at 60 W, at a distance of 9 cm from the irradiator to the seeds and an irradiation duration of 5 minutes.

Table 4

Germination of watermelon seeds irradiated simultaneously with 253.7 nm lamps (90–150 W) and 300 nm lamps (30 W)

$\lambda=253.7$ nm, P=90 W $\lambda=300$ nm, P=30 W			$\lambda=253.7$ nm, P=120 W $\lambda=300$ nm, P=30 W			$\lambda=253.7$ nm, P=150 W $\lambda=300$ nm, P=30 W		
H_{UV} , cm	t, min	Germination, %	H_{UV} , cm	t, min	Germination, %	H_{UV} , cm	t, min	Germination, %
6	3	87.6	6	3	92.5	6	3	88.8
	5	84.5		5	87.5		5	85.6
	7	75.7		7	77.4		7	76.3
9	3	78.2	9	3	79.9	9	3	79.1
	5	84.7		5	88.3		5	85.8
	7	77.8		7	78.3		7	78.5
12	3	81.7	12	3	84.1	12	3	82.8
	5	83.5		5	87.4		5	84.7
	7	68.1		7	68.3		7	68.3

Table 4 presents the results of the experiments carried out with lamps of 253.7 nm wavelength and 90–150 W power, together with lamps of 300 nm wavelength and 30 W power. The best germination rate, 92.5%, was obtained with the 253.7 nm lamp at 120 W and the 300 nm lamp at 30 W, at a distance of 6 cm from the irradiator to the seeds and an irradiation duration of 3 minutes.

Table 5

Germination of watermelon seeds irradiated with 300 nm lamps of 120–180 W power

$\lambda=300$ nm, P=120 W			$\lambda=300$ nm, P=150 W			$\lambda=300$ nm, P=180 W		
H _{uv} , cm	t, min	Germination, %	H _{uv} , cm	t, min	Germination, %	H _{uv} , cm	t, min	Germination, %
6	3	87.2	6	3	89.1	6	3	91.2
	5	91.5		5	95.8		5	93.9
	7	79.8		7	82.5		7	84.3
9	3	81.0	9	3	85.8	9	3	88.5
	5	88.9		5	92.4		5	90.4
	7	77.1		7	79.2		7	80.6
12	3	80.5	12	3	83.2	12	3	86.5
	5	88.0		5	91.6		5	91.2
	7	76.8		7	79.1		7	79.6

Table 5 presents the results of the experiments carried out with lamps of 300 nm wavelength and 120–180 W power. According to it, the best germination rate, 95.8%, was obtained with a 150 W irradiator at a distance of 6 cm from the seeds and an irradiation duration of 5 minutes.

Figure 4 shows the best average results obtained when lamps with wavelengths of 253.7 nm and 300 nm are used simultaneously.

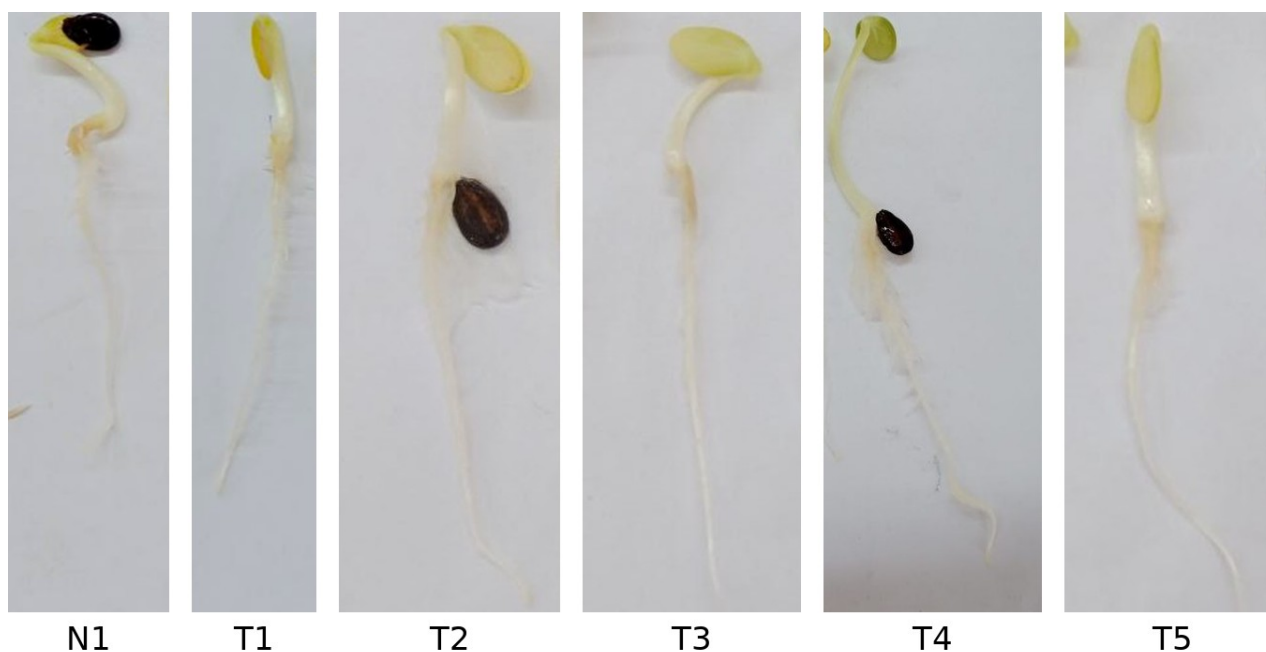


Fig. 4. N1 – control; T1, T2, T3, T4, T5 – experimental

4. DISCUSSION

Based on the analysis of the results presented in the tables, the following conclusion can be drawn: depending on the radiation dose, wavelength and exposure time, the effect of ultraviolet (UV) light on seeds can be both positive (stimulating) and negative (harmful). Light with a wavelength of 253.7 nm has the property of disinfecting microorganisms in seeds when applied for the required duration, whereas light with a wavelength of 300 nm has a stimulating property. Thus, using both lamps simultaneously prevents the seeds from becoming diseased and increases their germination. In agricultural and laboratory practice, treating seeds with ultraviolet light before sowing is an effective method for increasing yield and for disinfecting the seeds and increasing their germination.

Thus, it turns out that with the proposed stand for UV treatment of seeds, it is possible to obtain select seed material that is disease-resistant, ecologically clean and highly germinating.

5. CONCLUSION

The experimental studies conducted showed that ultraviolet radiation (UV) is highly effective in disinfecting “Dilnoz” variety watermelon seeds and increasing their germination under laboratory conditions. While the germination rate of seeds in the ordinary control variant was 84%, it reached 98.3% when treated with ultraviolet light in the optimal mode, and germination increased by 14.3%.

According to the results obtained, the highest value was recorded when lamps were used together at a distance of 9 cm from the irradiator to the seeds, an irradiation duration of 5 minutes, and wavelengths of 253.7 nm at 60 W and 300 nm at 90 W, a total power of 150 W (Table 2).

In conclusion, treating watermelon seeds with ultraviolet light before sowing, with correctly selected parameters and modes, increases the biological activity of the seeds and is an effective agrotechnical method that ensures yield.

DECLARATIONS

Author contributions CRedit

Conceptualization; Methodology; Investigation; Data curation; Writing – original draft; Writing – review & editing. All authors have read and agreed to the published version of the manuscript.

Funding

This research received no external funding.

Ethics approval

The study was carried out under laboratory conditions on watermelon seeds only; no human participants or animals were involved, and no ethics committee approval was required.

Informed consent

All authors have read and approved the final version of the manuscript and have given their consent to its submission and publication. The study involved no human participants and no personal data.

Data availability statement

The data obtained in the study are presented in the tables and figures of this article; the primary records are available from the authors on reasonable request.

Conflict of interest

The authors declare no conflict of interest.

Generative AI disclosure

Generative AI (Claude, Anthropic) was used in the editorial preparation of this article: for language editing, translation of the title, abstract and keywords between Uzbek, Russian and English, preparation of the extended English summary from the authors' text, and formatting of the reference list. No data, results or conclusions were generated by AI. The authors are responsible for the content of the publication.

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Effect of mineral fertilizer forms and rates on the germination rate and plant density of “Fayz-baraka” Jerusalem artichoke variety

Topinambur o'simligi Fayz-baraka navining unib chiqish darajasi va ko'chat qalinligiga mineral o'g'itlar shakllari va me'yorlarining ta'siri

Влияние форм и норм минеральных удобрений на всхожесть и густоту стояния растений топинамбура сорта «Файз-барака»

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AUTHOR, TITLE AND ABSTRACT METADATA (EN / UZ / RU)

ENGLISH

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Abstract. The article examines the effect of nitrogen fertilizer forms (ammonium sulfate, urea and ammonium nitrate) and rates (N_{60} – N_{150} against a $P_{90}K_{90}$ background) on seedling emergence and plant density of the Jerusalem artichoke variety Fayz-baraka. In the 2025 field experiment plant density increased in all variants over the observation dates, with the most intensive increase between 12 and 17 April (on average by 22–24 thousand plants/ha). Ammonium nitrate was the most effective form: at $N_{120}P_{90}K_{90}$ plant density reached 94.1 thousand plants/ha after thinning and 92.9 thousand plants/ha at the end of the growing season. $N_{120}P_{90}K_{90}$ was the optimal rate for all fertilizer forms, and increasing it to N_{150} reduced the indicators.

Keywords: Jerusalem artichoke; Fayz-baraka variety; nitrogen fertilizers; ammonium nitrate; urea; ammonium sulfate; emergence; plant density

O'ZBEKCHA

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Annotatsiya. Maqolada Fayz-baraka navli topinambur nihollarining unib chiqish darajasi va ko'chat qalinligiga azotli o'g'itlar shakllari (ammoniy sulfat, karbamid, ammoniy nitrat) va me'yorlarining ($P_{90}K_{90}$ fonida N_{60} – N_{150}) ta'siri o'rganilgan. 2025-yilgi dala tajribasida barcha variantlarda ko'chat qalinligi kuzatuv muddatlari bo'yicha ortib borgan, eng jadal o'sish 12.04–17.04 oralig'ida (o'rtacha 22–24 ming tup/ga) qayd etilgan. Ammoniy nitrat eng yuqori samaradorlik ko'rsatgan: $N_{120}P_{90}K_{90}$ me'yorida ko'chat qalinligi yaganadan keyin 94,1 ming tup/ga, amal davri oxirida 92,9 ming tup/ga ni tashkil etgan. Barcha o'g'it shakllari uchun $N_{120}P_{90}K_{90}$ optimal me'yor bo'lib, uni N_{150} gacha oshirish ko'rsatkichlarning pasayishiga olib kelgan.

Kalit so'zlar: topinambur; Fayz-baraka navi; azotli o'g'itlar; ammoniy nitrat; karbamid; ammoniy sulfat; unib chiqish; ko'chat qalinligi

РУССКИЙ

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Аннотация. В статье изучено влияние форм азотных удобрений (сульфат аммония, карбамид, аммиачная селитра) и их норм (N_{60} – N_{150} на фоне $P_{90}K_{90}$) на всхожесть и густоту стояния

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растений топинамбура сорта «Файз-барака». В полевом опыте 2025 года густота стояния во всех вариантах возрастала по срокам наблюдений; наиболее интенсивный прирост отмечен между 12.04 и 17.04 (в среднем на 22–24 тыс. растений/га). Наибольшую эффективность показала аммиачная селитра: при норме $N_{120}P_{90}K_{90}$ густота стояния после прореживания составила 94,1 тыс. растений/га, в конце вегетации — 92,9 тыс. растений/га. Для всех форм удобрений оптимальной оказалась норма $N_{120}P_{90}K_{90}$; её повышение до N_{150} снижало показатели.

Ключевые слова: топинамбур; сорт «Файз-барака»; азотные удобрения; аммиачная селитра; карбамид; сульфат аммония; всхожесть; густота стояния

1. KIRISH

Introduction

Zamonaviy qishloq xo'jaligida oziq-ovqat xavfsizligini ta'minlash, tuproq unumdorligini oshirish va ekologik muvozanatni saqlash muhim masalalardan biri hisoblanadi. Shu nuqtai nazardan, agrosanoat kompleksida yuqori hosilli, sermahsul va ekologik toza mahsulot beruvchi ekinlarni yetishtirish dolzarb masalaga aylangan. Bunday ekinlardan biri bu — Topinambur (Jerusalem artishoki, *Helianthus tuberosus* L.) hisoblanadi.

Topinambur yuqori biologik faollikka ega bo'lib, tarkibida inulin, vitaminlar (C, B1, B2, B6), temir, kaliy, kalsiy, magniy va boshqa foydali moddalarga boy. Shuningdek, u qandli diabet, yurak-tomir, oshqozon-ichak kasalliklarida foydali bo'lgan o'simlik hisoblanadi. Uning ildiz mevalari yem-xashak, oziq-ovqat va dori-darmon sanoatida keng qo'llaniladi.

Topinambur o'sishini jadallashtirish va hosildorligini oshirishda agrotekhnika tadbirlar, xususan, mineral o'g'itlar, ayniqsa azotli o'g'itlar me'yori to'g'ri belgilash muhim rol o'ynaydi. Ushbu maqolada topinambur o'simligining o'sishi, rivojlanishi va hosildorligiga o'g'itlarning miqdoriy ta'siri tahlili keltirilgan.

Topinambur ekini tuganaklarini unib chiqishi uchun havo harorati 12 °C dan, maysalarni boshlang'ich o'sib rivojlanishi uchun eng kamida 14-15 °C, keyingi fazalardagi maqbul havo harorati 26-28 °C kam bo'lmasligi talab etiladi. O'suv davrining 25-30 kunlari asosiy poyaning 5-8 barg qo'ltiqlaridan dastlabki bachki poyachalar shakllanish kuzatilsada, ular o'suv davri davomida sekin rivojlanadi. Ushbu bachki novdalardan asosiy poya zararlangandagina birlamchi shoxlar juda tez rivojlanadi. O'simlikning bu xususiyatidan chorvachilik yo'nalishida keng foydalanilsa bo'ladi. O'suv davrining 60-65 kunlari ildiz asosida birinchi hosil tuganaklari shakllana boshladi. Kartoshkadan farqliroq bu jarayon 80-100 kun davom etishi kuzatildi. Asosiy poya zararlanganda esa yon shoxlari rivojlanguncha (15-20 kun) tuganaklarning o'sishi butunlay to'xtadi [1]. Bitta o'simlikdagi poyalar soni o'zgaruvchan belgi bo'lib, tuganaklarning yirikligiga bog'liq holda, odatda "Mo'jiza" navida bitta tuganakdan 3-8

donagacha poyalar shakllanadi. Bu ko'p hollarda tuganakning yirikligiga va undagi ko'zlar soniga bog'liq bo'ladi. Topinamburning "Mo'jiza" navlarini o'suv davri bosqichlari (faza) davomiylikiga ekish muddatlarining ta'siri, asosan o'suv davrining unib chiqish davridan shonalash davrigacha bo'lgan vaqtda ko'rish mumkin bo'lib, tuganaklar qancha erta ekilsa, o'simlik unib chiqqandan keyingi davrdan shonalashgacha bo'lgan vaqt nisbatan uzoqroq davom etadi. O'simlik gullash bosqichiga o'tganda esa, o'sish sezilarli sekinlashishi, o'simlik to'la gullash bosqichiga kirganda esa, o'sish butunlay to'xtashi kuzatiladi. Topinambur ekinining fevral-mart oylarida ekilishi hosildorlikning sezilarli darajada ko'payishi hamda o'simlikdagi yirik tuganaklar miqdorining ortishiga sabab bo'lishi bilan bir vaqtda o'simlik parvarishi uchun sarflanadigan sarf-xarajatlarni ham kamayishiga ijobiy ta'sir qiladi [2-5].

2. NATIJALAR VA MUHOKAMA

Results and discussion

Ammoniy nitrat qo'llanilgan variantlar barcha o'g'it shakllari ichida eng yuqori ko'rsatkichlarni namoyon etganligini ta'kidlab o'tishni joiz deb hisobladik. $N_{120}P_{90}K_{90}$ da ko'chat qalinligi 33,9-99,3 ming tup/ga, yaganadan keyin 94,1 ming tup/ga, amal davri oxirida 92,9 ming tup/ga ni tashkil etdi. Bu ko'rsatkichlar ammoniy sulfatga nisbatan 1,7-2,9 ming tup/ga, karbamidga nisbatan esa 0,6-1,5 ming tup/ga ga yuqori bo'ldi. 2025-yilda barcha variantlar bo'yicha yuqori ko'rsatkichlarning qayd etilishi, asosan, qulay harorat rejimi va optimal namlik ta'minlanganligi bilan izohlash mumkin.

2025-yilda kuzatuv muddatlari bo'yicha olib borilgan tahlillar shuni ko'rsatdiki, barcha variantlarda ko'chat qalinligi vaqt o'tishi bilan oshib bordi. Eng intensiv o'sish ikkinchi (12.04) va uchinchi (17.04) kuzatuvlar oralig'ida kuzatilgan bo'lib, bu davrda ko'chat qalinligi o'rtacha 22-24 ming tup/ga ga oshdi. Qulay iqlim sharoitlari tufayli yagana qilinganidan keyin va amal davri oxirida ko'rsatkichlarning pasayishi boshqa yillarga nisbatan kamroq darajada kuzatildi.

1-jadval

Topinambur o'simligi nihollarining unib chiqish darajasi va ko'chat qalinligiga mineral o'g'itlar shakllari va me'yorlarining ta'siri (2025-yil) / **Table 1.** Effect of mineral fertilizer forms and rates on seedling emergence and plant density of Jerusalem artichoke (2025)

№	Qo'llanilgan azotli o'g'it turlari	Mineral o'g'it me'yorlari	Kuzatuv muddatlari				Ko'chat qalinligi, ming.tup/ga	
			07.04	12.04	17.04	20.04	Yaganadan keyin	Amal davri oxirida
1	(NH ₄) ₂ SO ₄ (Ammoniy sulfat)	O'g'itsiz (nazorat)	28,4	51,2	72,6	90,4	88,4	86,9
2		P ₉₀ K ₉₀	29,1	53,5	74,4	91,5	89,6	87,8
3		N ₆₀ P ₉₀ K ₉₀	30,3	54,8	76,5	91,9	90,6	88,2
4		N ₉₀ P ₉₀ K ₉₀	31,5	55,6	77,4	92,2	90,9	89,7
5		N ₁₂₀ P ₉₀ K ₉₀	32,4	57,5	79,2	94,8	92,8	90,6
6		N ₁₅₀ P ₉₀ K ₉₀	31,6	56,7	78,6	93,0	91,9	90,3
7	CO(NH ₂) ₂ (Karbamid)	N ₆₀ P ₉₀ K ₉₀	31,3	55,4	76,9	92,7	90,8	89,4
8		N ₉₀ P ₉₀ K ₉₀	32,4	56,6	78,4	93,3	91,6	90,5
9		N ₁₂₀ P ₉₀ K ₉₀	33,5	58,6	80,2	95,2	93,3	91,9
10		N ₁₅₀ P ₉₀ K ₉₀	33,0	58,0	80,1	93,4	92,6	91,2
11	NH ₄ NO ₃ (Ammoniy nitrat)	N ₆₀ P ₉₀ K ₉₀	31,5	55,9	77,7	93,1	91,6	90,0
12		N ₉₀ P ₉₀ K ₉₀	32,8	57,6	79,4	93,3	92,7	91,4
13		N ₁₂₀ P ₉₀ K ₉₀	33,9	59,3	81,6	95,1	94,1	92,9
14		N ₁₅₀ P ₉₀ K ₉₀	33,5	58,9	80,0	93,9	93,7	92,5

3. XULOSA

Conclusion

Yuqorida o'tkazilgan dala tajribalari natijalari topinambur o'simligi nihollarining unib chiqish darajasi va ko'chat qalinligiga mineral o'g'itlar shakllari va me'yorlarining sezilarli ta'sir ko'rsatishi aniqlandi. Tadqiqotda ammoniy sulfat, karbamid va ammoniy nitrat kabi uch xil azotli o'g'it shakllari hamda ularning N₆₀, N₉₀, N₁₂₀, N₁₅₀ me'yorlari P₉₀K₉₀ fonida qo'llanilib, olingan natijalar o'rtacha uch yillik ko'rsatkichlar asosida baholandi. O'rganilgan azotli o'g'it shakllari orasida ammoniy nitrat eng yuqori samaradorlikka ega bo'lib, uning N₁₂₀P₉₀K₉₀ me'yori ko'chat qalinligining maksimal darajaga (o'rtacha 93,1 ming tup/ga) chiqishini ta'minlaydi. Karbamid o'rtacha samaradorlikni (92,2 ming tup/ga), ammoniy sulfat esa nisbatan past samaradorlikni (91,4 ming tup/ga) namoyon qildi. Barcha uchala o'g'it shakli uchun N₁₂₀P₉₀K₉₀ optimal me'yor ekanligi aniqlandi, bu me'yordan oshib ketish (N₁₅₀) ko'rsatkichlarning o'rtacha 0,4-0,5 ming tup/ga.ga pasayishiga olib keldi.

DECLARATIONS

Declarations

Author contributions CRedit

Conceptualization; Methodology; Investigation; Writing – original draft; Writing – review & editing. The author has read and agreed to the published version of the manuscript.

Funding

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Ethics approval

The study was carried out in field conditions with plants only; no human participants or animals were involved, and no ethics committee approval was required.

Informed consent

The author has read and approved the final version of the manuscript and has given her consent to its submission and publication. The study involved no human participants and no personal data.

Data availability statement

The data obtained in the study are presented in the table of this article; the primary records are available from the author on reasonable request.

Conflict of interest

The author declares no conflict of interest.

Generative AI disclosure

Generative AI (Claude, Anthropic) was used in the editorial preparation of this article: for language editing, translation of the title, abstract and keywords between Uzbek, Russian and English, preparation of the extended English summary from the author's text, and formatting of the reference list. No data, results or conclusions were generated by AI. The author is responsible for the content of the publication.

EXTENDED SUMMARY IN ENGLISH

Kengaytirilgan inglizcha xulosa / Расширенный реферат на английском языке

Purpose and research problem

Ensuring food security, increasing soil fertility and maintaining ecological balance are among the key tasks of modern agriculture, and the cultivation of high-yielding crops that give ecologically clean products is therefore of growing importance. Jerusalem artichoke (*Helianthus tuberosus* L.) is one such crop: it has high biological activity and contains inulin, vitamins (C, B1, B2, B6), iron, potassium, calcium, magnesium and other useful substances, is regarded as beneficial in diabetes and cardiovascular and gastrointestinal diseases, and its tubers are widely used for fodder, food and pharmaceutical purposes. Agrotechnical measures, in particular the correct choice of mineral fertilizers and especially of nitrogen fertilizer rates, play an important role in accelerating its growth and increasing its yield. The aim of the article was to analyse the effect of the forms and rates of mineral fertilizers on the emergence and plant density of the Jerusalem artichoke variety Fayz-baraka.

Materials and methods

Literature data show that tubers of Jerusalem artichoke require an air temperature of at least 12 °C for sprouting, at least 14–15 °C for the initial growth of seedlings and 26–28 °C in the later phases; lateral shoots form in the axils of the 5th–8th leaves of the main stem on the 25th–30th day of growth and develop rapidly when the main stem is damaged, and tuber formation begins on the 60th–65th day and lasts 80–100 days. In the field experiment of 2025, three forms of nitrogen fertilizer — ammonium sulfate ((NH₄)₂SO₄), urea (CO(NH₂)₂) and ammonium nitrate (NH₄NO₃) — were applied at rates of N₆₀, N₉₀, N₁₂₀ and N₁₅₀ against a P₉₀K₉₀ background and compared with an unfertilized control and a P₉₀K₉₀ variant (14 variants in total). Seedling emergence was recorded on 7, 12, 17 and 20 April, and plant density (thousand plants per hectare) was determined after thinning and at the end of the growing season. The location of the experiment, soil characteristics, plot size and number of replications are not described in the article.

Results and discussion

In all variants plant density increased over the observation dates, and the most intensive increase occurred between the second (12 April) and third (17 April) observations, when density rose on average by 22–24 thousand plants per hectare. In the unfertilized control the values were 28.4, 51.2, 72.6 and 90.4 on the four observation dates, 88.4 thousand plants/ha after thinning and 86.9 thousand plants/ha at the end of the growing season. Ammonium nitrate gave the highest values of all fertilizer forms: at $N_{120}P_{90}K_{90}$ the values on the observation dates were 33.9, 59.3, 81.6 and 95.1, plant density after thinning was 94.1 thousand plants/ha and at the end of the growing season 92.9 thousand plants/ha, which was 1.7–2.9 thousand plants/ha higher than with ammonium sulfate and 0.6–1.5 thousand plants/ha higher than with urea. With urea the best rate, $N_{120}P_{90}K_{90}$, gave 93.3 and 91.9 thousand plants/ha, and with ammonium sulfate 92.8 and 90.6 thousand plants/ha after thinning and at the end of the season. The high values recorded in all variants in 2025 are explained mainly by a favourable temperature regime and optimal moisture supply, which also reduced the decline in density after thinning and at the end of the growing season compared with other years.

Conclusion and contribution

The forms and rates of mineral fertilizers had a significant effect on the emergence and plant density of Jerusalem artichoke seedlings. Of the nitrogen forms studied, ammonium nitrate was the most effective, and its $N_{120}P_{90}K_{90}$ rate ensured the maximum plant density; urea showed medium and ammonium sulfate relatively lower efficiency. $N_{120}P_{90}K_{90}$ was the optimal rate for all three fertilizer forms, while increasing the nitrogen rate to N_{150} reduced the indicators by 0.4–0.5 thousand plants per hectare on average. According to the author, these conclusions are based on average three-year indicators.

ADABIYOTLAR RO'YXATI

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Modern integrated control measures against fruit moths in the southern regions of Uzbekistan

O'zbekistonning janubiy hududlarida tarqalgan meva kuyalariga qarshi zamonaviy integratsiyalashgan kurash choralari

Современные комплексные меры борьбы с плодовыми молями в южных регионах Узбекистана

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ENGLISH

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Abstract. The article describes a modern integrated protection system aimed at reducing the harmfulness of fruit moths found in orchards in the southern regions of Uzbekistan, in particular in the Kashkadarya and Surkhandarya regions. Fruit moths, especially representatives of the Yponomeutidae family, can damage the leaf apparatus of fruit trees, reduce photosynthetic activity, and negatively affect yield and fruit quality. In a modern approach, pest control is based on the integration of agrotechnical, mechanical, biological, biotechnical, and, if necessary, selective chemical methods into a single system. The article analyzes the prospects for pheromone monitoring, phenological monitoring, economic damage criteria, protection of natural enemies, the use of entomopathogenic microorganisms, and digital monitoring.

Keywords: fruit moths; Yponomeutidae; Yponomeuta; apple moth; integrated management; IPM; pheromone monitoring; biological control; entomophages; entomopathogens; forecasting

O'ZBEKCHA

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Annotatsiya. Maqolada O'zbekistonning janubiy hududlari, xususan Qashqadaryo va Surxondaryo viloyatlarida meva bog'larida uchraydigan meva kuyalarining zararliligini kamaytirishga qaratilgan zamonaviy integratsiyalashgan himoya tizimi yoritilgan. Meva kuyalari, ayniqsa Yponomeutidae oilasi vakillari, meva daraxtlarining barg apparatiga zarar yetkazib, fotosintetik faollikni susaytirishi hamda hosildorlik va meva sifatiga salbiy ta'sir ko'rsatishi mumkin. Zamonaviy yondashuvda zararkunandalarga qarshi kurash agroteknika, mexanika, biologiya, bioteknika va zarurat tug'ilganda selektiv kimyoviy usullarni yagona tizimga birlashtirishga asoslanadi. Maqolada feromon monitoringi, fenologik kuzatuv, iqtisodiy zarar mezonlari, tabiiy kushandalarni muhofaza qilish, entomopatogen mikroorganizmlardan foydalanish va raqamli monitoringning istiqbollari tahlil qilingan.

Kalit so'zlar: meva kuyalari; Yponomeutidae; Yponomeuta; olma kuyasi; integratsiyalashgan himoya; IPM; feromon monitoring; biologik kurash; entomofaglar; entomopatogenlar; prognoz

РУССКИЙ

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Аннотация. В статье описывается современная комплексная система защиты, направленная на снижение вредности плодовых молей, встречающихся в садах южных регионов Узбекистана, в частности, Кашкадарьинской и Сурхандарьинской областей. Плодовые моли,

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особенно представители семейства Yponomeutidae, могут повреждать листовой аппарат плодовых деревьев, снижать фотосинтетическую активность и негативно влиять на урожайность и качество плодов. В современном подходе борьба с вредителями основана на интеграции агротехнических, механических, биологических, биотехнических и, при необходимости, селективных химических методов в единую систему. В статье анализируются перспективы феромонного мониторинга, фенологического мониторинга, экономических критериев ущерба, охраны естественных врагов вредителей, использования энтомопатогенных микроорганизмов и цифрового мониторинга.

Ключевые слова: плодовые моли; Yponomeutidae; Yponomeuta; яблоневая моль; интегрированная борьба с вредителями; IPM; феромонный мониторинг; биологический контроль; энтомофаги; энтомопатогены; прогнозирование

1. KIRISH

Introduction

Mevachilik O'zbekiston qishloq xo'jaligining muhim tarmoqlaridan biri bo'lib, mamlakatning janubiy hududlari issiq vegetatsiya davri va meva yetishtirish uchun qulay agroiklimiy sharoitlari bilan ajralib turadi. Biroq yuqori harorat, suv ta'minotidagi o'zgaruvchanlik, bog'larning intensivlashuvi va zararkunandalarning biologik xususiyatlari fitosanitar xavflarni oshirishi mumkin.

Yponomeutidae oilasiga mansub turlar meva bog'larida muhim zararkunanda sifatida namoyon bo'lishi mumkin. Masalan, olma meva kuyasi — Yponomeuta malinellus Zeller lichinka bosqichida barglarga zarar yetkazib, kuchli zararlanishda daraxtning fotosintetik apparatini susaytiradi.

Zamonaviy entomologiyada maqsad zararkunandani mutlaq yo'q qilish emas, balki uning populyatsiya zichligini iqtisodiy jihatdan maqbul darajada ushlab turishdir. Shu nuqtai nazaridan integratsiyalashgan zararkunanda boshqaruvi (IPM) monitoring, profilaktika, biologik, mexanik, agroteknik va zaruratda kimyoviy choralarni uyg'unlashtiradi.

1.1. Tadqiqotning maqsadi

Tadqiqotning maqsadi O'zbekistonning janubiy hududlarida tarqalgan meva kuyalariga qarshi ekologik xavfsiz, iqtisodiy samarali va zamonaviy texnologiyalarga asoslangan integratsiyalashgan himoya tizimini ilmiy jihatdan asoslashdan iborat. Asosiy vazifalar:

- 1) meva kuyalarining tarqalishi va mavsumiy rivojlanishini monitoring qilish;
- 2) populyatsiya dinamikasini aniqlash;
- 3) feromon va vizual kuzatuv usullarini birlashtirish;
- 4) tabiiy kushandalar faoliyatini baholash;
- 5) agroteknik va mexanik choralarni takomillashtirish;
- 6) biologik himoya vositalarining istiqbolini baholash;
- 7) iqlim ma'lumotlari asosida prognozlash;
- 8) IPM modeli ishlab chiqish.

2. TADQIQOT OBYEKTI VA METODOLOGIYASI

Materials and methods

Tadqiqotlarni janubiy O'zbekistonning mevalikka ixtisoslashgan hududlaridagi olma, nok va boshqa urug'li meva bog'larida tashkil etish maqsadga muvofiq.

Monitoringda feromon tutqichlar, vizual marshrut kuzatuvlari, zararlangan barg va novdalarni hisoblash, lichinka va g'umbaklar zichligini aniqlash, tabiiy kushandalarni hisobga olish, meteorologik ma'lumotlarni yig'ish, GPS asosida zararlanish nuqtalarini belgilash va elektron ma'lumotlar bazasini shakllantirish usullaridan foydalanish mumkin.

3. NATIJALAR

Results

Meva kuyalarining zarariligi. Meva kuyalarining zarariligi asosan lichinka bosqichi bilan bog'liq. Lichinkalar barg to'qimalari bilan oziqlanishi natijasida fotosintetik faol yuza kamayadi. Kuchli zararlanish daraxtning fiziologik holati va hosildorligiga ta'sir qilishi mumkin.

Yponomeuta malinellus lichinkalari dastlab barg to'qimalarini zararlaydi, keyinchalik bir nechta bargni ipaksimon to'rlar bilan birlashtirib koloniya hosil qiladi. Shuning uchun zararkunanda rivojlanishining dastlabki bosqichlarida aniqlash va boshqarish muhim.

Bog'larni sanitar holatda saqlash, zararlangan qismlarni o'z vaqtida olib tashlash, daraxt tojini meyorda shakllantirish, qalinlashgan shox-shabbani siyraklashtirish, sug'orish va oziqlantirish rejimini muvozanatlashtirish muhim. Agroteknik tadbirlarning maqsadi zararkunandani to'g'ridan-to'g'ri yo'q qilishdan ko'ra daraxtlarning fiziologik barqarorligini oshirish va zarar natijasini kamaytirishdir.

Feromon tutqichlar yordamida imagolarning uchish davri, avlodlar soni, populyatsiya dinamikasi va zararkunanda faolligining boshlanishi aniqlanishi mumkin. Eng muhim afzallik — qarorni kalendar sanasiga emas, real populyatsiya dinamikasiga asoslashdir. Kelgusida feromon tutqichlarini avtomatik hisoblagichlar, mobil ilovalar va geoaxborot tizimlari bilan integratsiyalash mumkin.

Tabiiy entomofaglarni muhofaza qilish zararkunanda populyatsiyasini tabiiy ravishda cheklashning muhim mexanizmi hisoblanadi. Yponomeuta malinellus bo'yicha tadqiqotlarda parazitoidlar qayd etilgan.

Ageniaspis fuscicollis kabi parazitoidlarning olma kuyasi populyatsiyasiga ta'siri xorijiy tadqiqotlarda o'rganilgan. Biroq O'zbekiston sharoitida xorijiy entomofaglarni joriy etishdan oldin ularning xavfsizligi, xo'jayin doirasi va samaradorligi ilmiy baholanishi shart.

Entomopatogen zamburug'lar, bakteriyalar va boshqa mikrobiologik vositalar zamonaviy biologik himoyaning istiqbolli yo'nalishlaridir. Yponomeuta malinellus ga qarshi entomopatogen zamburug'lardan foydalanish imkoniyatlari bo'yicha tadqiqotlar olib borilgan.

Janubiy O'zbekistonda ushbu vositalarning samaradorligi harorat, namlik va zararkunanda rivojlanish bosqichlari bilan bog'liq holda alohida o'rganilishi lozim.

Zararlangan barg va to'rlarni aniqlash, zararlangan qismlarni mexanik olib tashlash, sanitar kesish va zararlangan o'simlik qismlarini bog'dan chiqarish kichik va o'rta hajmdagi bog'larda samarali bo'lishi mumkin.

Zamonaviy IPM tizimida zararkunanda aniqlangani bilan avtomatik ravishda kimyoviy ishlov berilmaydi. Qaror qabul qilishda zararkunanda zichligi, zararlanish darajasi, tabiiy

kushandalar faolligi, o'simlik fenologiyasi, ob-havo va kutilayotgan iqtisodiy zarar kompleks baholanadi.

Har bir kuzatuv nuqtasini GPS koordinatalari bilan qayd etish, zararkunanda zichligi, fenologik faza, harorat, nisbiy namlik, yog'ingarchilik va tabiiy kushandalar haqidagi ma'lumotlarni elektron bazaga kiritish mumkin.

Keyinchalik ushbu ma'lumotlar asosida zararkunanda rivojlanishining qisqa muddatli prognoz modeli ishlab chiqilishi mumkin. "Meteostansiya + feromon tutqich + dalaviy kuzatuv + raqamli prognoz" kombinatsiyasi fitosanitar qarorlarni aniqlashtirish imkonini beradi.

Janubiy O'zbekistonda yuqori harorat va iqlim o'zgaruvchanligi zararkunandalar fenologiyasiga ta'sir qilishi mumkin. Shu sababli himoya tadbirlarini faqat kalendar muddatlariga emas, har yili yangilanadigan fenologik va meteorologik ma'lumotlarga asoslash maqsadga muvofiq.

Kimyoviy himoya integratsiyalashgan tizimda butunlay istisno qilinmaydi, ammo monitoring natijalari zararkunanda iqtisodiy xavfli darajaga yetganini ko'rsatgan holatda qo'llanishi lozim.

Bunda O'zbekistonda rasman ruxsat etilgan vositalardan foydalanish, selektiv ta'sirga ega preparatlarni ustuvor ko'rish, tabiiy kushandalarni asrash, ta'sir mexanizmini navbatlashtirish va yorliq talablariga rioya qilish muhim.

4. MUHOKAMA

Discussion

Janubiy O'zbekistonda meva kuyalariga qarshi kurashda eng muhim masalalardan biri himoya tadbirlarini zararkunanda populyatsiyasining real dinamikasiga bog'lashdir. Harorat va namlik yillar bo'yicha farq qilishi sababli kalendar bo'yicha ishlov berish har doim ham optimal natija bermasligi mumkin.

Shuning uchun «kalendar bo'yicha ishlov berish» modeli o'rniga «monitoring asosida qaror qabul qilish» modeli joriy qilinishi lozim. Kimyoviy vositalarga ortiqcha tayanish tabiiy entomofaunaga salbiy ta'sir qilishi va rezistentlik xavfini oshirishi mumkin.

5. XULOSA

Conclusion

O'zbekistonning janubiy hududlarida meva kuyalariga qarshi samarali kurash zararkunandani faqat kimyoviy usulda yo'q qilishga emas, balki uning populyatsiyasini ekotizim doirasida boshqarishga asoslanishi va quyidagilarga e'tibor qaratish kerak bo'ladi:

- Integratsiyalashgan himoya tizimi maqbul yondashuvlardan biridir;
- Feromon monitoringi zararkunanda uchish dinamikasini aniqlash imkonini beradi;
- Kurash kalendar muddatlari emas, monitoring natijalari asosida tashkil qilinishi kerak;
- Tabiiy entomofaglarni muhofaza qilish muhim biologik mexanizmdir;
- Entomopatogen zamburug'lar va boshqa biologik vositalarni mahalliy sharoitda sinovdan o'tkazish istiqbolli;
- Meteorologik ma'lumotlar, feromon monitoringi va raqamli texnologiyalarni birlashtirish prognozlashni yaxshilaydi;
- Kimyoviy himoya faqat iqtisodiy xavf asoslangan holatda qo'llanishi kerak;
- Janubiy O'zbekiston uchun eng istiqbolli modeli: "monitoring + prognozlash + biologik himoya + agrotexnik profilaktika + zaruratda selektiv himoya".

DECLARATIONS

Declarations

Author contributions *CRedit*

Conceptualization; Methodology; Investigation; Writing – original draft; Writing – review & editing. The author has read and agreed to the published version of the manuscript.

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Ethics approval

The article is based on an analysis of published scientific literature and monitoring methods for insect pests of orchards; the work involved no experiments on vertebrate animals and no human participants, and therefore required no separate ethics committee approval.

Informed consent

The author has read and approved the final version of the manuscript and has given his consent to its submission and publication. The study involved no human participants and no personal data.

Data availability statement

All sources analysed in the article are listed in the reference list; no new datasets were generated.

Conflict of interest

The author declares no conflict of interest.

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Generative AI (Claude, Anthropic) was used in the editorial preparation of this article: for language editing, translation of the title, abstract and keywords between Uzbek, Russian and English, preparation of the extended English summary from the author's text, and formatting of the reference list. No data, results or conclusions were generated by AI. The author is responsible for the content of the publication.

EXTENDED SUMMARY IN ENGLISH

Kengaytirilgan inglizcha xulosa / Расширенный реферат на английском языке

Purpose and research problem

Fruit growing is one of the important branches of agriculture in Uzbekistan, and the southern regions of the country are distinguished by a warm growing season and favourable agro-climatic conditions for fruit production. At the same time, high temperatures, variable water supply, the intensification of orchards and the biological features of pests can increase phytosanitary risks. Species of the family Yponomeutidae can become important orchard pests; for example, the apple ermine moth *Yponomeuta malinellus* Zeller damages leaves at the larval stage and, under heavy infestation, weakens the photosynthetic apparatus of the tree. Modern entomology aims not at the complete elimination of a pest but at keeping its population density at an economically acceptable level, and integrated pest management (IPM) combines monitoring, prevention and biological, mechanical, agrotechnical and, when necessary, chemical measures. The aim of the work was to substantiate an ecologically safe, economically effective and technology-based integrated protection system against fruit moths in the southern regions of Uzbekistan, with tasks covering the monitoring of moth distribution and seasonal development, population dynamics, the combination of pheromone and visual surveys, the assessment of natural enemies, the improvement of agrotechnical and mechanical measures, the prospects of biological control, climate-based forecasting and the development of an IPM model.

Materials and methods

The author proposes that the studies be organised in apple, pear and other pome-fruit orchards in the fruit-growing areas of southern Uzbekistan, in particular the Kashkadarya and Surkhandarya regions. The monitoring methods considered include pheromone traps, visual route surveys, counting of damaged leaves and shoots, determination of the density of larvae and pupae, accounting of natural enemies, collection of meteorological data, GPS marking of infestation points and the creation of an electronic database. The article analyses these

approaches on the basis of published international studies and FAO materials on integrated pest management, and the national legislation on plant protection.

Results and discussion

The harmfulness of fruit moths is associated mainly with the larval stage: feeding on leaf tissue reduces the photosynthetically active surface, and heavy damage can affect the physiological condition and yield of the tree. Larvae of *Y. malinellus* first damage the leaf tissue and then join several leaves with silken webs into colonies, so early detection and management are essential. Agrotechnical measures — orchard sanitation, timely removal of damaged parts, proper crown formation, thinning of dense branches and balanced irrigation and nutrition — aim mainly at increasing the physiological resistance of the trees. Pheromone traps make it possible to determine the flight period of adults, the number of generations, population dynamics and the onset of pest activity, so that decisions are based on real population dynamics rather than on calendar dates; in future the traps can be integrated with automatic counters, mobile applications and geographic information systems. The conservation of natural enemies is an important mechanism of natural population regulation: parasitoids of *Y. malinellus*, including *Ageniaspis fuscicollis*, have been studied abroad, but their safety, host range and efficiency must be evaluated scientifically before any introduction into Uzbekistan. Entomopathogenic fungi, bacteria and other microbiological agents are promising, and their efficiency in southern Uzbekistan should be studied in relation to temperature, humidity and the developmental stages of the pest. Mechanical removal of damaged leaves and webs and sanitary pruning can be effective in small and medium orchards. In modern IPM, detection of a pest does not automatically lead to chemical treatment: the decision takes into account pest density, the degree of damage, the activity of natural enemies, plant phenology, weather and the expected economic loss. Recording each observation point with GPS coordinates together with pest density, phenological phase, temperature, humidity, precipitation and natural enemies allows short-term forecasting models to be developed, and the combination "weather station + pheromone trap + field survey + digital forecast" refines phytosanitary decisions. Chemical protection is not excluded from the integrated system but should be used only when monitoring shows that the pest has reached an economically dangerous level, with officially approved and selective products, rotation of modes of action and observance of label requirements.

Conclusion and contribution

Because temperature and humidity vary from year to year, calendar-based treatments do not always give optimal results, and the author recommends replacing the "calendar treatment" model with "monitoring-based decision making"; excessive reliance on chemicals may harm the natural entomofauna and increase the risk of resistance. Effective control of fruit moths in southern Uzbekistan should be based on managing the pest population within the ecosystem rather than on chemical elimination alone. The integrated protection system is one of the optimal approaches; pheromone monitoring reveals the flight dynamics of the pest; control should be organised according to monitoring results rather than calendar dates; the conservation of natural enemies is an important biological mechanism; entomopathogenic fungi and other biological agents should be tested under local conditions; and meteorological data, pheromone monitoring and digital technologies should be combined for forecasting. The most promising model for southern Uzbekistan is "monitoring + forecasting + biological protection + agrotechnical prevention + selective protection when necessary".

ADABIYOTLAR RO'YXATI

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RESEARCH ARTICLE • PEER-REVIEWED • OPEN ACCESS • SERIES C • HAC/OAK 06.00.00 —
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Formation of skin thickness indicators in offspring obtained from different mating variants of Sur-coloured sheep

Sur rangli qo'ylarni turli variantlarda juftlashdan olingan avlodlarda teri qalinligi ko'rsatkichlarining shakllanishi**Формирование показателей толщины кожи у потомства, полученного при различных вариантах подбора овец окраски сур****B.S. MAMATOV^{1,*}**¹ Research Institute of Karakul Sheep Breeding and Desert Ecology, Samarkand, Uzbekistan* Corresponding author: bshms@mail.ru

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AUTHOR, TITLE AND ABSTRACT METADATA (EN / UZ / RU)

ENGLISH

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Abstract. The article analyzes the skin thickness parameters of offspring obtained from various variations of matching Sur Karakul sheep, taking into account their color types (silvery, diamond, golden). According to the research results, it was found that the selection of parental pairs has a differential effect on the distribution of lambs into groups with thin, thickened, and thick skin. In particular, statistical analysis proved that the highest rate of thin skin (75.0%) in offspring was recorded in the homogenous matching variant of rams and ewes of the diamond color type.

Keywords: Karakul farming; Sur color; silvery; diamond; golden; matching variants; offspring; skin thickness; scoring

O'ZBEKCHA

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Annotatsiya. Maqolada sur rangli qorako'l qo'ylarini turli rangbaranglik (kumushsimon, olmos, tillasimon) guruhlari bo'yicha variantli juftlashdan olingan avlodlarning teri qalinligi ko'rsatkichlari tahlil qilingan. Tadqiqot natijalariga ko'ra, ota-onalik shakllarini tanlab juftlash avlodlarning teri qoplamining yupqa, qalinlashgan va qalin guruhlarga taqsimlanishiga differensial ta'sir ko'rsatishi aniqlangan. Xususan, olmos rangbarangligiga mansub qo'chqor va sovliqlarni o'zaro gomogen juftlash variantida eng yuqori yupqa terilik ko'rsatkichi (75,0%) qayd etilganligi statistik tahlillar yordamida isbotlangan.

Kalit so'zlar: qorako'lchilik; sur rang; rangbaranglik; kumushsimon; olmos; tillasimon; juftlash variantlari; avlod; teri qalinligi; bonitirovka

РУССКИЙ

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Аннотация. В статье проанализированы показатели толщины кожи у каракульских ягнят, полученных от различных вариантов подбора каракульских овец окраски сур различных расцветок (серебристая, алмазная, золотистая). По результатам исследований установлено, что подбор родительских пар оказывает дифференцированное влияние на распределение ягнят по группам с тонкой, утолщенной и толстой кожей. В частности, статистически доказано, что при гомогенном подборе баранов и маток алмазной расцветки зафиксирован наибольший показатель выхода потомства (75,0%) с тонкой кожей.

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Ключевые слова: каракулеводство; расцветка суп; серебристая; алмазная; золотистая; варианты подбора; потомство; толщина кожи; бонитировка

1. KIRISH

Introduction

Qorako'lichilik nafaqat qishloq xo'jaligining mustaqil tarmog'i, balki cho'l va yarim cho'l hududlarining ekstremal ekologik sharoitlaridan unumli foydalanishning yagona iqtisodiy samarali yo'nalishi hisoblanadi. O'zbekiston Respublikasida chorvachilik tarmoqlarini jadal rivojlantirish, naslchilik ishlarini tubdan takomillashtirish hamda eksportbop maxsulot turlarini ko'paytirish davlat siyosatining ustuvor vazifalaridan biri etib belgilangan.

Qorako'l qo'ylarining ko'p sonli populyatsiyalari orasida sur rangli hayvonlar o'zlarining rang va rangbarangligi, qorako'l terilar yaltiroqligi va ipaksimonligi bilan alohida ajralib turadi. Sur qorako'l terilarining tovarlik qiymatini va jahon auksionlaridagi raqobatbardoshligini belgilovchi eng muhim seleksion belgilaridan biri – bu yangi tug'ilgan qo'zilarining teri qalinligidir. Teri qalinligi jun qoplami to'qimalarining gistologik tuzilishi, kollagen tolalari va yog'-ter bezlarining rivojlanishi bilan uzviy bog'liq bo'lib, u tayyor qorako'lning yengilligi, egiluvchanligi va mustahkamligini kafolatlaydi.

Sur rangli qo'ylarni urchitishda kumushsimon, olmos va tillasimon kabi rangbarangliklarini tizimli ravishda kombinatsiya qilish (juftlash) orqali teri qalinligining optimal parametrlariga ega avlodlarni shakllantirish mumkin. Biroq, rangbaranglik guruhlarining o'zaro ta'sirida teri qatlamlarining irsiylanish tabiati yetarli darajada tizimlashtirilmagan. Bu esa ushbu yo'nalishdagi genetik-seleksion tadqiqotlarning ko'lamini kengaytirish va amaliy tavsiyalar ishlab chiqish dolzarbligini belgilaydi.

1.1. Tadqiqotning maqsadi

Sur rangli qorako'l qo'ylarini turli rangbaranglik guruhlari bo'yicha o'zaro juftlash variantlarining yangi tug'ilgan avlodlar (qo'zilar) teri qoplamining qalinligi ko'rsatkichlariga ko'rsatadigan ta'sirini ilmiy jihatdan baholash va optimal juftlash kombinatsiyalarini aniqlashdan iborat.

Tadqiqotning vazifalari:

- Sur rangli qorako'l qo'ylari orasida ota-onalik shakllarining rangbaranglik xususiyatlariga ko'ra (kumushsimon, olmos, tillasimon) ilmiy asoslangan juftlash variantlarini tashkil etish;
- Har bir juftlash variantidan olingan yangi tug'ilgan avlodlarning teri qalinligini (yupqa, qalinlashgan va qalin) qiyosiy o'rganish;

1-jadval

Juftlash variantlarining avlodlar teri qoplamining qalinligiga ta'siri, % / **Table 1.** Effect of mating variants on the skin thickness of offspring, %

Juftlash variantlari		n	Teri qalinligi		
♂	♀		yupqa	qalinlashgan	qalin
Kumushsimon	Kumushsimon	120	70,8±4,15	17,5±3,46	11,7±2,93
	Olmos	65	72,3±5,55	21,5±5,09	6,2±2,99
	Tillasimon	45	71,1±6,75	17,8±5,70	11,1±4,68
Olmos	Kumushsimon	86	73,2±4,77	16,3±3,98	10,5±3,30
	Olmos	72	75,0±5,10	13,9±4,07	11,1±3,70
	Tillasimon	43	72,1±6,83	16,3±5,63	11,6±4,88

Jadval ma'lumotlaridan ko'rinib turibdiki, barcha kombinatsiyalarda ham yupqa terili avlodlarning ulushi yuqori darajada saqlanib qolgan bo'lib, bu ko'rsatkich 70,8 foizdan 75,0 foizgacha bo'lgan diapazonni tashkil etdi.

Eng yuqori yupqa terilik ko'rsatkichi ♂**Olmos** × ♀**Olmos** gomogen juftlash variantida qayd etilib, 75,0±5,10 foizni tashkil

- Olingan raqamli ma'lumotlarni variatsion statistika usullarida tahlil qilib, seleksiya ishlari uchun eng samarali juftlash tizimlarini tavsiya etish.

2. TADQIQOT USULLARI

Materials and methods

Ilmiy-tadqiqot ishlari sur rangli qorako'l qo'ylarini urchitishga ixtisoslashgan "Yangikazgan nurli diyor" MChJ xo'jaligi sharoitida olib borildi. Tajriba obyekti sifatida turli rangbaranglik (kumushsimon, olmos va tillasimon) guruhlariga mansub bo'lgan qorako'l qo'ylari hamda ulardan olingan avlodlar (qo'zilar) tanlab olindi.

Rangbarangliklar bo'yicha ota-onalik shakllarini o'zaro juftlash maqsadida 6 ta asosiy juftlash varianti shakllantirildi:

1. ♂Kumushsimon × ♀Kumushsimon (n=120)
2. ♂Kumushsimon × ♀Olmos (n=65)
3. ♂Kumushsimon × ♀Tillasimon (n=45)
4. ♂Olmos × ♀Kumushsimon (n=86)
5. ♂Olmos × ♀Olmos (n=72)
6. ♂Olmos × ♀Tillasimon (n=43)

Yangi tug'ilgan qo'zilar terisining qalinligini baholash S.Yu. Yusupov va boshqalar (2015) tomonidan ishlab chiqilgan «Qorako'lichilikda naslchilik ishlarini yuritish va qo'zilar baholash (bonitirovka qilish) bo'yicha qo'llanma»si asosida amalga oshirildi. Qo'zilar terisining qalinligi vizual va palpatsiya usullari yordamida yupqa, qalinlashgan va qalin guruhlariga ajratilgan holda baholandi.

Tadqiqotlardan olingan biometrik ma'lumotlar N.A. Ploxinskiy (1969) uslubi bo'yicha variatsion statistika metodlarida qayta ishlandi. Tahlillar jarayonida har bir variantdagi avlodlar soni (n), o'rtacha arifmetik qiymat ($\bar{X}$) hamda o'rtacha qiymatning xatoligi ($S\bar{x}$) aniqlandi.

3. TADQIQOT NATIJALARI VA ULARNING MUHOKAMASI

Results and discussion

Olib borilgan ilmiy kuzatuvlar shuni ko'rsatdiki, tanlab juftlash variantlari yangi tug'ilgan qo'zilar teri qoplamining qalinligiga sezilarli darajada ta'sir ko'rsatadi (1-jadval).

etdi. Ushbu variantda qalinlashgan terili qo'zilar ulushi eng kam qiymatni (13,9±4,07%) ko'rsatdi. Kumushsimon rangbaranglikka mansub qo'chqorlarni xuddi shu guruhdagi sovliqlar bilan gomogen juftlanganda (♂**Kumushsimon** × ♀**Kumushsimon**) yupqa terili avlodlar 70,8±4,15% ni, qalin terili qo'zilar esa 11,7±2,93% ni tashkil etgan.

Geterogen juftlash variantlari tahlil qilinganda, ♂ **Kumushsimon** × ♀ **Olmos** kombinatsiyasida olingan avlodlar orasida qalin terili qo'zilarining salmog'i minimal darajada, ya'ni $6,2 \pm 2,99$ bo'lganligi e'tiborga loyiqdir. Aksincha, ♂ **Olmos** × ♀ **Tillasimon** kombinatsiyasida qalin terili avlodlar ko'rsatkichi bir qadar yuqori bo'lib, $11,6 \pm 4,88$ ni tashkil qildi.

Ushbu qonuniyatlar shuni ko'rsatadiki, olmos rangbarangligi genotipi teri qoplamining elastikligi va yupqaligini ta'minlovchi genetik determinantlarning barqaror uzatilishiga xizmat qiladi.

4. XULOSALAR

Conclusions

1. Sur rangli qorako'l qo'yalarini turli rangbaranglik guruhlarini bo'yicha variantli tanlab juftlash olingan avlodlarning teri qalinligi gistotipiga differensial ta'sir ko'rsatadi.

2. Yupqa va nafis terili yuqori sifatli qorako'l elitlarini yetishtirishda ♂ **Olmos** × ♀ **Olmos** kombinatsiyasidan foydalanish yuqori seleksion samara beradi (yupqa terili avlodlar 75,0%).

3. Qalin terili qo'zilar tug'ilishini kamaytirish va barqaror tovarbop mahsulot olish uchun ♂ **Kumushsimon** × ♀ **Olmos** geterogen juftlash variantidan foydalanish maqsadga muvofiq hisoblanadi (qalin terilik atigi 6,2%).

DECLARATIONS

Declarations

Author contributions *CRedit*

Conceptualization; Methodology; Investigation; Writing – original draft; Writing – review & editing. The author has read and agreed to the published version of the manuscript.

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Ethics approval

The work with animals was carried out within routine zootechnical practice of breeding and evaluating Karakul sheep on the farm, in accordance with the veterinary and zootechnical requirements in force in the Republic of Uzbekistan.

Informed consent

The author has read and approved the final version of the manuscript and has given his consent to its submission and publication. The study involved no human participants and no personal data.

Data availability statement

The data obtained in the study are presented in the table of this article; the primary records are available from the author on reasonable request.

Conflict of interest

The author declares no conflict of interest.

Generative AI disclosure

Generative AI (Claude, Anthropic) was used in the editorial preparation of this article: for language editing, translation of the title, abstract and keywords between Uzbek, Russian and English, preparation of the extended English summary from the author's text, and formatting of the reference list. No data, results or conclusions were generated by AI. The author is responsible for the content of the publication.

EXTENDED SUMMARY IN ENGLISH

Kengaytirilgan inglizcha xulosa / Расширенный реферат на английском языке

Purpose and research problem

Karakul sheep breeding is not only an independent branch of agriculture but also the only economically efficient way of using the extreme ecological conditions of desert and semi-desert areas, and the accelerated development of livestock breeding, the improvement of breeding work and the expansion of export products are priorities of

state policy in Uzbekistan. Among the numerous populations of Karakul sheep, Sur-coloured animals stand out for the colour and colour types of their pelts and for their lustre and silkiness. One of the most important selection traits that determines the commercial value of Sur pelts and their competitiveness at international auctions is the skin thickness of newborn lambs, which is closely related to the histological structure of the skin, the development of collagen fibres and of sebaceous and sweat glands, and determines the lightness, flexibility and strength of the finished pelt. Systematic combination of the silvery, diamond and golden colour types makes it possible to obtain offspring with optimal skin thickness, but the inheritance of skin layers in the interaction of colour-type groups has not been sufficiently systematised. The aim of the study was to evaluate the effect of mating variants of Sur Karakul sheep by colour-type groups on the skin thickness of newborn lambs and to identify optimal mating combinations.

Materials and methods

The study was carried out at the Yangikazgan Nurli Diyor LLC farm, which specialises in breeding Sur Karakul sheep. Karakul sheep of the silvery (kumushsimon), diamond (olmos) and golden (tillasimon) colour types and their offspring were selected, and six main mating variants were formed: silvery × silvery (n=120), silvery × diamond (n=65), silvery × golden (n=45), diamond × silvery (n=86), diamond × diamond (n=72) and diamond × golden (n=43), where the first type refers to rams and the second to ewes. The skin thickness of newborn lambs was assessed according to the guide on breeding work and evaluation (grading) of lambs in Karakul sheep breeding by S.Yu. Yusupov et al. (2015): visually and by palpation, the skins were classified as thin, thickened or thick. The biometric data were processed by variation statistics according to N.A. Plokhinsky (1969), with the number of offspring in each variant (n), the arithmetic mean and its standard error calculated.

Results and discussion

Mating variants had a marked effect on the skin thickness of newborn lambs. In all combinations the proportion of offspring with thin skin remained high, ranging from 70.8% to 75.0%. The highest proportion of thin-skinned lambs was recorded in the homogeneous diamond × diamond variant ($75.0 \pm 5.10\%$), which also had the lowest proportion of lambs with thickened skin ($13.9 \pm 4.07\%$). In the homogeneous silvery × silvery variant thin-skinned offspring accounted for $70.8 \pm 4.15\%$ and thick-skinned lambs for $11.7 \pm 2.93\%$. Among heterogeneous variants, the silvery ram × diamond ewe combination gave the smallest proportion of thick-skinned lambs ($6.2 \pm 2.99\%$), whereas in the diamond ram × golden ewe combination this proportion was somewhat higher ($11.6 \pm 4.88\%$). In the other variants thin-skinned offspring accounted for 71.1–73.2%, thickened-skin offspring for 16.3–21.5% and thick-skinned offspring for 10.5–11.1%. According to the author, these regularities indicate that the diamond colour-type genotype contributes to the stable transmission of genetic determinants ensuring the elasticity and thinness of the skin.

Conclusion and contribution

Selective mating of Sur Karakul sheep by colour-type groups has a differential effect on the skin thickness histotype of the offspring. For breeding high-quality Karakul elites with thin and fine skin, the diamond × diamond combination gives a high selection effect, with 75.0% of offspring having thin skin. To reduce the birth of thick-skinned lambs and to obtain stable marketable products, the heterogeneous mating of silvery rams with diamond ewes is advisable, as it yields only 6.2% of thick-skinned lambs.

ADABIYOTLAR RO'YXATI

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REVIEW • PEER-REVIEWED • OPEN ACCESS • **SERIES C** • HAC/OAK 16.00.00 — VETERINARY SCIENCES •
UDC: 639.3.09:619:616-091:614.31

Pathomorphological changes, etiopathogenesis, and veterinary-sanitary measures of non-infectious branchionecrosis in carp

Karp baliqlarida yuqumsiz branxionekrozining patomorfologik o'zgarishlari, etiopatogenezi va veterinariya-sanitariya choralari

Патоморфологические изменения, этиопатогенез и ветеринарно-санитарные мероприятия при неинфекционном брахионекрозе карповых рыб

YULDASHEV Xojiakbar Toshpo'latovich^{1*}, **SULAYMANOVA Nafisa Abdimuminovna¹**, **IKROMOVA Sarvinoz Orifjon qizi¹**

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Abstract. Based on literature analysis, this scientific article investigates the causal factors, tissue-level pathogenesis, and organ-level pathomorphological changes of non-infectious gill necrosis (branchionecrosis), a disease frequently encountered in common carp (*Cyprinus carpio*) aquaculture that inflicts severe economic losses. The negative impacts of hydrochemical imbalance in artificial ponds, as well as elevated levels of free (un-ionized) ammonia and pH, on the gill respiratory epithelium are analyzed. Through pathohistological analysis, the systemic morphogenesis of pathological processes occurring in gill lamellae, such as proliferative hyperplasia and epithelial edema, is elucidated. Furthermore, the article scientifically substantiates a comprehensive set of veterinary and sanitary measures aimed at managing the pond ecosystem and promoting fish tissue recovery.

Keywords: Animal pathology; pathomorphology; histology; carp; gill necrosis; ammonium toxicosis; autointoxication; respiratory epithelium; hyperplasia

O'ZBEKCHA

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Annotatsiya. Ushbu ilmiy maqolada karp baliqlari (*Cyprinus carpio*) akvakulturasida ko'p uchraydigan va jiddiy iqtisodiy zarar keltiradigan yuqumsiz jabra nekrozi (branchionecrosis) kasalligining kelib chiqish sabablari, to'qimaviy patogenezi hamda organ darajasidagi patomorfologik o'zgarishlari adabiyotlar tahlili asosida o'rganilgan. Sun'iy havzalardagi gidrokimyoviy muvozanatning buzilishi, erkin ammoniy hamda vodorod ko'rsatkichi (pH) ko'tarilishining jabra respirator epiteliysiga ko'rsatadigan salbiy ta'siri tahlil qilingan. Patogistologik tahlillar yordamida jabra lamellarida sodir bo'ladigan proliferativ giperplaziya, epiteliy shishi kabi patologik jarayonlarning tizimli morfogenezi yoritilgan. Shuningdek, maqolada havza ekotizimini o'rganish hamda baliq to'qimalarini tiklashga qaratilgan kompleks veterinariya-sanitariya choralari ilmiy jihatdan asoslab berilgan.

Kalit so'zlar: Hayvonlar patologiyasi; patomorfologiya; gistologiya; karp; jabra nekrozi; ammoniy toksikozi; avtotoksikatsiya; respirator epiteliy; giperplaziya

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ЮЛДАШЕВ Хожиякбар Тошпулатович^{1*} , СУЛАЙМАНОВА Нафиса Абдимунировна¹ , ИКРОМОВА Сарвиноз Орифжон кизи¹

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Аннотация. В данной научной статье на основе анализа литературы изучены причины возникновения, тканевый патогенез и патоморфологические изменения на органном уровне неинфекционного некроза жабр (branchionecrosis) - заболевания, часто встречающегося в аквакультуре карповых рыб (*Cyprinus carpio*) и наносящего серьезный экономический ущерб. Проанализировано негативное влияние нарушения гидрохимического баланса в искусственных водоемах, повышения уровня свободного аммония и водородного показателя (pH) на респираторный эпителий жабр. С помощью патогистологических анализов освещен системный морфогенез таких патологических процессов, происходящих в жаберных ламеллах, как пролиферативная гиперплазия и отёк эпителия. Также в статье научно обоснован комплекс ветеринарно-санитарных мероприятий, направленных на оптимизацию экосистемы водоемов и восстановление тканей рыб.

Ключевые слова: Патология животных; патоморфология; гистология; карп; некроз жабр; аммонийный токсикоз; автотоксикация; респираторный эпителий; гиперплазия

1. MAVZUNING DOLZARBLIGI

Relevance of the topic

Dunyo va respublikamiz akvakulturasida karpdoshlar (*Cyprinidae*) oilasiga mansub baliqlarni, xususan oddiy karp (*Cyprinus carpio*) baliqlarini intensiv va yarim intensiv usullarda yetishtirish yetakchi o'rinni egallaydi. Hovuz xo'jaliklarida baliqlarni yuqori zichlikda joylashtirish va oqsilga boy sun'iy oзуqalar bilan faol oziqlantirish ko'p hollarda havza tubida hamda suv qatlamida bioorganik chiqindilarning me'yorida ortiq to'planishiga olib keladi. Ushbu ekologik yuklama suv muhitining keskin gidrokimyoviy disbalansiga sabab bo'ladi va baliqlar o'rtasida turli yuqumsiz organopatologiyalarni keltirib chiqaradi.

Baliqlarning jabra apparati o'ta nozik patogistologik va anatomik tuzilishga ega bo'lgan muhim a'zolaridan biridir. Jabralar faqatgina gaz almashinuvi (nafas olish) vazifasini bajarib qolmay, balki organizmdagi osmoregulyatsiya, kislota-ishqor muvozanatini saqlash va oqsil almashinuvining yakuniy mahsulotlarini (ayniqsa, endogen ammoniyni) tashqi muhitga chiqarish funksiyalarini ham ta'minlaydi. Shu bois, sun'iy suv havzalarining gidrokimyoviy rejimi buzilganda birinchi bo'lib aynan jabra epiteliysida jiddiy shikastlanishlar kuzatiladi.

Ko'p yillik ixtiopatologik adabiyotlar tahlili shuni ko'rsatadiki, baliqchilik xo'jaliklarida uchraydigan jabra apparati kasalliklarining 75-80 foizdan ortig'i yuqumsiz, ya'ni toksik-avtoksik kelib chiqishga ega. Adabiyotlarda uzoq vaqt davomida ushbu kasallik faqat mikotik (branxiomikoz) yoki virusli patogenlar oqibati deb talqin qilingan bo'lsa-da, zamonaviy tadqiqotlar uning ko'p omilli (polietologik) ekologik intoksikatsiya ekanligini to'liq isbotladi. Ushbu kasallik havzalarda baliqlarning 40 foizdan 90 foizgacha ommaviy nobud bo'lishiga olib kelishi va saqlab qolingani baliqlarning mahsuldorligini keskin pasaytirishi sababli veterinariya ilmining dolzarb muammolaridan biri bo'lib qolmoqda.

1.1. Tadqiqotning maqsadi

Karp baliqlarida yuqumsiz jabra nekrozining kelib chiqish sabablari (etiopatogenezi), to'qimaviy darajadagi patomorfologik va gistopatologik o'zgarishlarini ilmiy adabiyotlar tahlili yordamida tizimlashtirish hamda ushbu patologiyani bartaraf etishga qaratilgan samarali veterinariya-sanitariya choralarini asoslashdan iborat.

2. PATOMORFOLOGIK VA PATOGISTOLOGIK

Methods of pathomorphological and histopathological assessment

Kasallangan baliqlar organizmidagi strukturaviy o'zgarishlarni o'rganishda klassik patologoanatomik yorish metodlari va a'zolari makroskopik baholash mezonlariga tayanildi. Gistopatologik tahlillar uchun olingan ma'lumotlarda jabra to'qimalarining 10

foizli neytral formalin yoki Buen eritmasida fiksatsiya qilingan, parafin bloklarga quyilib, qalinligi 4-6 mkm o'lchamda kesilgan hamda gematoksilin va eozin usulida bo'yalgan gistologik preparatlarning mikroskopik tavsiflari tahlil qilindi.



1-rasm. Nekrozga uchragan baliq jabrasining ko'rinishi / **Fig. 1.** Appearance of a necrotic fish gill

3. YUQUMSIZ JABRA NEKROZINING ETIOPATOGENEZI

Etiopathogenesis of non-infectious gill necrosis

Ilmiy adabiyotlar tahlili shuni ko'rsatadiki, yuqumsiz jabra nekrozining boshlang'ich va yetakchi omili suv muhitidagi erkin ammoniy NH_3 intoksikatsiyasi va suv pH ko'rsatkichining disbalansi hisoblanadi. Suvdagi azot birikmalari ikki shaklda mavjud bo'ladi: ionlashgan, zaharli bo'lmagan ammoniy va ionlashmagan, o'ta kuchli hujayraviy zahar hisoblangan gazsimon erkin ammoniy (NH_3). Ularning muvozanati to'g'ridan-to'g'ri suvning pH ko'rsatkichi va haroratiga bog'liq. Yoz oylarida quyosh nurining intensiv ta'siri natijasida mikrosuv o'tlari havzada ommaviy ko'payadi ("suvning gullashi"). Bunday yuqori ishqoriy muhitda suvdagi mutlaqo zararsiz bo'lgan ammoniy ionlari zudlik bilan toksik NH_3 shakliga o'tadi.

Baliq qonidagi ammoniy konsentratsiyasi tashqi muhitdagidan yuqori bo'lsa, u jabra orqali suvga diffuziyanadi. Ammo tashqi muhitda NH_3 konsentratsiyasi 0.05 mg/l dan oshganda, ushbu jarayon teskarisiga aylanadi yoki to'xtaydi. Natijada baliq tanasida avtoksikatsiya (o'z-o'zini zaharlash) jarayoni boshlanadi. To'plangan ammoniy hujayra membranalari eritib, respirator epiteliy qavatining kuchli kimyoviy kuyishiga sabab bo'ladi.

4. PATOMORFOLOGIK VA GISTOPATOLOGIK O'ZGARISHLAR TASNIFI

Classification of pathomorphological and histopathological changes

1-jadval

Yuqumsiz jabra nekrozida to'qimaviy va gistopatologik o'zgarishlarning bosqichma-bosqich rivojlanishi / **Table 1.** Stage-by-stage development of tissue and histopathological changes in non-infectious gill necrosis

Bosqichlar	Patomorfologik jarayon turi	Patogistologik o'zgarishlar manzarasi	A'zoning makroskopik holati
I bosqich	Distrofiya va shishlar	Epitelial hujayralarning kapillyar devoridan ajralishi, lamellalararo ekssudat to'planishi.	Jabralar shishgan, to'q qizil yoki binafsha rangda, shilimshiq miqdori ortgan.
II bosqich	Proliferativ giperplaziya	Nafas olish epiteliysining tartibsiz ko'payishi, ikkilamchi lamellalarning o'zaro yopishishi (sinostoz).	Jabra varoqlari qalinlashgan, yuzasi notekis oqish tus olgan.
III bosqich	Venoz staz	Qon tomirlarining kengayishi, mikrotromb va mahalliy gemorragiyalar shakllanishi.	Jabra yuzasida oq va qizil sohalar almashinib, "marmarsimon" ko'rinish hosil qiladi.
IV bosqich	Nekroz va nekrobioz	Hujayralarda karioreksis va karioleyz jarayonlari. To'qimalarning to'liq strukturasiz amorf massaga (detritga) aylanishi.	Jabra varoqlari chirigan, yorilgan, jabra yoylari cheti tish-tish bo'lib kemirilgan.



2-rasm. Baliq jabrasida nekrotik jarayonning ko'rinishi / **Fig. 2.** Necrotic process in a fish gill

• **Dastlabki patomorfologik manzara:** H&E usulida bo'yalgan gistologik kesmalarda kapillyar tomirlarning membranasini va epiteliy qavati o'rtasida shish suyuqligi (shish ekssudati) to'planishi yaqqol ko'rinadi. Bu jarayon gaz almashinuv masofasini uzaytirib, baliqda gipoksiyani keltirib chiqaradi.

• **Proliferatsiya va giperplaziya:** Toksinlarning uzoq muddatli salbiy ta'siriga javoban respirator epiteliy hujayralari kompensator ravishda tartibsiz ko'payish boshlaydi. Ikkilamchi lamellalar bir-biri bilan qo'shilib ketadi (birlashadi). Natijada jabraning gaz almashinuv maydoni 70-80 foizga qisqaradi. Bokalsimon hujayralar o'ta faollashib, jabra yuzasini qalin shilimshiq parda bilan to'sib qo'yadi.

• **Destruksiya va qon tomir patologiyasi:** Jabra kapillyarlarida qon harakati sekinlashib, venoz staz rivojlanadi. Tomir devorlarining elastikligi yo'qolishi natijasida qon aylanishi buziladi. Tomirlar yorilib, to'qima ichiga qon quyiladi.

• **Nekroz bosqichi:** Patologiyaning yakuniy bosqichida hujayra yadrolarining parchalanishi (karioreksis) va erishi (karioleyz) sodir bo'ladi. Nafas olish epiteliysi butkul o'lib, chirindi massaga aylanadi. Baliqlarni patologoanatomik yorish natijalari ammoniy intoksikatsiyasining nafaqat mahalliy (jabra), balki tizimli xarakterga ega ekanligini tasdiqlaydi. Autopsiyada jigarda donador va yog'li distrofiya (jigarning sarg'ayishi), taloqning kattalashishi hamda buyraklarda gemorragik yallig'lanish o'choqlari qayd etilgan.

Adabiyotlardagi patologistologik tadqiqotlar natijalariga ko'ra, yuqumsiz jabra nekrozi rivojlanishida to'qima va a'zo darajasida to'rtta asosiy bosqich kuzatiladi (1-jadval).

5. QARSHI KURASH CHORALARI VA VETERINARIYA-SANITARIYA TADBIRLARI

Control measures and veterinary-sanitary actions

Yuqumsiz jabra nekrozining multifaktorli etiopatogenezini hisobga olgan holda, adabiyot ma'lumotlari va amaliy tavsiyalar asosida kompleks veterinariya-sanitariya hamda dekontaminatsiya choralari ishlab chiqilgan.

5.1. Havza gidrokimyoviy muhitini sog'lomlashtirish

1. **Suv almashinuvini tezlashtirish:** Kasallikning dastlabki klinik belgilari (baliqlarning suv yuzasida havo yutishi, yemdan bosh tortishi) kuzatilganda havzaga ozuqa berish zudlik bilan 3-5 kunga to'xtatiladi. Havza suvining 25-30% qismi chiqarib tashlanib, o'miga kislorodga boy, toza suv quyiladi. Bu erkin ammoniy konsentratsiyasini mexanik ravishda kamaytiradi.

2. **Faol aeratsiya:** Havzalarga kechki va tungi vaqtlarda (soat 22:00 dan 06:00 gacha) parrakli aeratorlar yordamida kuchli aeratsiya beriladi. Bu jarayon suvdagi erigan kislorod miqdorini 5.5 mg/l dan yuqori saqlash bilan birga, gazsimon ammoniyning atmosferaga uchib chiqib ketishini (stripping) ta'minlaydi.

6. XULOSA

Conclusion

Karp baliqlarining jabra nekrozi yuqumsiz tabiatga ega bo'lib, suv muhitida molekulyar erkin ammoniy NH_3 ko'payishi va pH ishqoriylashishi (pH - 9.0) natijasida kelib chiquvchi o'tkir va surunkali toksik-avtotoksik organopatologiya hisoblanadi.

1. Kasallikning patomorfologik va gistologik asosi – epiteliyning shishi, proliferativ giperplaziyasi, qon tomirlarining kengayishi va hujayralarning to'liq nekrotik parchalanishi bilan xarakterlanadi.

2. Havzalarda aeratsiyani kuchaytirish va suvdagi erigan kislorod miqdorini ko'paytirish baliqlar uchun muhim rol o'ynaydi.

DECLARATIONS

Declarations

Author contributions *CRedit*

Conceptualization; Methodology; Investigation; Data curation; Writing – original draft; Writing – review & editing. All authors have read and agreed to the published version of the manuscript.

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Ethics approval

The article is based on an analysis of published scientific literature. The work involved no experiments on live animals and no human participants, and therefore required no separate ethics committee approval.

Informed consent

All authors have read and approved the final version of the manuscript and have given their consent to its submission and publication. The study involved no human participants and no personal data.

Data availability statement

All sources analysed in this review are listed in the reference list of this article.

Conflict of interest

The authors declare no conflict of interest.

Generative AI disclosure

Generative AI (Claude, Anthropic) was used in the editorial preparation of this article: for language editing, translation of the title, abstract and keywords between Uzbek, Russian and English, preparation of the extended English summary from the authors' text, and formatting of the reference list. No data, results or conclusions were generated by AI. The authors are responsible for the content of the publication.

EXTENDED SUMMARY IN ENGLISH

Kengaytirilgan inglizcha xulosa / Расширенный реферат на английском языке

Purpose and research problem

Common carp (*Cyprinus carpio*), a member of the family Cyprinidae, is the leading species in pond aquaculture worldwide and in Uzbekistan, where it is raised under intensive and semi-intensive systems. High stocking densities and active feeding with protein-rich artificial feeds often lead to excessive accumulation of bio-organic waste at the pond bottom and in the water column. This ecological load causes a sharp hydrochemical imbalance of the aquatic environment and gives rise to various non-infectious organ pathologies in fish. The gills are delicate organs that are responsible not only for gas exchange but also for osmoregulation, maintenance of acid–base balance and excretion of the end products of protein metabolism, above all endogenous ammonia; they are therefore the first organs to be seriously damaged when the hydrochemical regime of artificial ponds is disturbed. According to the literature, more than 75–80% of gill diseases in fish farms are of non-infectious, toxic–autotoxic origin. Although gill necrosis was long interpreted as a consequence of fungal (branchiomycosis) or viral agents only, modern studies have shown that it is a multifactorial (polyetiological) ecological intoxication. Because the disease can cause mass mortality of 40–90% of fish in ponds and sharply reduces the productivity of surviving fish, it remains one of the pressing problems of veterinary science. The aim of the study was to systematise, on the basis of an analysis of the scientific literature, the causes (etiopathogenesis) and the tissue-level pathomorphological and histopathological changes of non-infectious gill necrosis in carp and to substantiate effective veterinary-sanitary measures aimed at eliminating this pathology.

Materials and methods

The work is based on an analysis of the scientific literature. Structural changes in the organism of diseased fish were assessed on the basis of classical pathoanatomical necropsy methods and criteria for macroscopic evaluation of organs. For the histopathological analysis, published microscopic descriptions of histological preparations of gill tissue were analysed; in these studies the tissue had been fixed in 10% neutral formalin or Bouin's solution, embedded in paraffin, sectioned at a thickness of 4–6 µm and stained with haematoxylin and eosin.

Results and discussion

The literature shows that the initial and leading factor of non-infectious gill necrosis is intoxication with free (un-ionised) ammonia (NH₃) in the water combined with an imbalance of water pH. Nitrogen compounds in water exist in two forms: ionised ammonium, which is not toxic, and gaseous un-ionised free ammonia, which is a potent

cellular poison; the balance between them depends directly on the pH and temperature of the water. In summer, intensive sunlight causes mass growth of microalgae in ponds ("water bloom"), and in the resulting highly alkaline environment harmless ammonium ions are rapidly converted into toxic NH₃. When the ammonia concentration in fish blood is higher than in the surrounding water, ammonia diffuses into the water through the gills; however, when the NH₃ concentration in the water exceeds 0.05 mg/L, this process is reversed or stops. As a result, autointoxication begins in the fish body, and the accumulated ammonia damages cell membranes and causes a severe chemical burn of the respiratory epithelium. According to published histopathological studies, four main stages are observed at the tissue and organ level in the development of non-infectious gill necrosis (Table 1): stage I, dystrophy and oedema — detachment of epithelial cells from the capillary wall and accumulation of exudate between the lamellae, with swollen dark-red or purple gills and an increased amount of mucus; stage II, proliferative hyperplasia — disordered proliferation of the respiratory epithelium and fusion of the secondary lamellae (synostosis), with thickened gill filaments that acquire an uneven whitish surface; stage III, venous stasis — dilation of blood vessels and formation of microthrombi and local haemorrhages, giving the gill surface a "marbled" appearance of alternating white and red areas; stage IV, necrosis and necrobiosis — karyorrhexis and karyolysis with transformation of the tissue into a structureless amorphous mass (detritus), while the gill filaments are rotten and ruptured and the edges of the gill arches are eroded. Oedema between the capillary membrane and the epithelium lengthens the gas-exchange distance and causes hypoxia; under prolonged exposure to toxins the respiratory epithelium proliferates in a compensatory but disordered manner, the secondary lamellae fuse and the gas-exchange surface of the gills decreases by 70–80%, while hyperactive goblet cells cover the gill surface with a thick layer of mucus. Slowing of blood flow, venous stasis and loss of elasticity of the vessel walls lead to rupture of vessels and haemorrhages into the tissue, and at the final stage the respiratory epithelium dies completely. Necropsy findings confirm that ammonia intoxication is systemic rather than only local: granular and fatty dystrophy of the liver, enlargement of the spleen and haemorrhagic inflammatory foci in the kidneys have been recorded. Taking into account the multifactorial etiopathogenesis, a set of veterinary-sanitary measures aimed at restoring the hydrochemical environment of ponds is proposed. When the first clinical signs appear (fish gulping air at the water surface and refusing feed), feeding is stopped immediately for 3–5 days, and 25–30% of the pond water is drained and replaced with clean, oxygen-rich water, which mechanically reduces the concentration of free ammonia. In addition, intensive aeration with paddle-wheel aerators in the evening and at night (from 22:00 to 06:00) keeps the dissolved oxygen content above 5.5 mg/L and promotes the release (stripping) of gaseous ammonia into the atmosphere.

Conclusion and contribution

Gill necrosis of carp is a non-infectious, acute and chronic toxic–autotoxic organ pathology that arises from an increase in molecular free ammonia (NH₃) in the aquatic environment and alkalinisation of the water (pH around 9.0). The pathomorphological and histological basis of the disease is oedema and proliferative hyperplasia of the epithelium, dilation of blood vessels and complete necrotic disintegration of cells. Intensifying aeration and increasing the dissolved oxygen content of pond water play an important role for fish in the prevention and control of the disease.

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Prevalence and seasonal variation of monieziosis in sheep in different geographical and climatic zones of Uzbekistan

O'zbekistonning turli geografik-iqlim mintaqalarida qo'ylar monieziyozining tarqalishi va mavsumiy o'zgarishlari

Распространение и сезонная изменчивость мониезиоза овец в различных географо-климатических зонах Узбекистана

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ENGLISH

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Abstract. The study aimed to determine the prevalence and seasonal variation of monieziosis in sheep under different geographical and climatic conditions of Uzbekistan. During 2021-2023, 2,465 sheep from the Republic of Karakalpakstan and 12 provinces were examined parasitologically. Fülleborn flotation, sequential washing sedimentation and a modified Berman-Orlov larvoscopic method were used. Monieziosis was detected in 123 animals, corresponding to an overall prevalence of 4.99% among the examined sheep. Prevalence reached 6.89% in foothill-mountain areas, 4.44% in irrigated areas and 3.44% in desert-pasture areas. Seasonal prevalence was highest in summer (35.8%), followed by spring (28.4%), autumn (23.6%) and winter (12.2%). In a separate field trial, a locally produced albendazole formulation, Alsus, showed an estimated extensive efficacy of 77.5% against monieziosis. The findings demonstrate pronounced geographical and seasonal variation in sheep monieziosis and support the use of locally adapted surveillance and control schedules.

Keywords: sheep; monieziosis; Moniezia; anoplocephalid cestodes; helminth infection; prevalence; seasonal dynamics; geographical-climatic zone; albendazole; Uzbekistan

O'ZBEKCHA

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Annotatsiya. Ushbu tadqiqot O'zbekistonning turli geografik-iqlim sharoitlarida qo'ylar monieziyozining tarqalish darajasi va mavsumiy o'zgarishlarini aniqlashga qaratildi. 2021-2023-yillarda Qoraqalpog'iston Respublikasi hamda Andijon, Buxoro, Jizzax, Qashqadaryo, Navoiy, Namangan, Samarqand, Sirdaryo, Surxondaryo, Toshkent, Farg'ona va Xorazm viloyatlarida jami 2465 bosh qo'y parazitologik tekshiruvdan o'tkazildi. Tekshiruvlarda Fülleborn flotatsion, ketmaket yuvish-sedimentatsion va Berman-Orlovning takomillashtirilgan larvoskopik usullaridan foydalanildi. Tekshirilgan hayvonlarning 123 boshida monieziyoz aniqlanib, zararlanish darajasi 4,99% ni tashkil etdi. Geografik-iqlim mintaqalari bo'yicha ko'rsatkich tog'oldi-tog' hududlarida

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HAC / OAK: On the HAC list of national scientific publications (Academy of Sciences of the Republic of Uzbekistan) for 06.00.00 Agricultural Sciences and 16.00.00 Veterinary Sciences. O'zbekiston Respublikasi FA huzuridagi OAK ro'yxatida: 06.00.00 – Qishloq xo'jaligi fanlari; 16.00.00 – Veterinariya fanlari.

6,89%, sugʻoriladigan hududlarda 4,44% va choʻl-yaylov hududlarida 3,44% boʻldi. Mavsumlar kesimida monieziyozning eng yuqori koʻrsatkichi yozda 35,8%, undan keyin bahorda 28,4%, kuzda 23,6% va qishda 12,2% qayd etildi. Mahalliy albendazol asosidagi Alsus preparati bilan oʻtkazilgan alohida sinovda monieziyozga qarshi ekstensiv samaradorlik 77,5% ni tashkil qilgan. Olingan natijalar monieziyozning tarqalishi hudud va mavsumga qarab sezilarli darajada oʻzgarishini koʻrsatib, parazitga qarshi tadbirlarni epidemiologik vaziyatga mos rejalashtirish zarurligini koʻrsatadi.

Kalit soʻzlar: qoʻy; monieziyoz; Moniezia; anoplotsefalatoz; gelmintoz; zararlanish darajasi; mavsumiy dinamika; geografik-iqlim mintaqasi; albendazol; Oʻzbekiston

РУССКИЙ

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Аннотация. Исследование посвящено определению распространенности и сезонной изменчивости мониезиоза овец в различных географо-климатических условиях Узбекистана. В 2021–2023 гг. паразитологически исследовано 2465 овец из Республики Каракалпакстан и Андижанской, Бухарской, Джизакской, Кашкадарьинской, Навоийской, Наманганской, Самаркандской, Сырдарьинской, Сурхандарьинской, Ташкентской, Ферганской и Хорезмской областей. Применяли флотационный метод Фюллеборна, последовательное промывание с осаждением и усовершенствованный метод ларвоскопии Берман-Орлова. Мониезиоз выявлен у 123 животных, экстенсивность инвазии составила 4,99%. В предгорно-горной зоне показатель составил 6,89%, в орошаемой зоне – 4,44%, в пустынно-пастбищной – 3,44%. Максимальная сезонная зараженность отмечена летом (35,8%), затем весной (28,4%), осенью (23,6%) и зимой (12,2%). При отдельном испытании препарата Алсус на основе альбендазола экстенсивность против мониезиоза составила 77,5%. Полученные данные свидетельствуют о выраженной территориальной и сезонной изменчивости мониезиоза и необходимости дифференцированного планирования профилактических мероприятий.

Ключевые слова: овцы; мониезиоз; Moniezia; аноплотцефалатоз; гельминтоз; экстенсивность инвазии; сезонная динамика; географо-климатическая зона; альбендазол; Узбекистан

1. KIRISH

Introduction

Monieziyoz qoʻylar orasida uchraydigan anoplotsefalid sestodozlardan biri boʻlib, uning tarqalishi yaylovdan foydalanish tizimi, oraliq xoʻjayinlar mavjudligi, iqlim va mavsumiy sharoitlar bilan bogʻliq. Kasallikning epizootologik koʻrinishi hududlar boʻyicha bir xil emas; namlik, harorat, oʻsimlik qoplami va yaylovlardan foydalanish xususiyatlaridagi farqlar parazitning rivojlanish sikliga taʼsir qilishi mumkin [1–3].

Moniezia expansa va Moniezia benedeni qoʻylar va boshqa kavsh qaytaruvchi hayvonlarda uchraydigan asosiy anoplotsefalid sestodalar hisoblanadi. Monieziya siklida oraliq xoʻjayin sifatida tuproq yuzasida yashovchi oribatid kanalar muhim oʻrin tutadi. Shu sababli yaylovning ekologik holati va mavsumiy sharoitlar invazyani shakllanishida muhim omillardan boʻlishi mumkin [3,4].

Turli mamlakatlarda olib borilgan tadqiqotlar monieziyozning tarqalish darajasi sezilarli oʻzgarishini koʻrsatadi. Shimoliy Kavkaz sharoitida invaziya asosan bahor-kuz davrida qayd etilib, yoz va kuz oylarida yuqoriroq koʻrsatkichlar kuzatilgan [4]. Senegal sharoitida kichik kavsh qaytaruvchilarda anoplotsefalid sestodalar ham qayd etilgan boʻlib, ularning tarqalishida mavsumiy oʻzgarishlar aniqlangan [5]. Oʻzbekistonda ham qoʻylarning ichak sestodozlari boʻyicha hududiy va ekologik farqlar qayd etilgan [6,7].

Oʻzbekiston hududining tabiiy sharoitlari sugʻoriladigan vohalar, togʻoldi-togʻ hududlari va choʻl-yaylov tizimlarining birgalikda mavjudligi bilan ajralib turadi. Bunday xilma-xillik qoʻylarning boqilish sharoitlari va parazitlarning rivojlanishiga taʼsir etuvchi omillarni hududlar boʻyicha farqlashi mumkin. Shu

nuqtayi nazardan, monieziyozning turli mintaqalardagi tarqalish darajasini va mavsumiy oʻzgarishini aniqlash amaliy veterinariya parazitologiyasi uchun muhimdir.

Tadqiqotning maqsadi Oʻzbekistonning turli geografik-iqlim mintaqalarida qoʻylar monieziyozining tarqalish darajasini aniqlash, uning mavsumiy oʻzgarishlarini baholash hamda aniqlangan epizootologik xususiyatlar asosida profilaktik tadbirlarni rejalashtirish uchun ilmiy asos yaratishdan iborat.

2. MATERIALLAR VA USULLAR

Materials and methods

Tadqiqotlar 2021–2023-yillarda Qoraqalpogʻiston Respublikasi hamda Andijon, Buxoro, Jizzax, Qashqadaryo, Navoiy, Namangan, Samarqand, Sirdaryo, Surxondaryo, Toshkent, Fargʻona va Xorazm viloyatlarida olib borildi. Tadqiqot materiallari fermer xoʻjaliklari, dehqon xoʻjaliklari va aholi xonadonlarida boqilayotgan qoʻylardan olindi. Jami 2465 bosh qoʻy tekshirildi.

Parazitologik tekshiruvlar najas namunalari gelmint tuxumlari va lichinkalarini aniqlash asosida amalga oshirildi. Gelmint tuxumlarini aniqlash uchun Fyulleborn flotatsion va ketma-ket yuvish-sedimentatsion usullaridan, lichinkalarni aniqlash uchun Veterinariya ilmiy-tadqiqot institutida takomillashtirilgan Berman-Orlov larvoskopik usulidan foydalanildi. Mikroskopik tekshiruvlar Motich B1 yorugʻlik mikroskopida 10×4, 10×40 va 10×100 kattalashtirishlarda bajarildi.

Tadqiqot hududlari ekologik sharoitlariga koʻra sugʻoriladigan, togʻoldi-togʻ va choʻl-yaylov mintaqalariga ajratildi. Mavsumiy tahlilda bahor, yoz, kuz va qish davrlari alohida baholandi. Har bir mintaq va mavsum uchun monieziyoz bilan zararlangan hayvonlar soni tekshirilgan hayvonlar soniga nisbatan foizlarda ifodalandi.

Moniyeziozning ekstensiv zararlanishi (EZ) quyidagi formula asosida hisoblandi: $EZ = (\text{zararlangan hayvonlar soni} / \text{tekshirilgan hayvonlar soni}) \times 100$. Aralash invazyalar mavjud bo'lishi mumkinligi sababli alohida gelmintozlar bo'yicha ko'rsatkichlar bir-biriga qo'shib yuborilmadi.

Antigelmintik samaradorlikni baholash uchun alohida 52 bosh tabiiy zararlangan qo'y ishtirokidagi tajriba natijalari tahlil qilindi. Hayvonlarga albendazol ekvivalentida 10 mg/kg dozada 10% li mahalliy Alsus suspenziyasi peroral berilgan. Davolashdan oldin va keyin parazitologik tekshiruvlar o'tkazilgan. Moniyeziozga qarshi ekstensiv samaradorlik 77,5% deb baholangan.

3. TADQIQOT NATIJALARI

Results

2021–2023-yillarda tekshirilgan 2465 bosh qo'yning 123 boshida moniyezioz aniqlanib, umumiy ekstensiv zararlanish 4,99% ni tashkil etdi. Bu ko'rsatkich tekshiruvga jalb qilingan hayvonlar orasida moniyezioz mavjudligini va invazyani mamlakatning turli hududlarida uchrashini ko'rsatadi.

1-jadval

Qo'yalar moniyeziozining umumiy tarqalishi / **Table 1.** Overall prevalence of monieziosis in sheep

Ko'rsatkich	Qiyamat
Tekshirilgan qo'yalar soni, bosh	2465
Moniyezioz aniqlangan qo'yalar soni, bosh	123
Ekstensiv zararlanish, %	4,99

Tadqiqot davomida moniyezioz boshqa gelmintozlar bilan birgalikda ham uchragan. Umumiy gelmintologik tekshiruvlarda nematodiroz 26,29%, marshallagiyoz 25,80%, boshqa oshqozon-ichak strongilyatozlari 19,88%, fassioloz 13,35% va moniyezioz 4,99% darajasida qayd etilgan. Mazkur ko'rsatkichlar moniyezioz qo'ylarning gelmintozlari tarkibida alohida o'rin egallashini ko'rsatadi.

2-jadval

Geografik-iqlim mintaqalari bo'yicha tarqalishi / **Table 2.** Distribution by geographical and climatic zones

Geografik-iqlim mintaqasi	Tekshirilgan, bosh	Moniyezioz aniqlangan, bosh	EZ, %
Sug'oriladigan	1216	54	4,44
Tog'oldi-tog'	755	52	6,89
Cho'l-yaylov	494	17	3,44

Moniyeziozning eng yuqori ko'rsatkichi tog'oldi-tog' mintaqasida qayd etilib, 755 bosh qo'yning 52 boshida invaziya aniqlangan va ekstensiv zararlanish 6,89% ni tashkil qilgan. Sug'oriladigan hududlarda 1216 boshdan 54 boshida moniyezioz aniqlanib, ko'rsatkich 4,44% bo'lgan. Cho'l-yaylov mintaqasida esa 494 bosh qo'yning 17 boshida invaziya qayd etilib, 3,44% ni tashkil qilgan.

Tog'oldi-tog' mintaqasidagi ko'rsatkich sug'oriladigan hududlarga nisbatan 2,45 foiz punktga, cho'l-yaylov hududlariga nisbatan esa 3,45 foiz punktga yuqori bo'ldi. Natijalar moniyeziozning tarqalishida ekologik sharoitlar bilan bog'liq hududiy tafovut mavjudligini ko'rsatadi.

3-jadval

Mavsumiy dinamika / **Table 3.** Seasonal dynamics

Fasl	Moniyezioz bilan zararlanish, %
Bahor	28,4
Yoz	35,8
Kuz	23,6
Qish	12,2

Mavsumlar bo'yicha moniyeziozning eng yuqori ko'rsatkichi yozda – 35,8% qayd etildi. Bahorda zararlanish 28,4%, kuzda 23,6% va qishda 12,2% ni tashkil etdi. Yozgi ko'rsatkich qishki ko'rsatkichdan 23,6 foiz punktga yuqori bo'ldi.

Mavsumiy o'zgarishlar moniyezioz invazyasining yil davomida bir xil darajada saqlanmasligini ko'rsatadi. Ayniqsa, bahor-yoz davrida zararlanishning yuqoriligi yaylovlarda parazitning rivojlanishi va qo'ylarning invazion bosqichlar bilan uchrashish ehtimoli ortishi bilan bog'liq bo'lishi mumkin. Biroq ushbu tadqiqotda oraliq xo'jayinlar soni, yaylov namligi va boshqa mikroiklim ko'rsatkichlari alohida o'lchanmaganligi sababli mavsumiy farqlarni muayyan ekologik omil bilan bevosita sababiy bog'lash ehtiyotkorlikni talab qiladi.

4. OLINGAN NATIJALAR TAHLILI

Discussion

Olingan natijalar O'zbekiston sharoitida qo'yalar moniyeziozining tarqalishi hudud va mavsumga qarab o'zgarishini ko'rsatdi. Tekshirilgan hayvonlarning 4,99% ida moniyezioz aniqlangan bo'lsa-da, ekologik mintaqalar bo'yicha ko'rsatkichlarning 3,44-6,89% oralig'ida farqlanishi invazyaning hududiy xususiyatga ega ekanligini ko'rsatadi.

Tog'oldi-tog' mintaqasida qayd etilgan 6,89% ko'rsatkich sug'oriladigan va cho'l-yaylov hududlariga nisbatan yuqori bo'ldi. Bu farq yaylovlarning o'simlik qoplami, namlik rejimi, qo'ylarning boqilish zichligi va parazitning oraliq xo'jayinlari uchun qulay mikrobiotoplar mavjudligi bilan bog'liq bo'lishi mumkin. Biroq mazkur omillarning har biri ushbu tadqiqotda alohida miqdoriy baholanmaganligi sababli ular faqat ehtimoliy tushuntirish sifatida qaraladi.

Mavsumiy tahlilda yozgi davrda 35,8% lik eng yuqori ko'rsatkich qayd etilgani moniyeziozga qarshi profilaktik tadbirlarni faqat qishki yoki kuzgi davr bilan cheklamaslik zarurligini ko'rsatadi. Shimoliy Kavkazdagi tadqiqotlarda ham moniyeziozning mavsumiy dinamikasi qayd etilib, yoz va kuz oylarida yuqori ko'rsatkichlar kuzatilgan [4]. Biroq mavsumiy cho'qqining aniq vaqti hududning iqlimi va chorvachilik tizimiga qarab farq qilishi mumkin.

O'zbekistonda ichak sestodozlari bo'yicha olib borilgan tadqiqotlar ham moniyeziozning hududiy va ekologik sharoitlarga bog'liq holda o'zgarishini ko'rsatadi [6,7]. Buxoro hududida olib borilgan zamonaviy tadqiqotlarda qo'ylarda Moniezia expansa qayd etilgani ham ushbu sestodaning mamlakat hududida saqlanib qolayotganini ko'rsatadi [8]. Shu bilan birga, mazkur tadqiqotda Moniezia turlari molekulyar yoki morfometrik tur darajasida alohida identifikatsiya qilinmaganligi sababli 4,99% ko'rsatkichni muayyan Moniezia turi uchun emas, moniyezioz invazyasi uchun qo'llash to'g'ri bo'ladi.

Antigelmintik sinovda Alsus preparatining moniyeziozga qarshi 77,5% ekstensiv samaradorligi qayd etildi. Moniyeziozga qarshi preparat samaradorligini baholashda faqat davolashdan oldingi va keyingi parazitologik aniqlash bilan cheklanmasdan, miqdoriy najas tekshiruvlari, nazorat guruhi va standartlashtirilgan fecal egg count reduction test kabi yondashuvlardan foydalanish maqsadga muvofiq. Bu ayniqsa albendazolga chidamlilik xavfini monitoring qilish uchun muhimdir [9-11].

Tadqiqotning muhim jihati – namunalar geografik jihatdan keng qamrovda olingani va ekologik hamda mavsumiy kesimlarning birgalikda baholanganidir. Shu bilan birga, hayvonlarning yoshi, jinsi, zoti, yaylovdan foydalanish tarixi, oziqlantirish tizimi va avvalgi degelmintizatsiya ishlari kabi omillar bo'yicha individual ma'lumotlarning yetarli emasligi sababli monieziyozning xavf omillarini statistik jihatdan chuqur tahlil qilish imkoniyati cheklangan. Keyingi tadqiqotlarda ushbu omillarni standart epidemiologik dizayn asosida kiritish maqsadga muvofiq.

5. XULOSALAR

Conclusions

1. 2021–2023-yillarda O'zbekistonning turli geografik-iqlim mintaqalarida tekshirilgan 2465 bosh qo'yning 123 boshida monieziyoz aniqlanib, umumiy ekstensiv zararlanish 4,99% ni tashkil etdi. Eng yuqori ko'rsatkich tog'oldi-tog' mintaqasida (6,89%), keyin sug'oriladigan (4,44%) va cho'l-yaylov (3,44%) hududlarida qayd etildi. Mavsumiy dinamika bo'yicha maksimal ko'rsatkich yozda (35,8%), minimal ko'rsatkich qishda (12,2%) kuzatildi.

2. Natijalar monieziyozga qarshi veterinariya tadbirlarini hudud va mavsum xususiyatlarini hisobga olgan holda tashkil etish zarurligini ko'rsatadi. Ayniqsa, bahor-yoz davrida parazitologik monitoringni kuchaytirish, tog'oldi-tog' mintaqalarida muntazam tekshiruvlar olib borish va davolash samaradorligini nazorat qilish maqsadga muvofiq.

DECLARATIONS

Declarations

Author contributions CRediT

Conceptualization; Methodology; Investigation; Data curation; Writing – original draft; Writing – review & editing. All authors have read and agreed to the published version of the manuscript.

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Ethics approval

The work with animals was carried out within routine veterinary diagnostic, treatment and preventive practice in accordance with the veterinary-sanitary requirements in force in the Republic of Uzbekistan.

Informed consent

All authors have read and approved the final version of the manuscript and have given their consent to its submission and publication. The study involved no human participants and no personal data.

Data availability statement

The data obtained in the study are presented in the tables of this article; the primary records are available from the authors on reasonable request.

Conflict of interest

The authors declare no conflict of interest.

Generative AI disclosure

Generative AI (Claude, Anthropic) was used in the editorial preparation of this article: for language editing, translation of the title, abstract and keywords between Uzbek, Russian and English, preparation of the extended English summary from the authors' text, and formatting of the reference list. No data, results or conclusions were generated by AI. The authors are responsible for the content of the publication.

EXTENDED SUMMARY IN ENGLISH

Kengaytirilgan inglizcha xulosa / Расширенный реферат на английском языке

Purpose and research problem

Monieziosis is one of the anoplocephalid cestodoses of sheep, and its distribution depends on the grazing system, the presence of

intermediate hosts, climate and seasonal conditions. Moniezia expansa and Moniezia benedeni are the main anoplocephalid cestodes of sheep and other ruminants, and oribatid mites living on the soil surface play an important role as intermediate hosts, so the ecological state of pastures and seasonal conditions may be important factors in the formation of invasion. Studies in different countries, such as the North Caucasus and Senegal, show that the prevalence of monieziosis varies considerably and has seasonal features, and regional and ecological differences in intestinal cestodoses of sheep have also been recorded in Uzbekistan. The natural conditions of Uzbekistan combine irrigated oases, foothill-mountain areas and desert-pasture systems, which may differentiate the conditions of sheep keeping and parasite development. The aim of the study was to determine the prevalence of monieziosis in sheep in different geographical and climatic zones of Uzbekistan, to assess its seasonal variation and to create a scientific basis for planning preventive measures.

Materials and methods

The studies were carried out in 2021–2023 in the Republic of Karakalpakstan and the Andijan, Bukhara, Jizzakh, Kashkadarya, Navoi, Namangan, Samarkand, Syrdarya, Surkhandarya, Tashkent, Fergana and Khorezm regions on sheep kept on farms, peasant farms and households; a total of 2465 sheep were examined. Faecal samples were examined for helminth eggs by the Fülleborn flotation and sequential washing-sedimentation methods and for larvae by the Berman–Orlov larvoscopy method as modified at the Scientific-Research Institute of Veterinary, using a Motic B1 light microscope at 10×4, 10×40 and 10×100 magnification. The study areas were divided into irrigated, foothill-mountain and desert-pasture zones, and spring, summer, autumn and winter were assessed separately. The extensity of invasion (EI) was calculated as the number of infected animals divided by the number of examined animals × 100, and indicators for different helminthoses were not summed because of possible mixed infections. To assess anthelmintic efficacy, the results of a separate trial in 52 naturally infected sheep given a 10% suspension of the local albendazole preparation Alsus orally at 10 mg/kg (albendazole equivalent) were analysed, with parasitological examinations before and after treatment.

Results and discussion

Monieziosis was found in 123 of the 2465 sheep examined in 2021–2023, giving an overall extensity of invasion of 4.99%. In general helminthological examinations, nematodirosis was recorded in 26.29% of animals, marshallagiosis in 25.80%, other gastrointestinal strongylatoses in 19.88%, fasciolosis in 13.35% and monieziosis in 4.99%, and monieziosis also occurred together with other helminthoses. The highest rate was recorded in the foothill-mountain zone, where 52 of 755 sheep were infected (6.89%); in irrigated areas 54 of 1216 sheep (4.44%) and in the desert-pasture zone 17 of 494 sheep (3.44%) were infected, so the foothill-mountain rate was 2.45 and 3.45 percentage points higher, respectively. By season, the highest value was recorded in summer (35.8%), followed by spring (28.4%), autumn (23.6%) and winter (12.2%), the summer value exceeding the winter one by 23.6 percentage points. The authors note that the number of intermediate hosts, pasture moisture and other microclimatic indicators were not measured, so the seasonal and zonal differences can only be explained tentatively by vegetation cover, moisture regime, grazing density and microhabitats favourable for oribatid mites. In the anthelmintic trial, the extensive efficacy of Alsus against monieziosis was 77.5%; the authors recommend that future efficacy studies include quantitative faecal examination, a control group and a standardised faecal egg count reduction test to monitor the risk of albendazole resistance. Moniezia species were not identified at the species level, so the 4.99% rate refers to monieziosis as a whole.

Conclusion and contribution

In 2021–2023, monieziosis was detected in 123 of 2465 sheep examined in different geographical and climatic zones of Uzbekistan, with an overall extensity of invasion of 4.99%. The highest rate was found in the foothill-mountain zone (6.89%), followed by irrigated (4.44%) and desert-pasture (3.44%) areas, and in seasonal dynamics the maximum was observed in summer (35.8%) and the minimum in winter (12.2%). The results show that veterinary measures against monieziosis should take into account regional and seasonal features; in particular,

parasitological monitoring should be intensified in spring and summer, regular examinations should be carried out in foothill-mountain zones and the efficacy of treatment should be controlled. Individual data on age, sex, breed, grazing history, feeding and previous deworming were insufficient for a statistical analysis of risk factors, which should be included in future studies with a standard epidemiological design.

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REVIEW • PEER-REVIEWED • OPEN ACCESS • **SERIES C** • HAC/OAK 16.00.00 — VETERINARY SCIENCES •
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Modern methods of treatment and prevention of argulosis in carp fish

Karpsimon baliqlarda argulyozni davolash va oldini olishning zamonaviy usullari**Современные методы лечения и профилактики аргулёза у карповых рыб****SULAYMANOVA Nafisa Abdimuminovna^{1,*} , BALIEV Shavkat Kuchkarovich¹ , BABAMURATOVA Nilufar Butayarovna¹**¹ Scientific-Research Institute of Veterinary, Samarkand, Uzbekistan* Corresponding author: nafisaabdimuminovna@gmail.com**ARTICLE INFO****ARTICLE TYPE**

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AUTHOR, TITLE AND ABSTRACT METADATA (EN / UZ / RU)**ENGLISH****SULAYMANOVA Nafisa Abdimuminovna^{1,*} , BALIEV Shavkat Kuchkarovich¹ , BABAMURATOVA Nilufar Butayarovna¹**¹ Scientific-Research Institute of Veterinary, Samarkand, Uzbekistan

Abstract. This article discusses the etiology, epizootology, and modern control methods of argulosis, a dangerous ectoparasitic disease of carp fish caused by crustaceans of the genus *Argulus*. The life cycle of the parasite, the mechanisms of its pathogenic effects on the host organism, and the factors contributing to the widespread dissemination of the invasion under aquaculture conditions are described. Particular attention is paid to the analysis of the seasonal dynamics of the disease and the influence of the hydrochemical regime of water bodies on the intensity of infestation. The paper presents comprehensive therapeutic and preventive measures, including the application of modern chemical preparations, biological methods for controlling parasite populations, and fishery-reclamation techniques aimed at disrupting the life cycle of the pathogen.

Keywords: Argulosis; *Argulus foliaceus*; cyprinid fish; ectoparasites; infestation; aquaculture; prevention; epizootology; veterinary and sanitary measures; disinfection; pond fish farming; pathogenesis; ichthyopathology; chlorophos; karbofos; biological control

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Annotatsiya. Maqolada karpsimon baliqlarning *Argulus* avlodiga mansub qisqichbaqasimonlar qo'zg'atadigan xavfli ektoparazitlar kasalligi — argulyozning etiologiyasi, epizootologiyasi va unga qarshi kurashning zamonaviy usullari ko'rib chiqilgan. Parazitning hayot sikli, uning xo'jayin organizmiga patogen ta'sir mexanizmlari hamda akvakultura sharoitida invaziyaning ommaviy tarqalishiga yordam beruvchi omillar bayon etilgan. Kasallikning mavsumiy dinamikasi va suv havzalari gidrokimyoviy rejimining invaziya intensivligiga ta'siri tahliliga alohida e'tibor qaratilgan. Ishda zamonaviy kimyoviy preparatlarni qo'llash, parazitlar sonini nazorat qilishning biologik usullari va qo'zg'atuvchining hayot siklini uzishga qaratilgan baliqchilik-melioratsiya tadbirlarini o'z ichiga olgan kompleks davolash-profilaktika choralari keltirilgan.

Kalit so'zlar: argulyoz; *Argulus foliaceus*; karpsimon baliqlar; ektoparazitlar; invaziya; akvakultura; profilaktika; epizootologiya; veterinariya-sanitariya choralari; dezinfektsiya; hovuz baliqchiligi; patogenez; ixtiopatologiya; xlorofos; karbofos; biologik himoya

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Аннотация. В данной статье рассматривается этиология, эпизоотология и современные

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методы борьбы с аргулезом-опасным эктопаразитарным заболеванием карповых рыб, вызываемым рачками рода *Argulus*. Описан жизненный цикл паразита, механизмы его патогенного воздействия на организм хозяина и факторы, способствующие массовому распространению инвазии в условиях аквакультуры. Особое внимание уделено анализу сезонной динамики заболевания и влиянию гидрохимического режима водоемов на интенсивность инвазии. В работе представлены комплексные лечебно-профилактические мероприятия, включающие применение современных химиопрепаратов, биологические методы контроля численности паразитов и рыбоводно-мелиоративные приемы, направленные на разрыв жизненного цикла возбудителя.

Ключевые слова: Аргулез; *Argulus foliaceus*; карповые рыбы; эктопаразиты; инвазия; аквакультура; профилактика; эпизоотология; ветеринарно-санитарные меры; дезинфекция; прудовое рыбоводство; патогенез; ихтиопатология; хлорофос; карбофос; биологическая защита

1. ВВЕДЕНИЕ

Introduction

Рыбное хозяйство играет важную роль в социально-экономическом развитии Республики, являясь одним из перспективных направлений агропромышленного комплекса. В условиях растущего спроса на экологически чистые и высокобелковые продукты питания рыба и рыбная продукция занимают особое место в обеспечении продовольственной безопасности населения. Развитие аквакультуры способствует не только увеличению объемов производства пищевой продукции, но и эффективному использованию водных ресурсов, созданию новых рабочих мест в сельской местности и повышению уровня доходов населения. Кроме того, рыбоводство имеет значительное значение для диверсификации сельского хозяйства и устойчивого развития регионов. Внедрение современных технологий выращивания рыбы, рациональное кормление, профилактика заболеваний и улучшение селекционной работы позволяют существенно повысить продуктивность отрасли. В связи с этим государственная поддержка рыбного хозяйства, научные исследования и подготовка квалифицированных специалистов являются ключевыми факторами дальнейшего развития данной сферы. Таким образом, рыбное хозяйство выступает важным элементом экономики Республики, способствующим укреплению продовольственной независимости, улучшению качества питания населения и устойчивому использованию природных ресурсов.

Аргулез (*lat. argulosis*)-одно из наиболее распространенных инвазионных заболеваний пресноводных рыб, особенно в прудовых хозяйствах, специализирующихся на разведении карпа (*Cyprinus carpio*), белого амура (*Stenopharyngodon idella*) и толстолобика (*Hypophthalmichthys*). Возбудителем являются жаброхвостые рачки (*Branchiura*) из рода *Argulus*, которых в обиходе называют «рыбьими вшами».

Актуальность проблемы обусловлена высокой выживаемостью паразита и его способностью наносить значительный экономический ущерб за счет снижения темпов роста рыб, ухудшения товарного вида и массовой гибели молоди.

2. ЭТИОЛОГИЯ И БИОЛОГИЯ ВОЗБУДИТЕЛЯ

Etiology and biology of the pathogen

Наиболее частым возбудителем является *Argulus foliaceus* (карпоед). Рачок имеет плоское, дисковидное тело длиной 4-8 мм, покрытое щитком. На голове расположены две мощные присоски, представляющие собой видоизмененные челюсти и колющий хоботок.

Жизненный цикл: Паразит является временным: он нападает на рыбу для питания кровью, после чего может свободно плавать в воде.

1. Откладка яиц: Самки откладывают яйца на камни, растения и элементы гидросооружений.
2. Развитие: Скорость развития зависит от температуры. При 20–25 °C эмбриональное развитие занимает 15–20 дней.
3. Личиночная стадия: Вылупившиеся личинки должны найти хозяина в течение 2–3 суток, иначе они погибают.

3. РАСПРОСТРАНЕНИЕ И ФАКТОРЫ РИСКА

Distribution and risk factors

Аргулез встречается повсеместно, но наиболее остро проявляется в южных регионах с прогреваемыми водоемами. **Сезонность:** Пик инвазии приходится на летние месяцы (июль-август), когда температура воды достигает максимума. **Плотность посадки:** В условиях интенсивного рыбоводства высокая плотность рыбы способствует быстрой передаче паразита от особи к особи. **Гидрохимия:** Заращение водоемов высшей водной растительностью создает идеальные условия для прикрепления яиц рачка.



Рис. 1. *Argulus foliaceus* / Fig. 1. *Argulus foliaceus*

4. ПАТОГЕНЕЗ И КЛИНИЧЕСКИЕ ПРИЗНАКИ

Pathogenesis and clinical signs

При нападении рачок прокалывает кожу рыбы хоботком и впрыскивает секрет ядовитых желез, который препятствует свертыванию крови и разрушает ткани.

Основные симптомы: Беспокойство рыбы: она трется о субстрат, выпрыгивает из воды. На коже появляются красные пятна, язвы и очаги некроза, обильное слизиотделение, вторичные инфекции: через раны в организм проникают бактерии *Aeromonas* и грибки *Saprolegnia*.

5. МЕРЫ ПРОФИЛАКТИКИ И БОРЬБЫ

Prevention and control measures

Для борьбы с эктопаразитами успешно применяются современные системные антипаразитарные средства, такие как

ветеринарный препарат «Эмикон» (активное вещество - эмамектин бензоат). Препарат «Эмикон» выпускается в форме порошка для орального применения (содержание эмамектин бензоата - 2 мг/г). Механизм действия основан на блокировании нервных импульсов (воздействие на рецепторы ГАМК в синапсах и h-рецепторы в мышечных клетках), что вызывает расслабление мышц, паралич и гибель ракообразных на всех стадиях развития. Дозировка: Препарат задается из расчета 0,14–0,15 г препарата на 1 кг массы тела рыбы.

Способ применения: Препарат тщательно смешивают с ежедневной нормой комбикорма. Курс лечения: Обработку проводят путем скармливания лечебного корма один раз в сутки в течение 7 дней подряд. При пероральном введении эмамектин бензоат быстро всасывается в желудочно-кишечном тракте рыбы, проникает в системный кровоток, кожную слизь и ткани.



Рис. 2. Внешние проявления аргулёза на теле рыбы / Fig. 2. External manifestations of argulosis on the fish body

Терапевтический эффект: Питающиеся кровью и кожными выделениями рыб паразиты (*Argulus* spp.) получают летальную дозу токсина непосредственно из тканей и слизи хозяина. Безопасность: При соблюдении регламентированных доз препарат не оказывает токсического влияния на самих рыб и других гидробионтов, а также обладает низкой способностью к биоаккумуляции. Профилактика рецидивов: Повторные курсы лечения (при необходимости) назначаются не ранее чем через 30 дней для карповых и осетровых видов рыб. Использование противопаразитарного препарата «Эмикон» в дозировке 0,14–0,15 г/кг массы рыбы курсом в течение 7 дней является высокоэффективным методом борьбы с аргулёзом в

аквакультуре. Данный метод позволяет надежно уничтожить паразитических рачков, улучшить санитарное состояние водоемов, сохранить товарный вид рыбы и предотвратить экономический ущерб рыбоводческим хозяйствам.

Примечание: Перед массовым применением препарата в хозяйстве рекомендуется провести предварительную пробную обработку небольшой группы рыбы для оценки общего состояния поголовья.

5.1. Рыбоводно-мелиоративные мероприятия

Летование прудов: Периодическое осушение и дезинфекция ложа пруда хлорной известью.

Борьба с растительностью: Регулярный скос жесткой водной растительности (тростник, камыш), на которую рачки откладывают яйца.

Фильтрация воды: Установка сороуловителей на водоподающих каналах для предотвращения заноса личинок.

Химические методы обработки: Для дезинвазии используют ванны и обработку всей акватории пруда: Aquatrifon - применяется в более низких концентрациях (1 г X 1000 гр) под строгим контролем ихтиопатолога.

6. ЗАКЛЮЧЕНИЕ

Conclusion

Борьба с аргулезом в карповых хозяйствах не может ограничиваться только медикаментозным лечением. Основой благополучия водоема является строгое соблюдение ветеринарно-санитарных правил, контроль качества воды и своевременная профилактическая обработка рыбоводного инвентаря. Применение комплексной стратегии позволяет минимизировать потери и обеспечить стабильный рост рыбопродуктивности.

DECLARATIONS

Declarations

Author contributions *CRedit*

Conceptualization; Methodology; Investigation; Data curation; Writing – original draft; Writing – review & editing. All authors have read and agreed to the published version of the manuscript.

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Ethics approval

The article is a review of published scientific literature. The work involved no experiments on animals and no human participants, and therefore required no separate ethics committee approval.

Informed consent

All authors have read and approved the final version of the manuscript and have given their consent to its submission and publication. The study involved no human participants and no personal data.

Data availability statement

All sources analysed in this review are listed in the reference list of this article.

Conflict of interest

The authors declare no conflict of interest.

Generative AI disclosure

Generative AI (Claude, Anthropic) was used in the editorial preparation of this article: for language editing, translation of the title, abstract and keywords between Uzbek, Russian and English, preparation of the extended English summary from the authors' text, and formatting of the reference list. No data, results or conclusions were generated by AI. The authors are responsible for the content of the publication.

EXTENDED SUMMARY IN ENGLISH

Kengaytirilgan inglizcha xulosa / Расширенный реферат на английском языке

Purpose and research problem

Fish farming plays an important role in the socio-economic development of the Republic as one of the promising branches of the agro-industrial complex: it helps to meet the growing demand for ecologically clean, protein-rich food, to use water resources efficiently, to create jobs in rural areas and to diversify agriculture. Argulosis is one

of the most widespread invasive diseases of freshwater fish, especially in pond farms rearing carp (*Cyprinus carpio*), grass carp (*Ctenopharyngodon idella*) and silver carp (*Hypophthalmichthys*). It is caused by branchiuran crustaceans of the genus *Argulus*, commonly called "fish lice". The relevance of the problem is determined by the high survival of the parasite and its ability to cause considerable economic damage by reducing the growth rate of fish, impairing their marketable appearance and causing mass mortality of juveniles. The aim of the article is to review the etiology, epizootology and modern methods of treatment and prevention of argulosis in carp fish.

Materials and methods

The article is a review of the biology of the pathogen and of control measures. The most frequent causative agent is *Argulus foliaceus* (the carp louse), a crustacean with a flat disc-shaped body 4–8 mm long covered with a carapace, bearing on the head two powerful suckers (modified maxillae) and a piercing proboscis. The parasite is temporary: it attacks fish to feed on blood and can then swim freely in the water. Females lay eggs on stones, plants and elements of hydraulic structures; the rate of development depends on temperature, and at 20–25 °C embryonic development takes 15–20 days, while hatched larvae must find a host within 2–3 days or they die. Argulosis occurs everywhere but is most acute in southern regions with well-warmed water bodies. The peak of invasion falls on July and August, when water temperature reaches its maximum; high stocking density in intensive fish farming promotes rapid transmission of the parasite from fish to fish, and the overgrowth of water bodies with higher aquatic vegetation creates ideal conditions for the attachment of the crustaceans' eggs.

Results and discussion

When attacking, the crustacean pierces the skin of the fish with its proboscis and injects the secretion of venom glands, which prevents blood clotting and destroys tissues. The main clinical signs are restlessness of the fish (rubbing against the substrate and jumping out of the water), red spots, ulcers and foci of necrosis on the skin, abundant mucus secretion and secondary infections with *Aeromonas* bacteria and *Saprolegnia* fungi entering through the wounds. Modern systemic antiparasitic agents such as the veterinary preparation Emikon (emamectin benzoate, 2 mg/g, powder for oral use) are used successfully: blocking nerve impulses through GABA receptors in synapses and H-receptors in muscle cells causes muscle relaxation, paralysis and death of the crustaceans at all developmental stages. The preparation is mixed thoroughly with the daily ration of compound feed at 0.14–0.15 g per kg of fish body weight and fed once a day for 7 consecutive days; emamectin benzoate is rapidly absorbed from the gastrointestinal tract and enters the bloodstream, skin mucus and tissues, so that parasites feeding on blood and skin secretions receive a lethal dose directly from the host. At the regulated doses the preparation is not toxic to the fish and other aquatic organisms and has a low capacity for bioaccumulation; repeated courses are prescribed not earlier than 30 days later for carp and sturgeon species, and a trial treatment of a small group of fish is recommended before mass application. Fish-farming and reclamation measures include summer drying of ponds and disinfection of the pond bed with chlorinated lime, regular mowing of hard aquatic vegetation (reed and bulrush) on which the crustaceans lay their eggs, installation of debris screens on water supply channels to prevent the entry of larvae, and chemical disinvasion by baths or treatment of the whole pond area under the strict control of an ichthyopathologist.

Conclusion and contribution

Control of argulosis in carp farms cannot be limited to drug treatment alone. The well-being of a water body is based on strict observance of veterinary and sanitary rules, control of water quality and timely preventive treatment of fish-farming equipment. A comprehensive strategy combining modern chemotherapeutic agents, biological methods of controlling parasite numbers and fish-farming reclamation measures aimed at breaking the life cycle of the pathogen makes it possible to minimise losses and ensure a stable growth of fish productivity.

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REVIEW • PEER-REVIEWED • OPEN ACCESS • **SERIES C** • HAC/OAK 16.00.00 — VETERINARY SCIENCES •
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Modern strategies for the control of helminth infections in farm animals

Qishloq xo'jalik hayvonlari gelmintozlariga qarshi kurashishning zamonaviy strategiyalari**Современные стратегии борьбы с гельминтозами сельскохозяйственных животных****AKRAMOV Komiljon^{1,*} , JUMOBOYEV Tokhir²**¹ Scientific-Research Institute of Veterinary, Samarkand, Uzbekistan² Veterinary station of Qangli Citizens' Assembly, Amudarya District, Republic of Karakalpakstan, Uzbekistan* Corresponding author: komiljonshuhratovich@gmail.com**ARTICLE INFO****ARTICLE TYPE**

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AUTHOR, TITLE AND ABSTRACT METADATA (EN / UZ / RU)**ENGLISH****AKRAMOV Komiljon^{1,*} , JUMOBOYEV Tokhir²**¹ Scientific-Research Institute of Veterinary, Samarkand, Uzbekistan² Veterinary station of Qangli Citizens' Assembly, Amudarya District, Republic of Karakalpakstan, Uzbekistan

Abstract. Helminth infections of farm animals are of major economic importance in livestock production due to their adverse effects on animal health and welfare, reduction in productivity, and increased veterinary costs. For many years, helminth control programs have relied primarily on routine and group-based deworming. However, frequent use of anthelmintic drugs without diagnostic testing and without adequate consideration of the epizootic situation is contributing to the development and spread of anthelmintic resistance in helminths. This review article aims to systematically analyze modern strategies for controlling the major helminth infections affecting cattle, sheep, and goats and to propose an integrated control model applicable to the conditions of Uzbekistan. The literature review covers the control of nematodes, trematodes, and cestodes; the rational use of anthelmintic drugs; anthelmintic resistance; fecal egg count-based diagnostics; pasture management; biological control; genetic resistance of animals; and modern diagnostic approaches.

Keywords: helminth infection; nematodosis; trematodosis; cestodosis; farm animals; anthelmintic resistance; integrated control

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Annotatsiya. Qishloq xo'jalik hayvonlarining gelmintozlari chorvachilikda hayvonlar salomatligi va farovonligiga salbiy ta'sir ko'rsatish, mahsuldorlikni pasaytirish hamda veterinariya xarajatlarini oshirish orqali katta iqtisodiy ahamiyat kasb etadi. Gelmintozlarga qarshi uzoq yillar davomida asosan muntazam va guruhli degelmintizatsiyaga tayangan nazorat tizimlari qo'llanib kelgan. Biroq antelmintik preparatlarning tez-tez, diagnostik tekshiruvlarsiz va epizootik vaziyat yetarli hisobga olinmasdan qo'llanilishi gelmintlarda antelmintik rezistentlikning shakllanishi va tarqalishiga olib kelmoqda. Mazkur sharh maqolasida qoramol, qo'y va echkilarda uchraydigan asosiy gelmintozlarga qarshi kurashishning zamonaviy strategiyalarini tizimli ravishda tahlil qilish hamda O'zbekiston sharoitida integratsiyalashgan nazorat modelini taklif etishdan iborat. Ilmiy adabiyotlar tahlilida nematodalar, trematodalar va sestodalarni nazorat qilish; antelmintik preparatlardan oqilona foydalanish; antelmintik rezistentlik; tezak namunasidagi tuxumlar sonini aniqlash; yaylovlarni boshqarish; biologik nazorat; hayvonlarning genetik rezistentligi va zamonaviy diagnostik yondashuvlar haqida ma'lumotlar aks ettirilgan.

Kalit so'zlar: gelmintoz; nematodoz; trematodoz; sestodoz; qishloq xo'jalik hayvonlari; antelmintik rezistentlik; integratsiyalashgan nazorat

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РУССКИЙ

АКРАМОВ Комилжон Шухрат ўғли^{1*}, ЖУМАБОВ Тохир Бекберган ўғли²¹ Научно-исследовательский институт ветеринарии, Самарканд, Узбекистан² Ветеринарный участок Канглинского СГФ Амударьинского района, Республика Каракалпакстан, Узбекистан

Аннотация. Гельминтозы сельскохозяйственных животных имеют большое экономическое значение в животноводстве, поскольку оказывают негативное влияние на здоровье и благополучие животных, снижают продуктивность и приводят к увеличению ветеринарных расходов. На протяжении многих лет системы контроля гельминтозов основывались преимущественно на регулярной и групповой дегельминтизации. Однако частое применение антигельминтных препаратов без проведения диагностических исследований и без достаточного учета эпизоотической ситуации способствует формированию и распространению устойчивости гельминтов к антигельминтным препаратам. Целью настоящей обзорной статьи является систематический анализ современных стратегий борьбы с основными гельминтозами крупного рогатого скота, овец и коз, а также разработка интегрированной модели контроля, адаптированной к условиям Узбекистана. В обзоре научной литературы рассмотрены вопросы контроля нематодозов, трематодозов и цестодозов; рационального применения антигельминтных препаратов; антигельминтной резистентности; диагностики на основе определения количества яиц гельминтов в образцах фекалий; управления пастбищами; биологического контроля; генетической устойчивости животных; и современных диагностических подходов.

Ключевые слова: гельминтозы; нематодозы; трематодозы; цестодозы; сельскохозяйственные животные; антигельминтная резистентность; интегрированный контроль

1. KIRISH

Introduction

Qishloq xo'jalik hayvonlarining gelmintozlari dunyoning deyarli barcha chorvachilik hududlarida uchraydigan va veterinariya tibbiyotining dolzarb muammolaridan biri hisoblangan invazion kasalliklardir. Qoramol, qo'y va echkilarda parazitlik qiluvchi nematodalar, trematodalar va sestodalar hayvon organizmida turli patologik jarayonlarni yuzaga keltirib, mahsuldorlik va reproduktiv ko'rsatkichlarning pasayishi, ozuqadan foydalanish samaradorligining yomonlashishi, yosh hayvonlarning o'sishdan qolishi hamda ayrim hollarda nobud bo'lishiga sabab bo'lishi mumkin.

Chorvachilik amaliyotida ayniqsa nematodalar muhim o'rin tutadi. *Haemonchus*, *Ostertagia*, *Trichostrongylus*, *Cooperia*, *Nematodirus* va *Oesophagostomum* avlodlariga mansub parazitlar yaylov sharoitida boqiladigan kavsh qaytaruvchi hayvonlarda keng tarqalgan. Trematodalar orasida *Fasciola spp.*, *Dicrocoelium dendriticum* va paramfistomlar, sestodalar orasida esa *Moniezia spp.* hamda zoonoz ahamiyatga ega *Echinococcus granulosus* alohida epidemiologik ahamiyatga ega.

O'zbekistonning keskin kontinental iqlimi, sug'oriladigan dehqonchilik hududlari, tog'oldi va yaylov ekotizimlari parazitlarning rivojlanishi va transmissiyasi uchun bir-biridan farq qiluvchi sharoitlarni shakllantiradi. Shu sababli gelmintozlarning epizootologiyasi hudud, mavsum, hayvon turi, yoshi, boqish texnologiyasi va yaylovdan foydalanish tizimiga bog'liq holda sezilarli farqlanishi mumkin.

O'zbekistonning Buxoro hududida 2025-yilda olib borilgan zamonaviy gelmintologik tadqiqotlarda qoramollarda 28, qo'ylarda 24 va echkilarda 21 tur gelmint aniqlangan. Qoramollarda aniqlangan gelmint turlarining 48 % nematodalar, 32 % sestodalar va 20 % trematodalar tashkil qilgan. Shu bilan birga, *Echinococcus granulosus*, *Taenia hydatigena* kabi zoonoz va *Fasciola spp.* yoki veterinariya-sanitariya ahamiyatiga ega gelmintlarning aniqlanishi gelmintozlarni "One Health" nuqtayi nazaridan ham baholash zarurligini ko'rsatadi.

Gelmintozlarga qarshi kurashda uzoq yillar davomida benzimidazollar, imidazotiazollar, tetragidropirimidinlar va

makrotsiklik laktonlarga mansub antgelmintik preparatlardan foydalanish asosiy usul bo'lib kelgan. Kimyoviy nazoratning yuqori dastlabki samaradorligi ko'plab xo'jaliklarda "kalendar bo'yicha degelmintizatsiya" modelining shakllanishiga sabab bo'lgan.

Biroq gelmint populyatsiyalarining evolyutsion moslashuvchanligi va bir xil preparatlarning takroran qo'llanishi natijasida antgelmintik rezistentlik dunyoning ko'plab chorvachilik hududlarida qayd etilmoqda. Ayniqsa nematodalarda bir yoki bir nechta antgelmintik sinflarga rezistentlikning shakllanishi mavjud nazorat tizimlarining barqarorligiga jiddiy xavf tug'dirmoqda.

Shuning uchun zamonaviy parazitologiyada asosiy savol "gelmintlarni qaysi preparat bilan yo'q qilish mumkin?" degan yondashuvdan "qaysi hayvonni, qachon, nima asosida va qaysi preparat bilan davolash kerak?" degan individual va epizootologik yondashuvga o'tmoqda.

1.1. Tadqiqotning maqsadi

Qishloq xo'jalik hayvonlari gelmintozlariga qarshi kurashning zamonaviy ilmiy yondashuvlarini tahlil qilish, antgelmintik rezistentlikning asosiy xavf omillarini baholash hamda diagnostika va xo'jalik boshqaruviga asoslangan integratsiyalashgan nazorat modelini O'zbekiston sharoitiga moslashtirish bo'yicha ilmiy konsepsiyani shakllantirish.

2. TADQIQOTNING MATERIAL VA METODLARI

Materials and methods

Mazkur tadqiqot analitik ilmiy adabiyotlar sharhi shaklida bajarilgan bo'lib, tahlilda veterinariya parazitologiyasi, gelmintologiya, antgelmintik rezistentlik, diagnostika va integratsiyalashgan parazit nazoratiga bag'ishlangan xalqaro ilmiy maqolalar, meta-tahlillar va metodik tavsiyalar o'rganilgan.

Ilmiy manbalarni tahlil qilishda quyidagi mezonlar asos qilib olindi: 1) gelmintlarning epizootologik va iqtisodiy ahamiyati; 2) antgelmintik preparatlar samaradorligi; 3) rezistentlikning rivojlanish mexanizmlari va xavf omillari; 4) diagnostik monitoring; 5) yaylov boshqaruvi; 6) biologik va genetik nazorat.

Tadqiqotda gelmintlarga qarshi dorilar (antgelmintiklar) qanchalik yaxshi ishlayotganini va parazitlar doriga chidamli bo'lib qolgan-qolmaganini aniqlash uchun xalqaro tashkilotning tavsiyalaridan foydalanilgan.

3. NATIJALAR

Results

3.1. Gelmintozlarni nazorat qilish asoslari

Adabiyotlar tahlili shuni ko'rsatadiki, qishloq xo'jalik hayvonlarida gelmintozlarga qarshi kurashish yondashuvlari so'nggi yillarda sezilarli darajada o'zgarmoqda. Ilgari gelmintozlarning oldini olish va ularga qarshi kurashishda asosiy e'tibor hayvonlarni ma'lum muddatlarda ommaviy ravishda degelmintizatsiya qilishga qaratilgan. Bunday yondashuvda hayvonlarda gelmintoz mavjudligi yoki mavjud emasligidan qat'i nazar, butun guruhga bir xil tartibda antgelmintik preparatlar qo'llanilgan.

An'anaviy yondashuvni "gelmintoz → guruhli degelmintizatsiya → takroriy degelmintizatsiya" ketma-ketligi orqali ifodalash mumkin. Ushbu usulning asosiy maqsadi hayvon organizmidagi gelmintlarni imkon qadar tez va keng miqyosda kamaytirishdan iborat bo'lgan. Biroq preparatlarni tez-tez va barcha hayvonlarga bir xil tartibda qo'llash ularning ortiqcha sarflanishiga hamda gelmintlarda preparatlarga chidamlilikning shakllanish xavfi oshishiga olib kelishi mumkin.

Zamonaviy yondashuvda esa gelmintozlarni nazorat qilish faqat dori vositalaridan foydalanish bilan cheklanmaydi. Avvalo xo'jalikdagi epidemiologik holat o'rganiladi, gelmintoz xavfi baholanadi va zarur hollarda laboratoriya-dagnostik tekshiruvlar o'tkaziladi. Olingan natijalarga asosan, hayvonlarni davolash zarurati aniqlanadi va davolashga ehtiyoji yuqori bo'lgan hayvonlarga selektiv tarzda antgelmintik preparatlar qo'llanadi. Shundan so'ng davolash samaradorligi qayta tekshiriladi va xo'jalikdagi epidemiologik vaziyat yana baholanadi.

Shu nuqtayi nazardan, zamonaviy nazorat tizimini "monitoring → xavfni baholash → diagnostika → davolash zaruratini aniqlash → selektiv davolash → samaradorlikni baholash → qayta monitoring" ketma-ketligida ifodalash mumkin. Bunday yondashuvning muhim afzalligi shundaki, antgelmintik preparatlar faqat zarur hollarda qo'llanadi va ularning samaradorligi muntazam nazorat qilinadi.

Gelmintozlarni nazorat qilish tizimining bunday o'zgarishida antgelmintik rezistentlik muammosi muhim o'rin tutadi. Preparatlar bir xil tartibda va tez-tez qo'llanilganda, ularga sezgir parazitlar nobud bo'lishi, preparat ta'siriga chidamli parazitlar esa saqlanib qolishi va ko'payishi mumkin. Natijada vaqt o'tishi bilan ilgari samarali bo'lgan preparatning ta'siri pasayishi ehtimoli ortadi. Shu sababli antgelmintik preparatlarni tanlash va qo'llashda ularning

amaldagi samaradorligini muntazam baholab borish muhim hisoblanadi.

Zamonaviy yondashuvda gelmintozlarni nazorat qilishning asosiy maqsadi barcha parazitlarni har qanday sharoitda mutlaq yo'q qilish emas, balki ularning hayvon salomatligi va mahsuldorligiga sezilarli zarar yetkazmaydigan darajada saqlanishini ta'minlashdan iborat. Bunda hayvonlarning klinik holati, mahsuldorligi, parazitlar bilan zararlanish darajasi va qo'llanilayotgan preparatlarning samaradorligi birgalikda hisobga olinadi.

Gelmintozlarga qarshi kurashishda "ko'proq va tez-tez davolash" tamoyilidan "aniq tashxisga va xavfni baholashga asoslangan davolash" tamoyiliga o'tish kuzatilmoqda. Ushbu yondashuv antgelmintik preparatlardan oqilona foydalanish, keraksiz davolashlarni kamaytirish va preparatlarga rezistentlik rivojlanishining oldini olishga qaratilgan kompleks nazorat tizimini shakllantirish imkonini beradi.

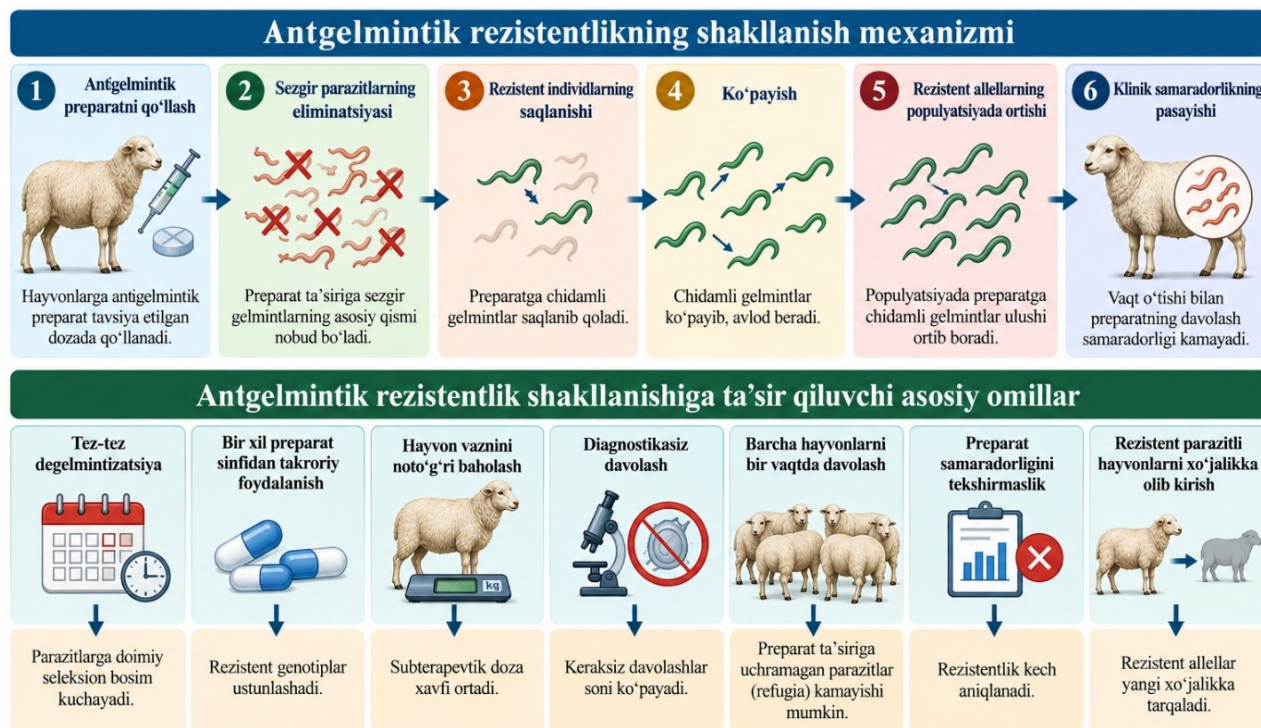
3.2. Antgelmintik rezistentlikning shakllanishi

Adabiyotlar tahlili shuni ko'rsatadiki, gelmintozlarni davolashda antgelmintik preparatlardan uzoq vaqt davomida va takroran foydalanish parazitlarda ushbu preparatlarga chidamlilikning shakllanishiga olib kelishi mumkin. Antgelmintik rezistentlik deganda, ilgari samarali ta'sir ko'rsatgan preparat tavsiya etilgan dozada qo'llanganda ham ayrim parazitlarning saqlanib qolishi va keyinchalik ularning ko'payishi natijasida preparatga chidamli parazitlar ulushining ortib borishi tushuniladi (1-rasm).

Rezistentlikning shakllanishi oddiy biologik jarayon hisoblanadi. Antgelmintik preparat qo'llanganda unga sezgir parazitlarning asosiy qismi nobud bo'ladi, preparat ta'siriga chidamli bo'lgan ayrim parazitlar esa saqlanib qoladi. Ushbu parazitlar keyinchalik ko'payib, o'z xususiyatlarini keyingi avlodlarga o'tkazadi. Natijada populyatsiyada preparatga chidamli parazitlar soni ortib, vaqt o'tishi bilan preparatning davolash samaradorligi pasayishi mumkin.

Antgelmintik rezistentlikning shakllanishiga bir qator omillar ta'sir ko'rsatadi. Jumladan, preparatlarni juda tez-tez qo'llash, bir xil ta'sir mexanizmiga ega preparatlarni takroran ishlatish, hayvon vaznini noto'g'ri aniqlash va natijada preparatning yetarli bo'lmagan dozasini qo'llash muhim xavf omillari hisoblanadi.

Shuningdek, diagnostik tekshiruvsiz davolash ham muammoni kuchaytirishi mumkin. Chunki gelmintoz mavjudligi va uning darajasi aniqlanmasdan barcha hayvonlarni muntazam davolash antgelmintik preparatlardan keragidan ortiq foydalanishga olib keladi. Barcha hayvonlarni bir vaqtda davolash esa preparat ta'siriga uchramagan parazitlar sonini kamaytirishi mumkin. Natijada populyatsiyada preparatga chidamli parazitlarning saqlanib qolish ehtimoli ortadi.



1-rasm. Antelmintik rezistentlik shakllanish mexanizmi va unga ta'sir qiluvchi asosiy omillar / **Fig. 1.** Mechanism of anthelmintic resistance development and the main factors influencing it

Yana bir muhim omil preparat samaradorligini muntazam tekshirib bormaslikdir. Agar davolashdan keyin parazitlar miqdori yetarli darajada kamaymasa, bu holat o'z vaqtida aniqlanmay qolishi va xo'jalikda samarasiz preparatdan qayta foydalanishga sabab bo'lishi mumkin. Shuningdek, boshqa xo'jaliklardan antelmintiklarga chidamli parazitlar bilan zararlangan hayvonlarning olib kelinishi ham rezistentlikning yangi hududga tarqalishiga sabab bo'lishi mumkin.

Shu sababli antelmintik rezistentlikka qarshi kurashishda faqat preparatni almashtirish yetarli emas. Eng muhimi, preparatni qachon, qaysi hayvonga, qanday dozada va qanday asosda qo'llash masalasiga ilmiy yondashishdir. Bunda diagnostik tekshiruvlar, davolash zaruratini aniqlash, preparat samaradorligini nazorat qilish va muntazam monitoringni birgalikda olib borish muhim ahamiyatga ega.

Antelmintik rezistentlikni kamaytirishning asosiy yo'li, antelmintik preparatlardan oqilona foydalanish va davolash strategiyasini diagnostika hamda monitoring natijalariga asoslashdir.

4. MUHOKAMALAR

Discussion

O'rganilgan ilmiy ma'lumotlar shuni ko'rsatadiki, gelmintozlarga qarshi kurash samaradorligini faqat hayvonlarga necha marta degelmintizatsiya o'tkazilganligi bilan baholash yetarli emas. Chunki degelmintizatsiya sonining ko'pligi preparatning samarali ishlayotganini yoki gelmintozlar nazorat ostida ekanligini to'liq ko'rsatmaydi.

Shu sababli gelmintozlarni nazorat qilishda bir nechta muhim ko'rsatkichlarni birgalikda baholash zarur. Bular: gelmintlar bilan zararlanish darajasi, hayvonlarning klinik holati, mahsuldorligi, antelmintik preparatlarning samaradorligi, rezistentlik holati va preparatlardan foydalanish miqdori hisoblanadi. Ushbu ko'rsatkichlarning birgalikda tahlil qilinishi xo'jalikdagi gelmintozlar holatini to'g'ri baholash imkonini beradi.

Antelmintik preparat qo'llangandan keyin hayvonlarda kasallik belgilari kamayishi preparatning samarali ekanligini

ko'rsatishi mumkin. Biroq bu natija preparat gelmintlarni yetarli darajada yo'q qilganini har doim ham anglatmaydi. Shuning uchun davolashdan oldingi va keyingi gelmintologik ko'rsatkichlarni taqqoslash, zarur hollarda preparat samaradorligini baholash muhim. Bunday tekshiruv preparat ta'sirining pasayishini erta aniqlashga yordam beradi.

Gelmintozlarni nazorat qilishda barcha xo'jaliklar uchun bir xil tartibni qo'llashdan ko'ra, mahalliy sharoit va xo'jalik xususiyatlariga moslashtirilgan protokollarni ishlab chiqish maqsadga muvofiqdir. Bunday yondashuv antelmintik preparatlardan oqilona foydalanish, keraksiz davolashlarni kamaytirish, hayvonlarning mahsuldorligini saqlash va preparatlarga rezistentlik rivojlanishini sekinlashtirishga xizmat qiladi.

5. XULOSALAR

Conclusions

1. Adabiyotlar tahlili shuni ko'rsatdiki, gelmintozlarga qarshi kurashda antelmintik preparatlarni muntazam va asossiz qo'llash parazitlarda preparatlarga chidamlilikning shakllanish xavfini oshiradi. Shu sababli preparatlarni qo'llash diagnostika va zararlanish darajasini hisobga olgan holda amalga oshirilishi kerak.

2. Antelmintik preparatlarning samaradorligini davolashdan oldingi va keyingi parazitologik ko'rsatkichlarni taqqoslash orqali muntazam nazorat qilish gelmintozlarni samarali boshqarishning muhim sharti hisoblanadi.

3. Zamonaviy adabiyotlar tahlili barcha hayvonlarni bir xil tartibda davolash o'rniga, gelmintoz xavfi va hayvonlarning holatiga qarab davolashni tashkil etish maqsadga muvofiqligini ko'rsatadi. Bunday yondashuv keraksiz preparat sarfini kamaytirish va rezistentlik rivojlanishini sekinlashtirishga yordam beradi.

4. Gelmintozlarni uzoq muddat nazorat qilishda faqat antelmintik preparatlarga tayanish yetarli emas. Diagnostika, yaylovlarni to'g'ri boshqarish, hayvonlarning klinik holatini kuzatish va preparat samaradorligini muntazam baholashni birgalikda olib borish barqaror nazorat tizimini shakllantirishning asosiy shartlari hisoblanadi.

DECLARATIONS

Declarations

Author contributions *CRedit*

Conceptualization; Methodology; Investigation; Data curation; Writing – original draft; Writing – review & editing. All authors have read and agreed to the published version of the manuscript.

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Ethics approval

The article is a review of published scientific literature. The work involved no experiments on animals and no human participants, and therefore required no separate ethics committee approval.

Informed consent

All authors have read and approved the final version of the manuscript and have given their consent to its submission and publication. The study involved no human participants and no personal data.

Data availability statement

All sources analysed in this review are listed in the reference list of this article.

Conflict of interest

The authors declare no conflict of interest.

Generative AI disclosure

Generative AI (Claude, Anthropic) was used in the editorial preparation of this article: for language editing, translation of the title, abstract and keywords between Uzbek, Russian and English, preparation of the extended English summary from the authors' text, and formatting of the reference list. No data, results or conclusions were generated by AI. The authors are responsible for the content of the publication.

EXTENDED SUMMARY IN ENGLISH

Kengaytirilgan inglizcha xulosa / Расширенный реферат на английском языке

Purpose and research problem

Helminth infections of farm animals occur in almost all livestock regions of the world and are among the pressing problems of veterinary medicine. Nematodes, trematodes and cestodes parasitising cattle, sheep and goats cause pathological processes that reduce productivity and reproductive performance, impair feed utilisation, retard the growth of young animals and sometimes cause death. Nematodes of the genera *Haemonchus*, *Ostertagia*, *Trichostrongylus*, *Cooperia*, *Nematodirus* and *Oesophagostomum* are widespread in grazing ruminants; among trematodes *Fasciola* spp., *Dicrocoelium dendriticum* and paramphistomes, and among cestodes *Moniezia* spp. and the zoonotic *Echinococcus granulosus* are of particular importance. The sharply continental climate of Uzbekistan, irrigated farming areas and foothill and pasture ecosystems create different conditions for parasite development and transmission, and recent studies in the Bukhara region found 28 helminth species in cattle, 24 in sheep and 21 in goats, including zoonotic species, which calls for a One Health perspective. For many years control relied on benzimidazoles, imidazothiazoles, tetrahydropyrimidines and macrocyclic lactones applied by calendar-based deworming, but repeated use of the same drugs has led to anthelmintic resistance in many livestock regions. The aim of the review was to analyse modern approaches to helminth control in farm animals, to assess the main risk factors for anthelmintic resistance and to form a concept of an integrated, diagnosis- and management-based control model adapted to the conditions of Uzbekistan.

Materials and methods

The study was performed as an analytical review of the scientific literature. International scientific articles, meta-analyses and methodological recommendations on veterinary parasitology, helminthology, anthelmintic resistance, diagnostics and integrated parasite control were examined. The sources were analysed according to the following criteria: the epizootological and economic importance of helminths; the efficacy of anthelmintic drugs; the mechanisms and

risk factors of resistance development; diagnostic monitoring; pasture management; and biological and genetic control. The recommendations of the World Association for the Advancement of Veterinary Parasitology (WAAVP) were used to assess how well anthelmintics work and whether parasites have become resistant to them.

Results and discussion

The literature shows that approaches to helminth control in farm animals have changed considerably in recent years. Previously, attention was focused on mass deworming of animals at fixed intervals, with the whole group treated in the same way regardless of whether helminths were present. The traditional scheme "helminthosis → group deworming → repeated deworming" is being replaced by a system of "monitoring → risk assessment → diagnosis → targeted treatment → efficacy control", in which control is based not only on drugs but also on diagnostics, pasture management and the clinical state of the animals, and the main goal is not to eliminate all parasites but to keep infection at a level that does not harm health and productivity. Anthelmintic resistance develops when, after repeated use of a previously effective drug at the recommended dose, some parasites survive and multiply, so that the proportion of resistant parasites in the population increases. Its development is promoted by frequent deworming, repeated use of the same drug class, underdosing due to incorrect estimation of body weight, treatment without diagnosis, simultaneous treatment of all animals, which reduces the refugia, failure to check drug efficacy and the introduction of animals carrying resistant parasites from other farms. Replacing one drug with another is therefore not sufficient: the key is a scientific approach to when, which animal, at what dose and on what basis to treat, combined with diagnostic examinations, assessment of the need for treatment, control of drug efficacy and regular monitoring.

Conclusion and contribution

The effectiveness of helminth control cannot be judged only by the number of dewormings performed; the level of infection, the clinical state and productivity of the animals, the efficacy of anthelmintics, the resistance status and the amount of drugs used should be assessed together, and pre- and post-treatment parasitological indicators should be compared to detect a decline in drug efficacy early. Regular and unjustified use of anthelmintics increases the risk of resistance, so treatment should be based on diagnosis and the level of infection, and drug efficacy should be monitored regularly. Instead of treating all animals in the same way, treatment should be organised according to the risk of helminthosis and the condition of the animals, which reduces unnecessary drug use and slows the development of resistance. Long-term control cannot rely on anthelmintics alone; diagnostics, proper pasture management, observation of the clinical state of animals and regular assessment of drug efficacy are the main conditions of a sustainable control system, and protocols adapted to local conditions and farm characteristics are preferable to a uniform scheme for all farms.

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REVIEW • PEER-REVIEWED • OPEN ACCESS • **SERIES C** • HAC/OAK 16.00.00 — VETERINARY SCIENCES •
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Animal brucellosis: the current global epizootic situation, distribution, and control measures

Hayvonlar brusellyozi. Dunyoda mavjud epizootik holat, tarqalishi va nazorat choralari**Бруцеллёз животных. Современная эпизоотическая ситуация в мире, распространение и меры контроля****BAKHRIDDINOV Doniyor Ilkhomovich^{1*}, ULUGMURADOV Azamat Daminovich¹, SAIDOV Akmaljon Akramovich¹, RUZIMURODOV Mukhiddin Akhrorovich¹**¹ Scientific-Research Institute of Veterinary, Samarkand, Uzbekistan

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ENGLISH

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Abstract. This article focuses on the global prevalence of animal brucellosis, its major species, particularly the course of the disease in cattle, clinical signs, modern diagnostic methods, and control measures. In addition, based on data from the World Organisation for Animal Health (WOAH), the epizootic situation was analysed across different continents and regions, including the Middle East, Mediterranean countries, sub-Saharan Africa, as well as China, India, Peru, Mexico, and countries of Central and South-West Asia. The article also presents findings from recent scientific studies indicating significant shortcomings in diagnostic approaches and epizootological surveillance, which make it difficult to accurately determine the true prevalence of brucellosis. Therefore, the article emphasises the importance of an integrated approach to brucellosis control based on the One Health concept, regular serological testing, laboratory confirmation, vaccination, biosecurity measures, and the identification of infected animals.

Keywords: brucellosis; Brucella abortus; Brucella melitensis; Brucella suis; cattle; sheep; goats; epizootology; zoonosis; diagnosis; vaccination; biosecurity

O'ZBEKCHA

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Annotatsiya. Mazkur maqolada hayvonlar brusellyozining dunyo bo'ylab tarqalish darajasi, turlar, ayniqsa qoramollarda kasallikning kechishi, klinik belgilari, zamonaviy diagnostikasi va qarshi kurash chora-tadbirlariga alohida e'tibor qaratilgan. Bundan tashqari maqolada Jahon hayvonlar salomatligi tashkiloti (JHST-WOAH) ma'lumotlari asosida qit'alarda, jumladan Yaqin Sharq, O'rtaer dengizi mamlakatlari, Sahroi Kabirdan janubdagi Afrika, Xitoy, Hindiston, Peru va Meksika, Markaziy va Janubi-G'arbiy Osiyo mamlakatlaridagi epizootik vaziyat tahlil qilingan. Shuningdek, maqolada so'nggi ilmiy tadqiqotlar brusellyozning haqiqiy tarqalish darajasini aniqlashda diagnostika va epizootologik monitoringda jiddiy kamchiliklar mavjudligi sababidan kasallikka qarshi kurashda «Yagona salomatlik» (One Health) yondashuvi, muntazam serologik tekshiruvlar, laboratoriya tasdiq'i, vaksinatsiya, bioxavfsizlik va kasal hayvonlarni aniqlashga asoslangan kompleks chora-tadbirlar muhim ahamiyat kasb etishi to'g'risida ma'lumotlar keltirilgan.

Kalit so'zlar: brusellyoz; Brucella abortus; Brucella melitensis; Brucella suis; qoramol; qo'y; echki; epizootologiya; zoonoz; diagnostika; vaksinatsiya; bioxavfsizlik

РУССКИЙ

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САИДОВ Акмалжон Акрамович¹, РУЗИМУРДОВ Мухиддин Ахрорович¹

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Аннотация. В данной статье особое внимание уделено распространённости бруцеллёза животных в мире, его видам, особенностям течения заболевания у крупного рогатого скота, клиническим признакам, современным методам диагностики и мерам борьбы. Кроме того, на основе данных Всемирной организации по охране здоровья животных (ВОАН) проанализирована эпизоотическая ситуация на различных континентах, в том числе в странах Ближнего Востока, Средиземноморья, Африки к югу от Сахары, а также в Китае, Индии, Перу, Мексике и странах Центральной и Юго-Западной Азии. В статье также представлены данные последних научных исследований, свидетельствующие о наличии серьёзных недостатков в диагностике и эпизоотологическом мониторинге, препятствующих точному определению истинной распространённости бруцеллёза. В связи с этим подчёркивается важное значение комплексного подхода к борьбе с заболеванием, основанного на принципах концепции «Единое здоровье» (One Health), регулярных серологических исследований, лабораторного подтверждения, вакцинации, обеспечения биобезопасности и выявления инфицированных животных.

Ключевые слова: бруцеллёз; *Brucella abortus*; *Brucella melitensis*; *Brucella suis*; крупный рогатый скот; овцы; козы; эпизоотология; зооноз; диагностика; вакцинация; биобезопасность

1. KIRISH

Introduction

Brusellyoz-*Brucella* avlodiga mansub bakteriyalar tomonidan chaqiriladigan yuqumli kasallik bo'lib, chorvachilik va veterinariya sohasidagi eng muhim transchegaraviy infeksiyalardan biri hisoblanadi. Jahon hayvonlar salomatligi tashkiloti brusellyozni iqtisodiy ahamiyati yuqori bo'lgan, odamlar uchun ham xavf tug'diradigan kasallik sifatida baholaydi. Qoramollarda asosan *B.abortus*, qo'y va echkilarda *B.melitensis*, cho'chqalarda esa *B.suis* muhim epizootologik ahamiyatga ega.

Kasallikning asosiy klinik belgisi reproduktiv buzilishlar, xususan, homila tashlash, bepustlik, sut mahsuldorligining kamayishi va podaning reproduktiv ko'rsatkichlari yomonlashishi bilan namoyon bo'ladi. Shu bilan birga, infeksiyalangan hayvonlar ba'zan tashqi klinik belgilsiz ham kasallik qo'zg'atuvchisini tarqatishi mumkin.

2. DUNYODAGI MAVJUD EPIZOOTIK HOLAT

Current global epizootic situation

Bugungi kunda brusellyoz dunyoning ko'plab mamlakatlarida saqlanib qolayotgan endemik infeksiyalardan biri hisoblanadi. JHST ma'lumotlariga ko'ra, kasallikning yuqori darajada uchrashi Yaqin Sharq, O'rtaer dengizi mamlakatlari, Sahroi Kabirdan janubdagi Afrika, Xitoy, Hindiston, Peru va Meksikada kuzatiladi. Ayniqsa Markaziy va Janubi-G'arbiy Osiyoda holatning ortib borayotgani veterinariya xizmatlari uchun dolzarb masala bo'lib qolmoqda.

Shu bilan birga, ayrim mamlakatlar va hududlarda uzoq yillik nazorat dasturlari natijasida brusellyozdan ozod maqomga erishilgan. G'arbiy va Shimoliy Yevropaning bir qator mamlakatlari, Kanada, Yaponiya, Avstraliya va Yangi Zelandiya kasallik qo'zg'atuvchisidan ozod hududlar sifatida qaraladi. Biroq bunday hududlarda ham infeksiyaning tashqi kirib kelishi, yovvoyi hayvonlar orqali qayta tarqalishi yoki nazoratdan chetda qolgan hayvonlar tufayli xavf saqlanib qoladi.

Muhim jihat shundaki, dunyo miqyosida brusellyozning aniq tarqalishini faqat rasmiy xabarlar asosida baholash qiyin. 2025-yilda e'lon qilingan tahlillarda chorva hayvonlarida brusellyoz diagnostikasi bo'yicha 349 ta tadqiqot o'rganilgan va ularning faqat 16 foizi namuna olish, diagnostik usul, protokol va natijalarni talqin qilish nuqtai nazaridan JHST tavsiyalariga to'liq mos kelgan. Bu holat ayrim mamlakatlarda kasallikning haqiqiy epizootik holati rasmiy ma'lumotlarda to'liq aks etmasligi mumkinligini ko'rsatadi.

3. QORAMOLLAR BRUSELLYOZI

Bovine brucellosis

Qoramollarda brusellyozning asosiy qo'zg'atuvchisi *B.abortus* hisoblanadi. Infeksiya asosan reproduktiv tizimga ta'sir ko'rsatib, bo'g'ozlikning ikkinchi yarmidagi abort, yashovchanligi past nasl tug'ilishi, yo'ldoshning ushlanib qolishi, endometrit, bepustlik va sut mahsuldorligining pasayishiga sabab bo'ladi.

Qoramollar orasida kasallikning tarqalishi chorva hayvonlarining intensiv ko'chirilishi, yangi hayvonlarni podaga veterinariya nazoratisiz qo'shish, tug'ish va abortdan keyingi biologik materiallarni veterinariya-sanitariya talablariga rioya qilmagan holda yo'qotish hamda fermada bioxavfsizlik choralarining yetarli emasligi bilan bog'liq bo'lishi mumkin.

So'nggi tadqiqotlar qoramollar brusellyozida xo'jalikni boshqarish usullari, hayvonlarning harakati, bioxavfsizlik va poda tarkibi kabi omillar infeksiya xavfiga ta'sir qilishini ko'rsatmoqda.

4. QO'Y VA ECHKILAR BRUSELLYOZI – ASOSIY XAVFLI YO'NALISHLARDAN BIRI

Brucellosis of sheep and goats

Qo'y va echkilarda *B.melitensis* eng muhim qo'zg'atuvchi bo'lib, u nafaqat chorvachilikka, balki aholi salomatligiga ham jiddiy xavf tug'diradi. Qo'y va echkilar brusellyozi dunyoda keng tarqalgan bo'lib, ayrim mamlakatlarga ushbu infeksiyadan ozod deb hisoblanadi.

2025-yilda chop etilgan global tahlilda 2010-2023-yillarda e'lon qilingan tadqiqotlar asosida *B.melitensis* infeksiyasining qo'y va echkilardagi tarqalishi baholangan. Hisob-kitoblarga ko'ra, qo'ylarda seropozitivlik ko'rsatkichi 8,07%, echkilarda 2,46%, ikki tur hayvon birgalikda baholaganda esa 5,54% ni tashkil etgan. Mintaqalar o'rtasida juda katta farqlar mavjudligi aniqlangan.

Bu raqamlarni butun dunyo chorva populyatsiyasiga to'g'ridan-to'g'ri tatbiq etish mumkin emas, chunki tadqiqotlar turli mamlakatlar, hayvon guruhlari va diagnostik usullar asosida o'tkazilgan. Biroq, ular *B.melitensis* infeksiyasi hali ham global veterinariya muammosi ekanini ko'rsatadi.

5. AFRIKA, OSIYO VA BOSHQA MINTAQALARDAGI VAZIYAT

Situation in Africa, Asia and other regions

Afrika qit'asida kichik kavsh qaytaruvchilar brusellyozi chorvachilik va aholi salomatligi uchun muhim muammo bo'lib qolmoqda. 2000-2025-yillardagi tadqiqotlarni qamrab olgan yangi tahlilda Afrikaning 28 mamlakati bo'yicha 151 ta tadqiqot ma'lumotlari umumlashtirilgan. Bu qit'ada brusellyoz bo'yicha

epidemiologik ma'lumotlar mavjud bo'lsa-da, mamlakatlar kesimida monitoring intensivligi va diagnostik imkoniyatlar bir xil emas.

Osiyoda ham brusellyozning epizootologik ahamiyati yuqori. Masalan, Xitoyda 2025-yil avgustgacha o'tkazilgan tadqiqotlarni qamrab olgan tahlilda qo'y va echkilarda umumiy seropozitivlik 3,0% deb baholangan, ammo hududlar o'rtasida sezilarli farqlar aniqlangan.

Amerika mintaqasida esa qoramollar bilan bir qatorda yovvoyi hayvonlar, jumladan bizon, bug'u va yovvoyi cho'chqalar infeksiyaning tabiiy rezervuari sifatida epizootologik ahamiyat kasb etishi to'g'risida ma'lumotlar mavjud. Yovvoyi hayvonlar bilan chorva hayvonlari o'rtasidagi kontakt infeksiyaning qayta kirib kelishiga sabab bo'lishi ehtimoli mavjud.

6. ODAMLAR UCHUN ZOONOZ XAVFI

Zoonotic risk for humans

Brusellyozning eng muhim xususiyatlaridan biri-uning hayvonlardan odamlarga yuqishidir. Insonlar asosan infeksiyalangan hayvonlar bilan bevosita kontakti, abort materiallari, yo'ldosh va biologik suyuqliklar bilan ishlash, shuningdek, xom yoki termik ishlov berilmagan sut va sut mahsulotlarini iste'mol qilish orqali zararlanishi mumkin. Veterinarlar, chorvadorlar, go'sht-sut mahsulotlarini qayta ishlash bilan shug'ullanuvchilar va laboratoriya mutaxassislari yuqori xavf guruhlari kiradi.

Shu sababli hayvonlarda brusellyozga qarshi kurash faqat veterinariya vazifasi emas, balki aholi salomatligini muhofaza qilishning muhim qismi hamdir. Hayvonlarda infeksiyani nazorat qilish insonlardagi brusellyoz xavfini kamaytirishning eng samarali yo'llaridan biri hisoblanadi.

7. DIAGNOSTIKADAGI ZAMONAVIY YONDASHUVLAR

Modern approaches to diagnosis

Brusellyozni aniqlashda serologik usullar, jumladan Roz Bengal va boshqa klassik serologik testlar, IFT va boshqa immunologik tekshiruvlar keng qo'llaniladi. Ayrim holatlarda bakterilogik usullar va PZR infeksiyani tasdiqlashda muhim ahamiyat kasb etadi.

Biroq, faqat bitta serologik test natijasiga asoslanib yakuniy xulosa chiqarish har doim ham to'g'ri emas. JHST diagnostikada klinik, epizootologik, allergik va laboratoriya ma'lumotlarini kompleks baholashni nazarda tutadi. Infeksiyani tasdiqlashda qo'zg'atuvchini ajratib olish yoki ijobiy diagnostik natijani epizootologik bog'liqlik bilan birgalikda baholash muhim. 2025-yilgi global tizimli tahlil ham diagnostika standartlariga rioya qilish muammosini ko'rsatdi. Tadqiqotlarning katta qismida laboratoriya usullari turlicha qo'llangani sababli mamlakatlar va hududlar o'rtasidagi ma'lumotlarni to'g'ridan-to'g'ri taqqoslash qiyin.

8. KASALLIKKA QARSHI KURASH VA PROFILAKTIKA

Control and prevention

Brusellyozni nazorat qilishda eng muhim choralar quyidagilardan iborat:

1. Muntazam monitoring va serologik skrining. Podani rejali tekshirish infeksiyani erta aniqlash imkonini beradi.
2. Infeksiya yuqtirgan hayvonlarni aniqlash. Ijobiy natija bergan hayvonlarni sog'lom podadan ajratish kasallik tarqalishini cheklash imkonini beradi.
3. Vaksinatсия. Endemik hududlarda emlash infeksiya darajasini pasaytirish uchun muhim vosita hisoblanadi. JHST bir

qator vaksina variantlaridan foydalanishni nazarda tutadi va bu borada turli davlatlarning o'z dasturlari mavjud.

4. Bioxavfsizlikni kuchaytirish. Yangi keltirilgan hayvonlarni karantinda saqlash, podaga kiritishdan oldin tekshirish, abort va tug'ish materiallarini xavfsiz yo'qotish hamda xo'jalikda veterinariya-sanitariya holatini me'yorda ushlash zarur.

5. Hayvonlar harakatini nazorat qilish. Identifikatsiyalash tadbirlarini to'liq amalga oshirish.

6. Sut mahsulotlarini termik ishlov (pasterizatsiya) berish. Bu odamlarga infeksiya yuqish xavfini sezilarli kamaytiradi.

7. Veterinariya va tibbiyot xizmatlarining hamkorligi. Brusellyoz zoonoz kasallik bo'lgani sababli odamlar va hayvonlar salomatligi bo'yicha ma'lumotlarni birgalikda doimiy tahlil qilish talab etiladi.

8.1. «Yagona salomatlik» konsepsiyasi doirasida

Bugungi kunda brusellyozga qarshi kurashda «Yagona salomatlik» konsepsiyasi tobora muhim ahamiyat kasb etmoqda. Ushbu yondashuv inson, hayvon va atrof-muhit salomatligini o'zaro bog'liq holda baholashni nazarda tutadi. Chorva hayvonlarida infeksiya saqlanib qolsa, insonlarda kasallanish xavfi ham davom etadi. Shuning uchun veterinariya xizmati, tibbiyot muassasalari, oziq-ovqat xavfsizligi tizimi va laboratoriyalar o'rtasida axborot almashinuvi kuchaytirilishi zarur.

9. XULOSA

Conclusion

Dunyoda hayvonlar brusellyozni hanuz dolzarb epizootologik va iqtisodiy muammo bo'lib qolmoqda. Ayrim mamlakatlar kasallikdan holi hudud maqomiga erishgan bo'lsa-da, ko'plab mintaqalarda, ayniqsa Yaqin Sharq, Afrika, Osiyoning ayrim qismlari va boshqa endemik hududlarda infeksiyaning aylanishi davom etmoqda. JHST ma'lumotlarida Markaziy va Janubi-G'arbiy Osiyoda holatning o'sishi alohida qayd etilgan.

Hozirgi bosqichda asosiy muammolardan biri nafaqat infeksiyani bartaraf etish, balki uning haqiqiy tarqalishini aniq baholashdir. So'nggi ilmiy tadqiqotlar diagnostika usullarining bir xil emasligi va epizootologik monitoringdagi kamchiliklar global epidemiologik manzarani baholashni qiyinlashtirayotganini ko'rsatmoqda.

Shu bois brusellyozga qarshi samarali strategiya - muntazam monitoring, standartlashtirilgan laboratoriya diagnostikasi, vaksinatсия, bioxavfsizlik, hayvonlar harakatini nazorat qilish, infeksiyalangan podalarni boshqarish va insonlar orasida profilaktik choralarni birlashtirishi lozim. Brusellyozni nazorat qilishda veterinariya va tibbiyot xizmatlarining hamkorligi kasallikning iqtisodiy hamda zoonoz ta'sirini kamaytirishning asosiy sharti hisoblanadi.

DECLARATIONS

Declarations

Author contributions *CRedit*

Conceptualization; Methodology; Investigation; Data curation; Writing – original draft; Writing – review & editing. All authors have read and agreed to the published version of the manuscript.

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Ethics approval

The article is a review of published scientific literature and official data. The work involved no experiments on animals and no human participants, and therefore required no separate ethics committee approval.

Informed consent

All authors have read and approved the final version of the manuscript and have given their consent to its submission and publication. The study involved no human participants and no personal data.

Data availability statement

All sources analysed in this review are listed in the reference list of this article.

Conflict of interest

The authors declare no conflict of interest.

Generative AI disclosure

Generative AI (Claude, Anthropic) was used in the editorial preparation of this article: for language editing, translation of the title, abstract and keywords between Uzbek, Russian and English, preparation of the extended English summary from the authors' text, and formatting of the reference list. No data, results or conclusions were generated by AI. The authors are responsible for the content of the publication.

EXTENDED SUMMARY IN ENGLISH

Kengaytirilgan inglizcha xulosa / Расширенный реферат на английском языке

Purpose and research problem

Brucellosis is an infectious disease caused by bacteria of the genus *Brucella* and one of the most important transboundary infections in livestock farming and veterinary medicine. The World Organisation for Animal Health (WOAH) regards it as a disease of high economic importance that also poses a risk to humans. In cattle the main causative agent is *B. abortus*, in sheep and goats *B. melitensis* and in pigs *B. suis*. The main clinical manifestations are reproductive disorders — abortion, infertility, reduced milk yield and deterioration of herd reproductive indicators — while infected animals may also spread the pathogen without visible clinical signs. The aim of the review is to analyse the global prevalence of animal brucellosis, the course of the disease in different species, modern diagnostic approaches and control measures on the basis of WOAH data and recent scientific publications.

Materials and methods

The article reviews WOAH data, international guidelines, national regulatory documents of Uzbekistan and recent systematic reviews and meta-analyses on the global epizootic situation, the epidemiology of brucellosis in cattle, sheep and goats, its zoonotic importance, diagnostic standards and control strategies.

Results and discussion

Brucellosis remains endemic in many countries: according to WOAH, high incidence is observed in the Middle East, the Mediterranean, sub-Saharan Africa, China, India, Peru and Mexico, and the situation is worsening in Central and South-West Asia, whereas several countries of Western and Northern Europe, Canada, Japan, Australia and New Zealand have achieved freedom from the disease, though the risk of reintroduction remains. A 2025 systematic review of 349 diagnostic studies in livestock found that only 16% fully followed WOAH recommendations on sampling, test choice, protocol and interpretation, so official data may not reflect the true situation. In cattle, *B. abortus* causes abortion in the second half of pregnancy, weak offspring, retained placenta, endometritis, infertility and reduced milk yield, and its spread is associated with intensive animal movement, introduction of animals without veterinary control, improper disposal of birth and abortion materials and insufficient farm biosecurity. A 2025 global meta-analysis of studies published in 2010–2023 estimated the seroprevalence of *B. melitensis* at 8.07% in sheep, 2.46% in goats and 5.54% in both species combined, with large regional differences. A review of 151 studies from 28 African countries showed uneven monitoring and diagnostic capacity, the overall seroprevalence in sheep and goats in China was estimated at 3.0%, and in the Americas wild animals such as bison, elk and feral pigs act as natural reservoirs. Humans are infected through direct contact with infected animals, abortion materials and biological fluids and through consumption of raw milk and dairy products, so veterinarians, livestock keepers, meat and milk processors and laboratory staff are at high risk. Diagnosis relies on serological tests such as the Rose Bengal test, ELISA and other

immunological assays, with bacteriological methods and PCR for confirmation, but a final conclusion should not be based on a single serological result: WOAH requires a combined assessment of clinical, epizootological, allergic and laboratory data. The main control measures are regular monitoring and serological screening, identification and isolation of infected animals, vaccination in endemic areas, strengthened biosecurity, control of animal movement and identification, heat treatment of milk and cooperation between veterinary and medical services within the One Health concept.

Conclusion and contribution

Animal brucellosis remains an urgent epizootological and economic problem worldwide: although some countries have achieved disease-free status, circulation of the infection continues in many regions, particularly the Middle East, Africa and parts of Asia, and WOAH data indicate an increase in Central and South-West Asia. One of the main current problems is not only eliminating the infection but also accurately assessing its true prevalence, since differences in diagnostic methods and gaps in epizootological monitoring complicate the global epidemiological picture. An effective strategy should combine regular monitoring, standardised laboratory diagnosis, vaccination, biosecurity, control of animal movement, management of infected herds and preventive measures among people, and cooperation between veterinary and medical services is the key condition for reducing the economic and zoonotic impact of the disease.

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RESEARCH ARTICLE • PEER-REVIEWED • OPEN ACCESS • SERIES C • HAC/OAK 16.00.00 — VETERINARY SCIENCES • UDC: 638.15:615.32:616.08

Therapeutic and prophylactic efficacy of phytopreparations used against varroosis and tropilaelapsosis

Varroatoz va trapilelapsozga qarshi qo'llanilgan fitopreparatlarning terapevtik va profilaktik samaradorligi

Терапевтическая и профилактическая эффективность фитопрепаратов, применяемых против варроатоза и тропилелапсоза

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ENGLISH

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Abstract. This article analyzes the therapeutic and prophylactic efficacy of phytopreparations used against varroosis and tropilaelapsosis in honeybees. It examines the acaricidal activity of medicinal plants and essential oils, their safety for honeybee colonies, the prospects for using locally available plant-based preparations, the selection of optimal concentrations, and their potential integration into comprehensive strategies for controlling parasitic mite infestations.

Keywords: honeybees; varroosis; tropilaelapsosis; Varroa destructor; Tropilaelaps clareae; phytopreparations; medicinal plants; essential oils; acaricidal activity; therapeutic efficacy; prevention

O'ZBEKCHA

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Annotatsiya. Ushbu maqolada asalarilarning varroatoz va trapilelapsoz kasalliklariga qarshi fitopreparatlarning terapevtik-profilaktik samaradorligi, dorivor o'simliklar va efir moylarining akaritsid faolligi hamda asalari oilalari uchun xavfsizligi tahlil qilingan. Shuningdek, mahalliy fitopreparatlarni qo'llash istiqbollari, optimal konsentratsiyalarni tanlash va ularni invazion kasalliklarga qarshi integratsiyalashgan kurash tizimiga joriy etish imkoniyatlari yoritilgan.

Kalit so'zlar: asalarilar; varroatoz; trapilelapsoz; Varroa destructor; Tropilaelaps clareae; fitopreparatlar; dorivor o'simliklar; efir moylari; akaritsid faollik; terapevtik samaradorlik; profilaktika

РУССКИЙ

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Аннотация. В статье проанализирована терапевтическая и профилактическая эффективность фитопрепаратов, применяемых против варроатоза и тропилелапсоза пчёл. Рассмотрены акарицидная активность лекарственных растений и эфирных масел, их безопасность для пчелиных семей, перспективы применения местных фитопрепаратов, выбор оптимальных концентраций и возможности их включения в систему интегрированной борьбы с инвазионными заболеваниями пчёл.

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Ключевые слова: пчёлы; варроатоз; тропилаэлапсоз; *Varroa destructor*; *Tropilaelaps clareae*; фитопрепараты; лекарственные растения; эфирные масла; акарицидная активность; терапевтическая эффективность; профилактика

1. KIRISH

Introduction

Varroatoz va trapilelapsoz asalari oilalarining salomatligi, rivojlanishi va mahsuldorligiga salbiy ta'sir ko'rsatuvchi muhim invazion kasalliklar hisoblanadi. Ushbu kasalliklarga qarshi kurashishda kimyoviy akaritsidlardan uzoq muddat foydalanish parazitlarda chidamlilik shakllanishi hamda asalarichilik mahsulotlarida preparat qoldiqlarining to'planishi xavfini yuzaga keltirishi mumkin. Shu sababli dorivor o'simliklar asosida tayyorlangan, akaritsid faollikka ega va asalari oilalari uchun xavfsiz vositalarni izlash, ularning terapevtik-profilaktik samaradorligini ilmiy asosda baholash dolzarb ilmiy-amaliy ahamiyatga ega. Fitopreparatlarning varroatoz va trapilelapsoz qo'zg'atuvchilariga ta'sirini, optimal konsentratsiyalarini hamda asalari oilalarining hayotchanligiga ta'sirini o'rganish kasalliklarga qarshi kurashishning samarali va ekologik jihatdan maqbul usullarini takomillashtirishga xizmat qiladi.

2. MUAMMONING O'RGANILGANLIK DARAJASI

Literature review

Bir guruh tadqiqotchilar 30 xil efir moyining *Varroa destructor* kanallari va ishchi asalariilarga ta'sirini qiyosiy o'rgangan. Tajribalarda ayrim efir moylarining kanallarga qarshi yuqori akaritsid faolligi aniqlangan, biroq ularning asalariilarga toksik ta'siri ham alohida baholangan. Mualliflarning ishlari o'simlik moylarini varroatozga qarshi qo'llashda nafaqat parazitlarga ta'sirini, balki asalari oilalari uchun xavfsizligini ham hisobga olish zarurligini ko'rsatadi [4]. Olimlar *Thymus satureioides* va *Origanum elongatum* o'simliklari efir moylarining kimyoviy tarkibi hamda *V. destructor* ga qarshi akaritsid xususiyatlarini o'rgangan. Tadqiqotda ushbu moylarning asalari uyasida fumigatsiya usulida qo'llanganda samarali ta'sir ko'rsatishi aniqlangan. Ayniqsa, tarkibida karvakrol ko'p bo'lgan efir moyining fumigant ta'siri yuqoriroq bo'lgan. Ushbu natijalar mahalliy dorivor o'simliklardan olinadigan biologik faol moddalarni varroatozga qarshi vositalar yaratishda o'rganish muhimligini ko'rsatadi [6].

Tadqiqotchilar Jazoirida o'sadigan *Artemisia herba-alba*, *Artemisia campestris*, *Artemisia judaica* va *Ruta montana* o'simliklari efir moylarining *V. destructor* ga qarshi ta'sirini baholagan. Natijalar barcha tekshirilgan moylarda akaritsid faollik mavjudligini ko'rsatgan. Shu bilan birga, moylarning ta'siri va asalari uchun selektivligi o'simlik turiga qarab farqlangan. Mualliflar ushbu tabiiy vositalarni varroatozga qarshi qo'llash istiqbolini ta'kidlagan, ammo ularni amaliy asalarichilik sharoitida ham qo'shimcha tekshirish zarurligini qayd etgan [3]. Dastlab biz tomonimizdan olib borilgan tadqiqotlarda ham mahalliy dorivor o'simliklar asosida tayyorlangan preparatlarning asalari kasalliklariga qarshi samaradorligi va ulardan foydalanish imkoniyatlari o'rganilgan. Tadqiqotlarda dolchin (*Cinnamomum spp.*) va boshqa biologik faol o'simlik komponentlarining akaritsid hamda mikroblarga qarshi xususiyatlariga e'tibor qaratilgan. Mualliflar fitopreparatlarni qo'llash asalari oilalarining yashovchanligini saqlash, parazitlarga qarshi kurashish va asalarichilik mahsulotlarida kimyoviy qoldiqlar to'planishi xavfini kamaytirishda istiqbolli ekanligini ta'kidlagan. Shuningdek, o'simlik asosidagi vositalarni kimyoviy preparatlarga muqobil yoki ular bilan uyg'unlashgan holda, integratsiyalashgan kurash tizimida qo'llash muhimligi qayd etilgan [5].

Olimning “Средства неспецифической профилактики варроатоза пчёл на основе растительного сырья и научные

основы их применения” mavzusidagi dissertatsiyasida varroatozga qarshi o'simlik xomashyosidan foydalanishning ilmiy asoslari o'rganilgan. Tadqiqotda achchiq shuvoq (*Artemisia absinthium*) va qarag'ay kurtaklari asosida tayyorlangan KAS-81 preparatining terapevtik-profilaktik xususiyatlari baholangan. Muallif ma'lumotlariga ko'ra, preparatni oziqlantirish orqali qo'llash asalari oilalarining kanallarga zararlanish darajasini kamaytirishga yordam bergan. Ishda preparatning asalari oilalarining qishlashi, nasl rivojlanishi va hayotchanligiga ta'siri ham o'rganilgan [8]. Tadqiqot Hindistonning Himachal-Pradesh shtatidagi Kangra vodiysi va Rajasthan hududlarida *Tropilaelaps clareae* bilan zararlangan asalari oilalarida olib borilgan. Uch marta ishlov berilgandan so'ng, kekik (*Thymus vulgaris*) moyi nasldagi zararlanishni 42,33% dan 2,00% gacha kamaytirgan, ya'ni 94,83% samaradorlik qayd etilgan. Evkalipt (*Eucalyptus globulus*) moyi qo'llangan guruhda zararlanish 3,00% gacha tushib, 91,36% kamayish kuzatilgan. Ish ushbu ikki o'simlik moyining trapilelapsozga qarshi istiqbolli ekanligini ko'rsatadi [1]. Mualliflar *V. destructor* va *T. clareae* bilan birgalikda zararlangan *Apis mellifera* oilalarida kekik, evkalipt, qalampirmunchoq va limon o'ti (lemongrass) efir moylarini laboratoriya hamda dala sharoitida tekshirgan. *T. clareae* ga qarshi nisbiy samaradorlik kekik moyida 81,70%, qalampirmunchoq moyida 76,95%, evkalipt moyida 74,53% va limon o'ti moyida 69,74% bo'lgan. Kekik moyi eng yuqori natijani ko'rsatgan; uning qo'llanilishi nasl maydonining sezilarli oshishi bilan ham bog'langan [7].

Mualliflar *Tropilaelaps mercedesae* biologiyasi, tarqalishi va unga qarshi kurash usullarini umumlashtirgan sharh maqola tayyorlagan. Unda timol, limonen va limon o'ti moyi kabi o'simliklardan olinadigan birikmalarning akaritsid imkoniyatlari yoritilgan. Shu bilan birga, laboratoriyada kuzatilgan ta'sir har doim ham dala sharoitida takrorlanmasligi, optimal konsentratsiya va qo'llash usullarini yanada takomillashtirish zarurligi ta'kidlangan [2].

Xulosa qilib aytganda, xorijiy va mahalliy tadqiqotchilar tomonidan dorivor o'simliklar hamda ulardan olingan efir moylarining *Varroa destructor* va *Tropilaelaps* kanallariga qarshi akaritsid samaradorligi o'rganilgan. Ayniqsa, kekik, evkalipt, qalampirmunchoq, limon o'ti va boshqa o'simlik vositalarining istiqbolli ta'siri aniqlangan. Biroq ularning samaradorligi, asalari oilalari uchun xavfsizligi hamda amaliy asalarichilik sharoitidagi qo'llash usullari bo'yicha qo'shimcha tadqiqotlar talab etiladi. Shu sababli mahalliy dorivor o'simliklar asosida samarali va xavfsiz fitopreparatlar ishlab chiqish, ularning terapevtik-profilaktik xususiyatlarini hamda olingan asal sifatiga ta'sirini kompleks baholash muhim ilmiy-amaliy ahamiyatga ega.

3. MATERIALLAR VA TADQIQOT USULLARI

Tadqiqotlar davomida kavrak (*Ferula assa-foetida*) o'simligidan tayyorlangan suvli ekstrakt (damlama) asalari oilalarida varroatoz va trapilelapsoz qo'zg'atuvchilariga qarshi sinovdan o'tkazildi. Tayyorlangan fitopreparatlarni qo'llashda asalari oilalarining fiziologik holati, parazitlarning biologik rivojlanish xususiyatlari hamda preparatlarning asalari organizmiga xavfsiz ta'sirini ta'minlash tamoyillari hisobga olindi.

Fitopreparatlar asalari oilalariga romlar oraliq'iga purkash usuli orqali yuborildi. Ushbu usul tanlanishining asosiy sababi shundan iboratki, *Varroa destructor* va *Tropilaelaps clareae* kanallari asosan ishchi asalari tanasining tashqi yuzasida, ayniqsa qorin qismi, ko'krak bo'limi va uya ichidagi naslli kataklarda joylashadi.

Preparat eritmasining mayda tomchilar holida tarqalishi uning

asalari tanasi, uya ichki muhiti va parazitlar joylashadigan hududlarga bir tekis yetib borishini ta'minladi.



1-rasm. Asalari romlari oralig'iga fitopreparatni purkash usuli orqali yuborish jarayoni / **Fig. 1.** Application of the phytopreparation by spraying between the honeycomb frames

4. TADQIQOT NATIJALARI

Results

Varroatoz va trapilelappoz asalari oilalarining biologik rivojlanishi, mahsuldorligi va yashovchanligiga salbiy ta'sir ko'rsatuvchi muhim ektoparazitlar kasalliklar hisoblanadi. Ushbu kasalliklarning qo'zg'atuvchilari - *Varroa destructor* va *Tropilaelaps clareae* - asalarilarning gemolimfasi bilan oziqlanib, ularning fiziologik holatini zaiflashtiradi. Natijada nasl rivojlanishining buzilishi, asalari oilalarining kuchsizlanishi va mahsuldorlikning pasayishi kuzatiladi.

An'anaviy sintetik akaritsidlarni uzoq muddat va takroran qo'llash parazitlarda rezistentlik shakllanishiga hamda asalarichilik mahsulotlarida dori vositalari qoldiqlarining to'planishiga sabab bo'lmoqda. Shu bois ekologik xavfsiz, biologik parchalanadigan va asalari oilalariga nisbatan kam toksik vositalarni izlash dolzarb masalalardan biridir. Mazkur jihatdan dorivor o'simliklar asosida tayyorlangan Fitopreparatlar istiqbolli muqobil vosita sifatida katta

ilmiy-amaliy ahamiyat kasb etadi. Xususan, kavrak (*Ferula assa-foetida*) va burgan (*Artemisia* spp.) tarkibidagi biologik faol birikmalar akaritsid, repelent va antimikrob xususiyatlarga ega bo'lishi mumkin. Bunday preparatlarning qo'llanilishi parazitlar sonini kamaytirish bilan bir qatorda asalari oilalarining biologik barqarorligini saqlashga xizmat qilishi mumkin. Shuningdek, fitopreparatlarning terapevtik va profilaktik samaradorligini ilmiy asosda baholash organik va ekologik xavfsiz asalarichilikni rivojlantirish uchun muhim ahamiyatga ega.

1-jadvalda kavrak (*Ferula assa-foetida*) xomashyosidan turli nisbatlarda suvli damlama tayyorlash va uni asalari oilalariga qo'llash uchun mo'ljallangan tajriba sxemasi keltirilgan. Tajribada asosiy o'zgaruvchi omil suv miqdori, barcha tajriba variantlarida esa quritilgan kavrak xomashyosi 25 g miqdorida bir xil saqlangan. Bunday yondashuv xomashyo miqdorini standartlashtirgan holda, suv hajmini bosqichma-bosqich kamaytirish orqali damlamaning konsentratsion farqini hosil qilish va uning biologik samaradorligini qiyosiy baholash imkonini beradi.

1-jadval

Kavrak damlamasining turli nisbatlarda tayyorlash sxemasi / **Table 1.** Scheme for preparing asafoetida (*Ferula assa-foetida*) infusion at different ratios

Guruh	Quritilgan kavrak xomashyosi	Suv	Xomashyo: suv nisbati	50 ml dozadagi xomashyo ekvivalenti	Konsentratsiya
I-tajriba	25 g	500 ml	1:20	2,5 g	Past
II-tajriba	25 g	375 ml	1:15	3,33 g	O'rtacha-past
III-tajriba	25 g	250 ml	1:10	5,0 g	O'rtacha
IV-tajriba	25 g	125 ml	1:5	10,0 g	Yuqori
V-nazorat	0 g	500 ml	-	0 g	Nazorat

Tajriba uchun quritilgan va maydalangan kavrak xomashyosi barcha tajriba guruhlarida 25 g miqdorda olinib, unga mos ravishda 500, 375, 250 va 125 ml suv qo'shilgan. Natijada xomashyo:suv nisbati mos ravishda 1:20, 1:15, 1:10 va 1:5 ko'rinishida shakllantirilgan. Suv hajmining kamayishi natijasida bir xil miqdordagi kavrak xomashyosi kamroq hajmdagi erituvchiga ekstraksiyalanganligi sababli damlamaning hisobiy xomashyo yuklamasi bosqichma-bosqich oshib borgan. Shu asosda 1:20 variant past, 1:15 o'rtacha-past, 1:10 o'rtacha va 1:5 yuqori konsentratsiyali tajriba varianti sifatida qabul qilingan.

Mazkur tajriba dizaynining muhim metodik jihati shundaki, barcha variantlarda quritilgan kavrak xomashyosi miqdori 25 g qilib doimiy saqlangan, suv hajmi esa 500 ml dan 125 ml gacha izchil kamaytirilgan. Natijada tajriba guruhlarida o'rtasidagi asosiy farq aynan xomashyo:suv nisbatining o'zgarishi hisobiga yuzaga keladi. Bu yondashuv kavrak xomashyosining turli konsentratsion variantlarini qiyoslashda xomashyoning boshlang'ich massasini standartlashtirish imkonini beradi. 50 ml preparatning bir asalari

oilasiga qo'llanilishi hisobga olinganda, har bir tajriba variantida 50 ml dozaga to'g'ri keladigan quruq kavrak xomashyosi ekvivalenti mos ravishda 2,50; 3,33; 5,00 va 10,00 g ni tashkil etadi.

Tajribaning V-nazorat guruhida kavrak xomashyosi qo'llanilmagan va preparat tarkibida xomashyo mavjud emas. Nazorat guruhining hisobiy xomashyo ekvivalenti 0 g ni tashkil etadi. Ushbu guruh tajriba davomida *Varroa destructor* va *Tropilaelaps clareae* invaziyasining tabiiy dinamikasini baholash hamda tajriba guruhlarida kuzatilgan o'zgarishlarni kavrak damlamasi ta'siri bilan qiyoslash uchun xizmat qiladi.

Kavrak damlamasi konsentratsiyasining bosqichma-bosqich oshirilishi uning ta'siri konsentratsiyaga qarab qanday o'zgarishini aniqlash imkonini beradi. Bunda 1:20 nisbatdagi damlamadan 50 ml qo'llanganda 2,50 g, 1:15 da 3,33 g, 1:10 da 5,00 g va 1:5 da 10,00 g quruq xomashyo ekvivalenti bir asalari oilasiga to'g'ri keladi. Shu sababli yuqori nisbatdagi konsentratsiya avtomatik ravishda optimal deb hisoblanmaydi. Optimal variant *V. destructor*

va *T. clareae* ga qarshi akaritsid samaradorlik bilan bir qatorda asalari oilalarining hayotchanligi, asalari nobud bo'lishi, bachadonning tuxum qo'yish faolligi, nasl maydoni va preparatning ehtimoliy toksik ta'siri kabi ko'rsatkichlar majmuasi asosida aniqlanishi kerak.

Umuman olganda, mazkur tajriba sxemasida 25 g kavrak xomashyosining doimiy saqlanishi va suv miqdorining 500 ml dan 125 ml gacha kamaytirilishi tajriba variantlari o'rtasida izchil konsentratsiya o'zgarishini shakllantiradi. Xomashyo:suv

2-jadval

Kavrak damlamasining tajribada qo'llash sxemasi / **Table 2.** Scheme of application of asafetida infusion in the experiment

Guruh	Xomashyo: suv nisbati	Bir oilaga doza	Qo'llash usuli	Ishlovlar soni	Ishlovlar oralig'i
I-tajriba	1:20	50 ml	Romlar oralig'iga purchash	3	7 kun
II-tajriba	1:15	50 ml	Romlar oralig'iga purchash	3	7 kun
III-tajriba	1:10	50 ml	Romlar oralig'iga purchash	3	7 kun
IV-tajriba	1:5	50 ml	Romlar oralig'iga purchash	3	7 kun
Nazorat	-	-	Ishlov berilmadi	-	-

Kavrak (*Ferula assa-foetida* L.) damlamasining asalari oilalarida varroatoz va trapilelapsozga qarshi terapevtik hamda profilaktik samaradorligini aniqlash maqsadida tajriba maxsus sxema asosida tashkil etildi. Tajribada kavrak damlamasining 1:20, 1:15, 1:10 va 1:5 xomashyo:suv nisbatlari sinovdan o'tkazilib, damlama konsentratsiyasining *Varroa destructor* va *Tropilaelaps clareae* ga qarshi samaradorlikka ta'siri qiyosiy baholandi. Bunda preparatning bir asalari oilasiga qo'llaniladigan hajmi barcha tajriba guruhlarida bir xil - 50 ml/oila miqdorida standartlashtirildi. Shu sababli tajriba variantlari o'rtasidagi asosiy farq preparat hajmida emas, balki uning tarkibidagi kavrak xomashyosining hisobiy miqdorida bo'ldi.

Tajribaning I guruhida 1:20, II guruhida 1:15, III guruhida 1:10 va IV guruhida 1:5 nisbatdagi kavrak damlamasi qo'llanildi. Har bir tajriba oilasiga 50 ml dan preparat romlar oralig'iga Varramor apparati yordamida mayda dispers purchash usulida yuborildi. Har bir guruhda ishlov 7 kunlik interval bilan jami 3 marotaba amalga oshirildi. Bunday ishlov sxemasini kavrak damlamasining parazitlarga ketma-ket ta'sirini ta'minlash hamda birinchi ishlovdan keyin saqlanib qolgan parazitlarga takroriy ishlov orqali ta'sir ko'rsatish maqsadida tanlandi.

Preparatning 50 ml hajmda standartlashtirilishi tajriba natijalarini qiyosiy baholash uchun muhim metodik shart bo'ldi. 1-jadvaldagi hisob-kitoblarga muvofiq, 50 ml 1:20 nisbatdagi damlama bir asalari oilasiga 2,5 g, 1:15 nisbatdagi damlama 3,33 g, 1:10 nisbatdagi damlama 5,0 g, 1:5 nisbatdagi damlama esa 10,0 g quruq kavrak xomashyosi ekvivalentini tashkil etadi. Mazkur qiymatlar tayyor damlama tarkibidagi haqiqiy biologik faol moddalar miqdorini emas, balki 50 ml preparatni tayyorlashga sarflangan quruq kavrak xomashyosining hisobiy ekvivalentini ifodalaydi.

Tajriba variantlarida xomashyo:suv nisbatining 1:20 dan 1:5 gacha o'zgarishi natijasida 50 ml preparatga to'g'ri keladigan xomashyo ekvivalenti ham bosqichma-bosqich oshib bordi. Shu tariqa I guruhda 2,5 g, II guruhda 3,33 g, III guruhda 5,0 g va IV guruhda 10,0 g quruq kavrak xomashyosi ekvivalenti bir asalari

nisbatining 1:20 → 1:15 → 1:10 → 1:5 tarzida o'zgarishi natijasida 50 ml preparatga to'g'ri keladigan xomashyo ekvivalenti 2,50 → 3,33 → 5,00 → 10,00 g gacha ortadi.

Mazkur yondashuv kavrak damlamasining *V. destructor* va *T. clareae* ga qarshi biologik samaradorligini konsentratsiyaga bog'liq holda baholash, terapevtik ta'sirning optimal darajasini aniqlash hamda samaradorlik va asalari xavfsizligi o'rtasidagi maqbul nisbatni ilmiy asoslash uchun metodik asos bo'lib xizmat qildi.

oilasiga qo'llanildi. Bunday tartib kavrak damlamasi ta'sirining konsentratsiyaga bog'liq ravishda o'zgarishini aniqlash imkonini berdi.

Nazorat guruhidagi asalari oilalariga kavrak damlamasi bilan ishlov berilmadi. Nazorat guruhining kiritilishi tajriba davomida parazitlar invaziyasining tabiiy o'zgarishini aniqlash va tajriba guruhlarida kuzatilgan natijalarni preparat ta'siri bilan qiyoslash imkonini berdi. Shu asosda 1:20, 1:15, 1:10 va 1:5 nisbatdagi kavrak damlamalarining *V. destructor* va *T. clareae* ga qarshi ta'siri, shuningdek, asalari oilalarining umumiy holatiga ta'siri kompleks ravishda baholandi.

Tajriba davomida har bir ishlovdan oldin va keyingi kuzatuv davrlarida asalari oilalarining umumiy holati, ishchi asalarilarning faolligi, ona arining tuxum qo'yish jadalligi, nasl maydoni, parazitlar soni hamda asalarilar nobud bo'lishi muntazam nazorat qilindi. Shuningdek, preparat qo'llanilgandan keyin zaharlanish, bezovtalik, oziqlanish faolligining pasayishi yoki boshqa nojo'ya reaksiyalar mavjudligi qayd etildi. Olingan natijalar asosida har bir nisbatdagi damlamaning terapevtik samaradorligi *V. destructor* va *T. clareae* bo'yicha invaziya ekstensivligi (EI), invaziya intensivligi (II), parazitlarning nobud bo'lish darajasi va umumiy terapevtik samaradorlik ko'rsatkichlari orqali baholandi.

Jadval ma'lumotlaridan ko'rinib turibdiki, *V. destructor* bo'yicha ekstensiv invaziya (EI) kamayishi 1:20 nisbatdagi damlama qo'llanilganda 34,8%, 1:15 nisbatda 57,6%, 1:10 nisbatda 84,5% va 1:5 nisbatda 88,3% ni tashkil etdi. Demak, 1:20 nisbatga nisbatan 1:10 nisbatdagi damlamada EI kamayishi 49,7 foiz punktga, 1:5 nisbatda esa 53,5 foiz punktga yuqori bo'ldi. Ayniqsa, 1:15 dan 1:10 nisbatga o'tilganda samaradorlikning sezilarli oshishi kuzatilib, 1:10 dan 1:5 nisbatga o'tilganda qo'shimcha samaradorlik nisbatan kam bo'ldi. 1:10 nisbatda 84,5% natijaga erishilgan bo'lsa, 1:5 nisbatda bu ko'rsatkich atigi 3,8 foiz punktga oshgan. Bu holat 1:10 nisbatda kavrak damlamasining antiparazitlar ta'siri yuqori darajaga yetganligini ko'rsatadi.

V. destructor bo'yicha intensiv invaziya (II) kamayishi ham xuddi shunday qonuniyatni namoyon etdi.

3-jadval

Kavrak (*Ferula assa-foetida* L.) damlamasining optimal konsentratsiyasini (xomashyo:suv nisbatini) aniqlash mezonlari / **Table 3.** Criteria for determining the optimal concentration (raw material:water ratio) of *Ferula assa-foetida* L. infusion

Ko'rsatkich	1:20	1:15	1:10	1:5	Optimal variantni tanlash mezonlari
V. destructor EI kamayishi, %	34,8	57,6	84,5	88,3	Yuqori
V. destructor II kamayishi, %	31,5	55,2	82,8	87,4	Yuqori
T. clareae EI kamayishi, %	29,7	52,8	80,6	84,5	Yuqori
T. clareae II kamayishi, %	28,9	51,6	83,0	84,9	Yuqori
Parazitlar nobud bo'lishi, %	36,2	59,4	83,7	87,5	Yuqori
Ona ari tuxum qo'yishi, dona/kun	1 420	1 445	1 468	1 438	Nazoratga yaqin
Nasl maydoni, sm ²	3 420	3 510	3 590	3 470	Nazoratga yaqin
Asalarilar nobud bo'lishi, dona/oila	3,2	3,8	4,1	9,6	Minimal
Zaharlanish belgilari	Kuzatilmadi	Kuzatilmadi	Kuzatilmadi	Yengil	Bo'lmisligi
Umumiy terapevtik samaradorlik, %	32,2	55,3	82,9	86,5	Yuqori samaradorlik va xavfsizlik uyg'unligi
Yakuniy baho	Qoniqarli	Yaxshi	Eng maqbul	Yuqori samarali, ammo xavfsizlik pastroq	1:10 - optimal

Mazkur ko'rsatkich 1:20 nisbatdagi damlamada 31,5%, 1:15 da 55,2%, 1:10 da 82,8% va 1:5 da 87,4% ni tashkil etdi. 1:20 dan 1:10 gacha bo'lgan nisbatlarda intensiv invaziya darajasining kamayishi 51,3 foiz punktga oshgan bo'lsa, 1:10 dan 1:5 gacha bo'lgan bosqichda qo'shimcha o'sish atigi 4,6 foiz punktga tashkil etdi. Ushbu natijalar kavrak damlamasining 1:10 nisbatdagi varianti *V. destructor* kanalarining nafaqat oilalar bo'yicha tarqalish darajasini, balki bitta asalari oilasiga to'g'ri keladigan parazitlar sonini kamaytirishda ham yetarlicha yuqori samaradorlikka ega ekanligini ko'rsatadi.

Varroa destructor bilan bir qatorda, tajribada *Tropilaelaps clareae* kanallari bo'yicha ham sezilarli antiparazitlar ta'sir qayd etildi. *T. clareae* EI kamayishi 1:20 nisbatdagi damlamada 29,7%, 1:15 da 52,8%, 1:10 da 80,6% va 1:5 da 84,5% ni tashkil etdi. 1:20 nisbatga nisbatan 1:10 nisbatda mazkur ko'rsatkich 50,9 foiz punktga yuqori bo'ldi. 1:10 dan 1:5 gacha bo'lgan nisbatda esa samaradorlikning qo'shimcha o'sishi 3,9 foiz punktga tashkil etdi. Bu ma'lumotlar kavrak damlamasi *T. clareae* ga qarshi ham sezilarli akaritsid faollikka ega ekanligini va 1:10 nisbatda ushbu ta'sir amaliy jihatdan yuqori darajaga yetishini ko'rsatadi.

T. clareae bo'yicha intensiv invaziya kamayishi 1:20 nisbatda 28,9%, 1:15 da 51,6%, 1:10 da 83,0% va 1:5 da 84,9% ni tashkil etdi. Bunda 1:20 variantga nisbatan 1:10 nisbatda samaradorlik 54,1 foiz punktga oshgan. Shu bilan birga, 1:10 dan 1:5 gacha nisbat kuchaytirilganda mazkur ko'rsatkichning atigi 1,9 foiz punktga yaxshilangani kuzatildi. Demak, *T. clareae* ning intensiv invaziyasini kamaytirishda 1:10 nisbatdagi kavrak damlamasi yetarlicha yuqori va barqaror natija bergan.

Kavrak damlamasining antiparazitlar ta'sirini baholovchi muhim ko'rsatkichlardan biri kanalarining bevosita nobud bo'lish darajasi hisoblanadi. Ushbu ko'rsatkich 1:20 nisbatda 36,2%, 1:15 da 59,4%, 1:10 da 83,7% va 1:5 da 87,5% ni tashkil etdi. 1:20 dan 1:10 gacha nisbat kuchaytirilganda nobud bo'lgan parazitlar ulushi 47,5 foiz punktga oshgan. 1:10 dan 1:5 gacha oshirilganda esa bu farq faqat 3,8 foiz punktga tashkil etdi. Shunday qilib, 1:10 nisbatda kanalariga qarshi bevosita letal ta'sir yuqori bo'lib, nisbatni 1:5 gacha kuchaytirish qo'shimcha samaradorlikni keskin oshirmagan.

4.1. Asalari oilalarining fiziologik holati

Kavrak damlamasining terapevtik samaradorligi bilan bir qatorda, uning asalari oilalarining biologik va fiziologik holatiga

ta'sirini baholash muhim ahamiyatga ega. Chunki antiparazitlar preparatning yuqori samaradorligi asalari oilasiga toksik yoki stresslovchi ta'sir ko'rsatgan taqdirda uni amaliyotda optimal preparat sifatida baholash imkonini bermaydi. Shu sababli tadqiqotda ona arining tuxum qo'yish faolligi, nasl maydoni, asalari nobud bo'lishi hamda zaharlanish belgilari alohida hisobga olindi.

Ona arining tuxum qo'yish ko'rsatkichi 1:20 nisbatda kuniga 1420 dona, 1:15 da 1445 dona, 1:10 da 1468 dona va 1:5 nisbatda 1438 donani tashkil etdi. Eng yuqori natija 1:10 nisbatdagi damlama qo'llanilgan oilalarda qayd etilib, kunlik tuxum qo'yish 1468 donaga yetdi. 1:5 nisbatda esa ushbu ko'rsatkich 1438 donagacha kamayib, 1:10 variantga nisbatan 30 donaga pasaydi. Bu holat 1:10 nisbatda preparatning antiparazitlar ta'siri bilan asalari oilasining reproduktiv faolligi o'rtasida nisbatan qulay muvozanat shakllanganligini ko'rsatadi.

Nasl maydoni ham nisbatlar bo'yicha farq qildi. Mazkur ko'rsatkich 1:20 variantda 3420 sm², 1:15 da 3510 sm², 1:10 da 3590 sm² va 1:5 da 3470 sm² ni tashkil etdi. Eng katta nasl maydoni 1:10 nisbatdagi damlama qo'llanilgan oilalarda kuzatilib, 3590 sm² ga yetdi. 1:5 nisbatda esa nasl maydoni 3470 sm² gacha kamayib, 1:10 variantga nisbatan 120 sm² ga qisqardi. Bu natijalar ham 1:10 nisbatda asalari oilalarining fiziologik faolligi nisbatan yaxshi saqlanganligini ko'rsatadi.

4.2. Asalarilar xavfsizligi bo'yicha tahlil

Tadqiqotning muhim jihatlaridan biri kavrak damlamasining asalari oilalariga xavfsizlik darajasini aniqlashdan iborat bo'ldi. Olingan ma'lumotlarga ko'ra, 1:20 nisbatda asalari nobud bo'lishi 3,2 dona/oila, 1:15 da 3,8 dona/oila, 1:10 da 4,1 dona/oila va 1:5 nisbatda 9,6 dona/oila bo'lgan. Demak, 1:10 nisbatdan 1:5 ga o'tilganda nobud bo'lgan asalari soni 5,5 dona/oilaga, ya'ni qariyb 2,3 baravar oshgan. Bu holat yuqori xomashyo:suv nisbatida preparatning asalari uchun xavfsizlik chegarasi pasayishini ko'rsatadi.

Zaharlanish belgilari bo'yicha 1:20, 1:15 va 1:10 nisbatlarda zaharlanish holatlari kuzatilmadi. 1:5 nisbatda esa yengil zaharlanish belgilari qayd etildi. Shunday qilib, 1:5 nisbat antiparazitlar samaradorlik bo'yicha yuqori natijani ko'rsatgan bo'lsa-da, uning asalari xavfsizligi bo'yicha ko'rsatkichlari 1:10 variantga nisbatan noqulay bo'lgan.

4.3. Umumiy terapevtik samaradorlik

Tadqiqot natijalarini kompleks baholash maqsadida *V. destructor* va *T. clareae* bo'yicha ekstensiv va intensiv invaziya kamayishi hamda parazitlarning nobud bo'lish darajasi asosida umumiy terapevtik samaradorlik aniqlandi. Ushbu ko'rsatkich 1:20 nisbatda 32,2%, 1:15 da 55,3%, 1:10 da 82,9% va 1:5 da 86,5% ni tashkil etdi.

Nisbatning 1:20 dan 1:10 gacha kuchaytirilishi umumiy terapevtik samaradorlikni 50,7 foiz punktga oshirgan bo'lsa, 1:10 dan 1:5 gacha kuchaytirilganda samaradorlik atigi 3,6 foiz punktga yaxshilandi. Shu bilan birga, 1:5 nisbatda asalarilar nobud bo'lishining 9,6 dona/oilaga yetishi va yengil zaharlanish belgilarining paydo bo'lishi kuzatildi. Demak, 1:5 nisbat sof antiparazitar samaradorlik bo'yicha yuqori natijaga ega bo'lsa-da, uni xavfsizlik nuqtayi nazaridan optimal variant deb hisoblash maqsadga muvofiq emas.

4.4. Optimal nisbatni tanlashning ilmiy asoslanishi

Olingan natijalarni kompleks tahlil qilish natijasida kavrak (*Ferula assa-foetida*) damlamasining 1:10 xomashyo:suv nisbati optimal variant sifatida belgilandi. Mazkur nisbatda *V. destructor* EI kamayishi 84,5%, II kamayishi 82,8%, *T. clareae* EI kamayishi 80,6%, II kamayishi 83,0% va parazitlarning nobud bo'lishi 83,7%

4-jadval

Kavrak damlamasining *Varroa destructor* kanallari soniga ta'siri / **Table 4.** Effect of asafetida infusion on the number of *Varroa destructor* mites

Kunlar (tajriba davomiyligi)	Tajriba guruhi - 1:10 nisbatdagi kavrak damlamasi qo'llanilgan guruhdagi <i>Varroa destructor</i> kanallari soni (M±m)	Nazorat guruhi - ishlov berilmagan guruhdagi <i>Varroa destructor</i> kanallari soni (M±m)
Boshlanishi	32,0 ± 0,2	32,0 ± 0,2
3-kun	29,0 ± 1,0	32,0 ± 0,7
6-kun	27,0 ± 0,2	33,0 ± 0,1
9-kun	22,0 ± 1,0	34,0 ± 0,8
12-kun	18,0 ± 0,5	35,0 ± 0,4
15-kun	11,0 ± 0,6	37,0 ± 1,2
18-kun	9,0 ± 0,5	38,0 ± 0,1
21-kun	6,0 ± 0,1	39,0 ± 0,4

Kuzatuvning keyingi kunlarida kavrak damlamasining akaritsid ta'siri yanada yaqqol namoyon bo'ldi. Jumladan, 6-kunda tajriba guruhida kanalar soni 27,0±0,2 tani, 9-kunda 22,0±1,0 tani va 12-kunda 18,0±0,5 tani tashkil etdi. Shu davrda nazorat guruhida esa *V. destructor* kanallari soni aksincha 33,0±0,1 tadan 35,0±0,4 tagacha ortib bordi.

15-kunga kelib tajriba guruhida kanalar soni 11,0±0,6 tagacha kamayib, preparatning davomli biologik ta'siri kuzatildi. 18-kunda mazkur ko'rsatkich 9,0±0,5 tani tashkil etgan bo'lsa, 21-kun yakunida atigi 6,0±0,1 ta kana qayd etildi. Bu boshlang'ich ko'rsatkichga nisbatan kanallarning soni 81,255% ga kamayganligini ko'rsatadi.

Nazorat guruhida esa 21 kun davomida kanalar soni 32,0±0,2 tadan 39,0±0,4 tagacha ortib, invaziyaning tabiiy rivojlanish dinamikasi saqlanib qolgan. Shunday qilib, tajriba natijalari kavrak damlamasining *Varroa destructor* ga qarshi yuqori biologik va terapevtik samaradorlikka ega ekanligini ko'rsatdi. Ayniqsa, preparat qo'llanilgandan keyingi 12-21-kunlar oralig'ida kanalar sonining jadal kamayishi uning davomli akaritsid ta'siriga ega

ni tashkil etib, umumiy terapevtik samaradorlik 82,9% ga yetdi. Shu bilan birga, ona arining tuxum qo'yish faolligi 1468 dona/kun, nasl maydoni 3590 sm² bo'lib, asalarilar nobud bo'lishi 4,1 dona/oila darajasida saqlangan va zaharlanish belgilari kuzatilmagan.

1:5 nisbatda umumiy terapevtik samaradorlik 86,5% gacha oshgan bo'lsa-da, bu 1:10 variantga nisbatan atigi 3,6 foiz punktlik qo'shimcha samaradorlikni ta'minladi. Biroq ayni vaqtda asalarilar nobud bo'lishi 9,6 dona/oilaga oshib, yengil zaharlanish belgilari paydo bo'lgan, ona arining tuxum qo'yishi va nasl maydoni esa 1:10 variantga nisbatan pasaygan. Shuning uchun 1:10 nisbatdagi kavrak damlamasi antiparazitar samaradorlik, asalari oilasining fiziologik barqarorligi va preparat xavfsizligi o'rtasidagi eng maqbul nisbatni ta'minlovchi variant sifatida baholandi.

Quyidagi 4-jadval ma'lumotlarining tahlili kavrak damlamasi *Varroa destructor* kanallari soniga sezilarli darajada kamaytiruvchi ta'sir ko'rsatganligini namoyon etdi. Tajriba boshlanishida har ikkala guruhda kanallarning o'rtacha soni bir xil, ya'ni 32,0±0,2 tani tashkil etgan bo'lib, bu guruhlarning dastlabki zararlanish darajasi o'zaro qiyoslanadigan holatda ekanligini ko'rsatadi. Kuzatuvning 3-kunida tajriba guruhida kanalar soni 29,0±1,0 tagacha kamaygan bo'lsa, nazorat guruhida ushbu ko'rsatkich o'zgarmagan holda 32,0±0,7 tani tashkil etdi.

ekanligini tasdiqlaydi. Mazkur natijalar kavrak damlamasidan varroatozga qarshi davolash va profilaktika tadbirlarida fitoterapevtik vosita sifatida foydalanish istiqbolli ekanligini ko'rsatadi.

Quyidagi 5-jadval ma'lumotlari 1:10 nisbatdagi kavrak damlamasining *Tropilaelaps clareae* kanallari soniga sezilarli kamaytiruvchi ta'sir ko'rsatganligini ko'rsatadi. Tajriba boshida tajriba guruhida kanalar soni 29,0±0,2 ta, nazorat guruhida esa 28,0±0,1 tani tashkil etib, boshlang'ich invaziya darajasi deyarli bir xil bo'lgan. Kuzatuvning 3-kunida tajriba guruhida kanalar soni 29,0±0,8 tani tashkil etgan bo'lsa, 6-kunga kelib 26,0±0,2 tagacha kamaygan.

9-kunda tajriba guruhida *T. clareae* kanallari soni 21,0±0,3 taga, 12-kunda 18,0±0,5 taga, 15-kunda esa 15,0±0,6 taga tushgan. 18-kunda ushbu ko'rsatkich 9,0±0,5 tani, 21-kun yakunida esa atigi 6,0±0,1 tani tashkil etgan. Demak, 21 kunlik kuzatuv davomida tajriba guruhida kanallarning boshlang'ich soniga nisbatan 79,3% ga kamayishi qayd etilgan.

5-jadval

Kavrak damlamasining *Tropilaelaps clareae* kanalari soniga ta'siri / **Table 5.** Effect of asafetida infusion on the number of *Tropilaelaps clareae* mites

Kunlar (tajriba davomiyligi)	Tajriba guruhi - 1:10 nisbatdagi kavrak damlamasi qo'llanilgan guruhdagi <i>Tropilaelaps clareae</i> kanalari soni (M±m)	Nazorat guruhi - ishlov berilmagan guruhdagi <i>Tropilaelaps clareae</i> kanalari soni (M±m)
Boshlanishi	29,0 ± 0,2	28,0 ± 0,1
3-kun	29,0 ± 0,8	30,0 ± 0,7
6-kun	26,0 ± 0,2	30,0 ± 0,1
9-kun	21,0 ± 0,3	31,0 ± 0,4
12-kun	18,0 ± 0,5	33,0 ± 0,4
15-kun	15,0 ± 0,6	35,0 ± 0,2
18-kun	9,0 ± 0,5	35,0 ± 0,1
21-kun	6,0 ± 0,1	37,0 ± 0,4

Demak, 21 kunlik kuzatuv davomida tajriba guruhida kanalarining boshlang'ich soniga nisbatan 79,3% ga kamayishi qayd etilgan.

Nazorat guruhida esa aksincha, kanalarining soni 28,0±0,1 tadan 37,0±0,4 tagacha oshgan bo'lib, *T.clareae* invaziyasining davom etishi va kuchayishi kuzatilgan. Tajriba va nazorat guruhlarida o'rtasidagi farq ayniqsa 12-21-kunlarda yaqqol namoyon bo'lgan. Olingan natijalar 1:10 nisbatdagi kavrak damlamasi *Tropilaelaps clareae* ga qarshi yuqori akaritsid faollikka ega ekanligini va uning ta'siri kuzatuv davri davomida izchil kuchayib borganligini ko'rsatadi (5-jadval).

5. XULOSALAR

Conclusions

1. Kavrak (*Ferula assa-foetida*) damlamasining turli konsentratsiyalari *Varroa destructor* va *Tropilaelaps clareae* kanalari invaziyasiga qarshi turlicha samaradorlik namoyon etishi aniqlandi. Xomashyo:suv nisbati 1:20 dan 1:5 gacha oshirilganda umumiy terapevtik samaradorlik 32,2% dan 86,5% gacha ko'tarildi.

2. Kavrak damlamasining 1:10 xomashyo:suv nisbati optimal variant sifatida belgilandi. Ushbu nisbatda *V. destructor* bo'yicha ekstensiv invaziya 84,5% ga, intensiv invaziya 82,8% ga, *T. clareae* bo'yicha esa tegishli ravishda 80,6% va 83,0% ga kamaydi. Parazitlarning nobud bo'lish darajasi 83,7%, umumiy terapevtik samaradorlik esa 82,9% ni tashkil etdi.

3. Kavrak damlamasining 1:10 nisbatda qo'llanilishi asalari oilalarining biologik va fiziologik ko'rsatkichlarini saqlash nuqtayi nazaridan maqbul natija berdi. Ona arining kunlik tuxum qo'yishi 1468 donaga, nasl maydoni 3590 sm² ga yetdi, asalarilar nobud bo'lishi 4,1 dona/oilani tashkil etdi va zaharlanish belgilari kuzatilmadi. Aksincha, 1:5 nisbatda asalarilar nobud bo'lishi 9,6 dona/oilaga yetib, yengil zaharlanish belgilari qayd etildi.

4. 21 kunlik kuzatuv natijalariga ko'ra, 1:10 nisbatdagi kavrak damlamasi qo'llanilgan tajriba guruhida *V. destructor* kanalari soni 32,0 tadan 6,0 tagacha, *T. clareae* kanalari soni esa 29,0 tadan 6,0 tagacha kamaydi. Bu boshlang'ich ko'rsatkichlarga nisbatan mos ravishda 81,3% va 79,3% kamayishni tashkil etdi. Nazorat guruhlarida esa kanalarining soni ortdi. Olingan natijalar kavrak damlamasining har ikki turdagi kanalarga qarshi istiqbolli fitoterapevtik vosita ekanligini ko'rsatadi.

DECLARATIONS

Declarations

Author contributions CRediT

Conceptualization; Methodology; Investigation; Data curation; Writing – original draft; Writing – review & editing. All authors have read and agreed to the published version of the manuscript.

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Ethics approval

The work with animals was carried out within routine veterinary diagnostic, treatment and preventive practice in accordance with the veterinary-sanitary requirements in force in the Republic of Uzbekistan.

Informed consent

All authors have read and approved the final version of the manuscript and have given their consent to its submission and publication. The study involved no human participants and no personal data.

Data availability statement

The data obtained in the study are presented in the tables and figure of this article; the primary records are available from the authors on reasonable request.

Conflict of interest

The authors declare no conflict of interest.

Generative AI disclosure

Generative AI (Claude, Anthropic) was used in the editorial preparation of this article: for language editing, translation of the title, abstract and keywords between Uzbek, Russian and English, preparation of the extended English summary from the authors' text, and formatting of the reference list. No data, results or conclusions were generated by AI. The authors are responsible for the content of the publication.

EXTENDED SUMMARY IN ENGLISH

Kengaytirilgan inglizcha xulosa / Расширенный реферат на английском языке

Purpose and research problem

Varroosis and tropilaelapsosis are important parasitic diseases that impair the health, development and productivity of honeybee colonies. Their causative agents, *Varroa destructor* and *Tropilaelaps clareae*, feed on the haemolymph of bees, weaken their physiological condition and disturb brood development, which leads to the weakening of colonies and reduced productivity. Long-term and repeated use of synthetic acaricides promotes resistance in the parasites and the accumulation of drug residues in bee products, so remedies based on medicinal plants that have acaricidal activity and are safe for bee colonies are being sought. Foreign and local studies have evaluated essential oils and medicinal plants against these mites, but the optimal concentrations of local phytopreparations and their safety for colonies require further study. The aim of the work was to evaluate the therapeutic and prophylactic efficacy of an aqueous infusion of asafetida (*Ferula assa-foetida* L.) against varroosis and tropilaelapsosis and to determine its optimal concentration.

Materials and methods

An aqueous infusion of dried and ground asafetida (*Ferula assa-foetida*) raw material was tested in honeybee colonies infested with *V. destructor* and *T. clareae*. In all experimental groups 25 g of raw material was used, and the amount of water was varied to obtain raw material:water ratios of 1:20 (500 ml), 1:15 (375 ml), 1:10 (250 ml) and

1:5 (125 ml); the control group received no treatment. The dose per colony was standardised at 50 ml, corresponding to 2.5, 3.33, 5.0 and 10.0 g of raw material, respectively, so that the groups differed only in the amount of plant material applied. The infusion was sprayed between the honeycomb frames three times at 7-day intervals: the mites are located mainly on the body surface of worker bees and in brood cells, and fine droplets ensured an even distribution over the bees and inside the nest. Before each treatment and during the subsequent observation periods, the general condition of the colonies, worker activity, the egg-laying intensity of the queen, the brood area, the number of parasites, bee mortality and signs of poisoning or other adverse reactions were recorded. Therapeutic efficacy was assessed from the reduction of the extensity (EI) and intensity (II) of invasion for both mite species, the mortality of the parasites and the overall therapeutic efficacy, and the dynamics of mite numbers were followed for 21 days in the group treated with the 1:10 infusion and in the untreated control group.

Results and discussion

The efficacy of the infusion increased with its concentration. The reduction of *V. destructor* EI was 34.8%, 57.6%, 84.5% and 88.3% at ratios of 1:20, 1:15, 1:10 and 1:5, and the reduction of II was 31.5%, 55.2%, 82.8% and 87.4%, respectively; for *T. clareae* the reduction of EI was 29.7%, 52.8%, 80.6% and 84.5%, and of II 28.9%, 51.6%, 83.0% and 84.9%. Parasite mortality reached 36.2%, 59.4%, 83.7% and 87.5%, and the overall therapeutic efficacy was 32.2%, 55.3%, 82.9% and 86.5%. The largest gain occurred between the 1:15 and 1:10 ratios, whereas moving from 1:10 to 1:5 added only 3.6–4.6 percentage points. The physiological state of the colonies remained close to that of the control at ratios up to 1:10: the queen laid 1420, 1445, 1468 and 1438 eggs per day and the brood area was 3420, 3510, 3590 and 3470 cm² at the four ratios. Bee mortality was 3.2, 3.8 and 4.1 bees per colony at 1:20, 1:15 and 1:10 without signs of poisoning, but rose to 9.6 bees per colony with mild signs of poisoning at 1:5. During the 21-day observation, the number of *V. destructor* mites in the group treated with the 1:10 infusion decreased from 32.0 ± 0.2 to 6.0 ± 0.1 (by 81.3%), while in the control group it increased from 32.0 ± 0.2 to 39.0 ± 0.4 ; the number of *T. clareae* mites decreased from 29.0 ± 0.2 to 6.0 ± 0.1 (by 79.3%), whereas in the control group it rose from 28.0 ± 0.1 to 37.0 ± 0.4 . The difference between the groups was most pronounced on days 12–21, indicating a prolonged acaricidal effect of the infusion.

Conclusion and contribution

Different concentrations of *Ferula assa-foetida* infusion showed different efficacy against *V. destructor* and *T. clareae*, and increasing the raw material:water ratio from 1:20 to 1:5 raised the overall therapeutic efficacy from 32.2% to 86.5%. The 1:10 ratio was identified as optimal: it reduced the extensity and intensity of *V. destructor* invasion by 84.5% and 82.8% and those of *T. clareae* by 80.6% and 83.0%, with 83.7% parasite mortality and 82.9% overall therapeutic efficacy, while preserving the biological and physiological indicators of the colonies (1468 eggs per day, a brood area of 3590 cm², bee mortality of 4.1 per colony and no signs of poisoning). The 1:5 ratio gave only slightly higher efficacy, but bee mortality more than doubled and mild signs of poisoning appeared. Over 21 days the 1:10 infusion reduced the numbers of *V. destructor* and *T. clareae* by 81.3% and 79.3%, whereas mite numbers increased in the control groups, which shows that *assafoetida* infusion is a promising phytotherapeutic agent against both mite species.

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Epizootological significance of the lesser mealworm *Alphitobius diaperinus* and modern methods of its control (a case study of a poultry farm)

Alphitobius diaperinus – zararkunanda qora qo'ng'izlarning epizootologik ahamiyati va ularga qarshi kurashishning zamonaviy usullari (parrandachilik fabrikasi misolida)

Эпизоотологическое значение малого мучного хрущака *Alphitobius diaperinus* и современные методы борьбы с ним (на примере птицефабрики)

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Abstract. The article analyzes the population density, bio-morphological characteristics, and economic-structural damages caused by the lesser mealworm (*Alphitobius diaperinus*) in commercial poultry houses. The epizootological role of this pest as a reservoir and vector for dangerous avian pathogens (*Salmonella*, *Escherichia coli*, and various viruses) is evaluated. The high efficacy (92-96%) of integrated pest management is demonstrated by monitoring population dynamics using advanced traps (Arends tube, pheromone, and corrugated cardboard traps) and applying the synthetic pyrethroid cypermethrin via the spraying method during the downtime (inter-flock) periods.

Keywords: *Alphitobius diaperinus*; poultry production; zoo-hygiene; epizootology; *Salmonella*; cypermethrin; monitoring; Arends trap; feed conversion

O'ZBEKCHA

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Annotatsiya. Maqolada parrandachilik xo'jaliklarida keng tarqalgan zararkunanda — kichik qora qo'ng'iz (*Alphitobius diaperinus*) populyatsiyasining zichligi, uning bio-morfologik xususiyatlari hamda parrandachilik korxonalariga keltiradigan iqtisodiy-strukturaviy zararlari tahlil qilingan. Shuningdek, hasharotning parrandalar o'rtasida xavfli infeksiyalar (*Salmonella*, *E. coli*, viruslar) tarqalishidagi epizootologik roli o'rganilgan. Zararkunanda populyatsiyasini zamonaviy tuzoqlar (Arends, feromonli va kartonli) yordamida monitoring qilish hamda unga qarshi kimyoviy kurashda sintetik piretroid — sipermetrin moddasini texnologik tanaffus davrida purkash usuli bilan qo'llashning yuqori samaradorligi (92-96%) asoslab berilgan.

Kalit so'zlar: *Alphitobius diaperinus*; parrandachilik; zoogigiyena; epizootologiya; *Salmonella*; sipermetrin; monitoring; Arends tuzog'i; ozuqa konversiyasi

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РУССКИЙ

АХМАДАЛИЕВ Нурмухаммад Турсуналиевич^{1*} , ХУШНАЗАРОВА Мохигул Илхомовна² , ХУШНАЗАРОВ Алишер Худойбердиевич³ 

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Аннотация. В статье анализируются плотность популяции, биоморфологические особенности и экономико-структурный ущерб, наносимый малым мучным хрущакom (*Alphitobius diaperinus*) в птицеводческих хозяйствах. Изучена эпизоотологическая роль насекомого как резервуара и переносчика опасных инфекций птиц (*Salmonella*, *E. coli*, вирусы). Обоснована высокая эффективность (92-96%) комплексного контроля вредителя путем еженедельного мониторинга с помощью современных ловушек (трубчатые ловушки Арендса, феромонные и картонные ловушки) и применения синтетического пиретроида циперметрина методом опрыскивания в период технологического перерыва.

Ключевые слова: *Alphitobius diaperinus*; птицеводство; зоогигиена; эпизоотология; сальмонелла; циперметрин; мониторинг; ловушка Арендса; конверсия корма

1. KIRISH

Introduction

Parrandachilik sanoati global oziq-ovqat xavfsizligini ta'minlashda yetakchi tarmoqlardan biri hisoblanadi. Biroq, parrandaxonalardagi mikroiklim sharoitlari nafaqat qushlar, balki turli zararkunanda hasharotlarning ko'payishi uchun ham qulay muhit yaratadi. Ular orasida eng keng tarqalgan va iqtisodiy jihatdan jiddiy zarar keltiradigan ob'ekt — kichik qora qo'ng'iz (*Alphitobius diaperinus*) hisoblanadi. Ushbu hasharot asosan broyler yetishtirishga ixtisoslashgan xo'jalik binolarida ommaviy ko'payib, parrandachilik sanoatiga ko'p tomonlama zarar yetkazadi.

Alphitobius diaperinus parrandaxonalarda nafaqat strukturaviy buzilishlarni keltirib chiqaradi, balki parrandalarning salomatligi va mahsuldorligiga to'g'ridan-to'g'ri salbiy ta'sir ko'rsatadi. Uning lichinkalari g'umbakka aylanish jarayonida binoning issiqlik izolyatsiya materiallarini (penoplast va yog'och konstruksiyalar) teshib, vayron qiladi. Natijada, xonalarni shamollatish va isitish xarajatlari keskin ortadi. Eng xavfli, ushbu qo'ng'izlar parrandachilikda epizootologik jarayonning zanjiri bo'lib xizmat qiladi.

Ular parrandalar uchun o'ta xavfli bo'lgan virusli (Marek, Gumboro, parranda grippi, reovirus), bakterial (*Salmonella typhimurium*, *Escherichia coli*, *Campylobacter spp.*), zamburug'li (*Aspergillus spp.*) patogenlarni hamda gelmint tuxumlari va koksidiyalar oraliq xo'jayini sifatida saqlaydi va tashiydi. Jo'jalarning ushbu hasharotlar bilan oziqlanishi ularning ozuqa konversiyasini yomonlashtiradi, hazm tizimini jarohatlaydi va o'sishdan ortda qoldiradi.

1.1. Tadqiqotning maqsadi

Parrandachilik xo'jaliklarida *Alphitobius diaperinus* populyatsiyasining zichligini zamonaviy monitoring usullari yordamida baholash hamda ularga qarshi kurashda sipermetrin faol moddali insektitsidni qo'llash samaradorligini o'rganish.

2. METODLAR

Methods

Tadqiqotlar parrandachilik fabrikasining broyler yetishtirish sexlarida (30°C optimal va 20°C minimal haroratli sharoitlarda) o'tkazildi. Zararkunanda qo'ng'izlarning hayot sikli, biologik xususiyatlari va populyatsiya zichligi laboratoriya va dala sharoitida kuzatildi.

2.1. Monitoring va tuzoqlar tizimi

Qo'ng'izlar sonini aniqlash va ommaviy bosqin darajasini baholash uchun quyidagi zamonaviy monitoring vositalaridan foydalanildi:

Gofrirovka qilingan kartonli tuzoqlar: Qo'ng'izlarning tirqishlar orasiga panoh izlab kirish instinktiga asoslangan holda o'rnatildi.

Arends trubkali tuzog'i (Arends tube trap): PVC quvur bo'lagi ichiga o'ralgan karton qog'ozli qurilmalar broyler xonalarning burchaklari va to'shamalari (litter) ustiga 1 hafta muddatga joylashtirildi.

Feromonli tuzoqlar: Sintetik to'planish feromonlari qo'llanilgan chuqurchasimon (*pitfall traps*) tuzoqlar yordamida hasharotlar jalb qilindi.

2.2. Kimyoviy kurash usuli (sipermetrin qo'llanilishi)

Zararkunandalar soni iqtisodiy zarar yetkazish mezonidan oshganda, ularga qarshi kimyoviy kurash usuli qo'llanildi. Buning uchun keng ta'sir doirasiga ega bo'lgan sintetik piretroidlar guruhiga mansub sipermetrin faol moddali insektitsid tanlab olindi. Ishchi eritma yo'riqnomaga muvofiq tayyorlanib, parrandaxona bo'shatilgandan so'ng (texnologik tanaffus davrida), bino devorlari, pol, to'shama qoldiqlari hamda darz va tirqishlarga purkash usulida ishlov berildi.

3. NATIJALAR

Results

O'tkazilgan kuzatuvlar shuni ko'rsatdiki, *Alphitobius diaperinus* to'liq metamorfoz orqali rivojlanadi va uning rivojlanish tezligi atrof-muhit haroratiga to'g'ridan-to'g'ri bog'liq (1-jadval).

1-jadval

Haroratning A. diaperinus rivojlanish davrlariga ta'siri / **Table 1.** Effect of temperature on the developmental stages of A. diaperinus

Harorat (°C)	Rivojlanish bosqichi xususiyatlari	To'liq sikl davomiyligi (kun)
30 °C (Optimal)	Lichinka 8–11 yosh bosqichidan o'tadi. Uzunligi 11 mm gacha yetadi. Bosqichlararo davr — 2 kun.	34 – 38 kun
20 °C (Minimal)	O'sish va rivojlanish keskin sekinlashadi.	165 kungacha
< 20 °C	Rivojlanish butunlay to'xtaydi.	Rivojlanmaydi

3.1. Ko'payish ko'rsatkichlari va oziqlanish xarakteri

Urg'ochi qo'ng'izlarning hayot davomiyligi 4 oydan 1 yilgacha yetishi aniqlandi. Ular kuniga o'rtacha 3,5 ta tuxum qo'yadi. Hayoti davomida tabiiy sharoitda 200–400 tagacha, laboratoriyada esa 2000 tagacha tuxum qo'yishi tasdiqlandi. Oziq-ovqat tanqis bo'lganda populyatsiyada kannibalizm (turdoshlarini yeyish) va agressiv yirtqichlik (kichik umurtqalilarga jamoaviy hujum qilish) kuzatildi.

3.2. Epizootologik ahamiyat va kimyoviy ishlov samaradorligi

Bakteriologik tahlillar natijasida qo'ng'izlar organizmida patogenlarning uzoq muddat saqlanishi tasdiqlandi. Xususan, *Salmonella* bakteriyalari qo'ng'iz ichagida 5 haftadan ortiq vaqt davomida faol hayotchanligini yo'qotmadi.

Parrandaxona binolariga sipermetrin bilan ishlov berilgandan so'ng, imago (voyaga yetgan qo'ng'izlar) va lichinkalar populyatsiyasining o'lim ko'rsatkichi dastlabki 24–48 soat ichida yuqori samaradorlikni (92–96%) ko'rsatdi. Sipermetrinning o'tkir kontakt va ichak orqali ta'sir etish xususiyati tufayli, yashirin joylardan sirtga chiqqan zararkunandalar to'liq zararsizlantirildi.

4. MUHOKAMA

Discussion

Tadqiqot natijalari shuni ko'rsatdiki, *Alphitobius diaperinus* parrandachilik iqtisodiyotiga va bioxavfsizligiga global tahdid soluvchi biologik vektordir. Jo'jalar (ayniqsa 1–5 kunlik) to'shamadagi qo'ng'izlarni yuqori ishtiyoq bilan iste'mol qiladi, biroq ularning qattiq xitin qobig'ini hazm qila olmaydi. Bu ichak yallig'lanishiga (enterit) va ozuqa konversiyasining buzilishiga olib keladi. Bizning hisob-kitoblarimiz va xalqaro modellarga ko'ra, har 100,000 bosh broyler uchun ozuqa samaradorligi pasayishi hisobiga \$2,649 dan \$4,262 gacha to'g'ridan-to'g'ri moliyaviy zarar ko'riladi.

Bu zararkunandani parrandachilik binosidan butunlay yo'q qilish amalda imkonsiz, chunki dezinfeksiya paytida ular izolyatsiya materiallari va pol ostidagi chuqur qatlamlarga yashirinadi. Shuning uchun ham zamonaviy strategiyada kimyoviy preparatlarni to'g'ri tanlash va almashlab qo'llash (rotatsiya) muhim rol o'ynaydi.

Bizning tadqiqotimizda qo'llanilgan sipermetrin o'zining uzoq muddatli qoldiq ta'sir qilish (residual) xususiyati bilan ajralib turadi. Binoni yangi partiya jo'jalar kelishiga tayyorlash jarayonida (texnologik tanaffusda) sipermetrin bilan tizimli ishlov berish bino devorlari va pollardagi patogen tashuvchi qo'ng'izlar zanjirini uzishga imkon beradi. Tuzoqlar (Arends trubkasi va kartonli tizimlar) yordamida haftalik monitoring o'tkazish esa fermerlarga sipemetrinni maqsadsiz sepavermasdan, faqat populyatsiya me'yordan oshganda qo'llash orqali iqtisodiy tejamkorlikka erishish imkonini beradi.

5. XULOSA

Conclusion

1. *Alphitobius diaperinus* parrandachilik korxonalarida yuqori hayotchanlik va ko'payish potentsialiga ega bo'lib, 30°C haroratda 34–38 kunda to'liq siklni yakunlaydi.

2. Hasharot parrandalar o'rtasida *Salmonella*, *E. coli* va turli virusli infeksiyalarni tanaffus davrlarida ham saqlab beruvchi xavfli rezervuardir.

3. Zararkunandaga qarshi kurashda uni tizimli monitoring qilish va populyatsiya ommaviy ko'paygan davrda sipermetrin faol moddali preparatlar bilan texnologik tanaffus paytida ishlov berish yuqori epizootologik va iqtisodiy samaradorlikni ta'minlaydi.

DECLARATIONS

Declarations

Author contributions CRediT

Conceptualization; Methodology; Investigation; Data curation; Writing – original draft; Writing – review & editing. All authors have read and agreed to the published version of the manuscript.

Funding

This research received no external funding.

Ethics approval

The work was carried out within routine veterinary-sanitary and pest control practice on a poultry farm in accordance with the veterinary-sanitary requirements in force in the Republic of Uzbekistan; no experiments on vertebrate animals were performed.

Informed consent

All authors have read and approved the final version of the manuscript and have given their consent to its submission and publication. The study involved no human participants and no personal data.

Data availability statement

The data obtained in the study are presented in the text and table of this article; the primary records are available from the authors on reasonable request.

Conflict of interest

The authors declare no conflict of interest.

Generative AI disclosure

Generative AI (Claude, Anthropic) was used in the editorial preparation of this article: for language editing, translation of the title, abstract and keywords between Uzbek, Russian and English, preparation of the extended English summary from the authors' text, and formatting of the reference list. No data, results or conclusions were generated by AI. The authors are responsible for the content of the publication.

EXTENDED SUMMARY IN ENGLISH

Kengaytirilgan inglizcha xulosa / Расширенный реферат на английском языке

Purpose and research problem

The poultry industry is one of the leading branches ensuring global food security, but the microclimate of poultry houses creates favourable conditions not only for birds but also for the reproduction of insect pests. The most widespread and economically damaging of them is the lesser mealworm (*Alphitobius diaperinus*), which multiplies massively in broiler houses. Its larvae bore into and destroy the thermal insulation of buildings (polystyrene foam and wooden structures) during pupation, which sharply increases ventilation and heating costs. More importantly, the beetles act as a link in the epizootic process: they harbour and carry viral (Marek's disease, Gumboro disease, avian influenza, reovirus), bacterial (*Salmonella* Typhimurium, *Escherichia coli*, *Campylobacter* spp.) and fungal (*Aspergillus* spp.) pathogens and serve as intermediate hosts of helminths and coccidia, while chicks that feed on them show impaired feed conversion, digestive injuries and growth retardation. The aim of the study was to assess the population density of *A. diaperinus* in poultry farms using modern monitoring methods and to study the efficacy of a cypermethrin-based insecticide against it.

Materials and methods

The studies were carried out in the broiler-rearing houses of a poultry farm under optimal (30 °C) and minimal (20 °C) temperature conditions, and the life cycle, biological characteristics and population density of the beetles were observed in laboratory and field conditions. To determine the number of beetles and the level of mass infestation, corrugated cardboard traps exploiting the beetles' instinct to shelter in crevices, Arends tube traps (rolled cardboard inside a section of PVC pipe placed for one week in the corners of broiler houses and on the litter) and pitfall traps baited with synthetic aggregation pheromones were used. When the pest numbers exceeded the economic damage threshold, chemical control was applied with a broad-spectrum insecticide based on the synthetic pyrethroid cypermethrin: the working solution was prepared according to the instructions and, after the house

had been emptied (during the technological break between flocks), the walls, floor, litter residues, cracks and crevices were sprayed.

Results and discussion

A. diaperinus develops by complete metamorphosis, and its rate of development depends directly on the ambient temperature. At 30 °C the larva passes through 8–11 instars, reaches up to 11 mm in length with an interval of 2 days between instars, and the full cycle takes 34–38 days; at 20 °C growth and development slow down sharply and the cycle lasts up to 165 days, and below 20 °C development stops. Females live from 4 months to 1 year and lay on average 3.5 eggs per day, up to 200–400 eggs in natural conditions and up to 2000 in the laboratory; when food is scarce, cannibalism and aggressive predation (collective attacks on small vertebrates) occur. Bacteriological analyses confirmed long-term persistence of pathogens in the beetles: *Salmonella* remained viable in the beetle gut for more than 5 weeks. After treatment of the poultry houses with cypermethrin, the mortality of adults and larvae reached 92–96% within the first 24–48 hours, and pests emerging from hiding places were completely neutralised owing to the contact and intestinal action of the insecticide. Chicks, especially 1–5 days old, readily eat beetles from the litter but cannot digest their hard chitinous cover, which leads to enteritis and impaired feed conversion; according to the authors' calculations and international models, the resulting direct financial loss amounts to USD 2,649–4,262 per 100,000 broilers.

Conclusion and contribution

A. diaperinus has high viability and reproductive potential in poultry enterprises and completes its full cycle in 34–38 days at 30 °C. The insect is a dangerous reservoir that maintains *Salmonella*, *E. coli* and various viral infections among poultry even during the breaks between flocks. Complete elimination of the pest from poultry buildings is practically impossible because during disinfection the beetles hide in insulation materials and deep layers under the floor, so the correct choice and rotation of chemical preparations are important. Systematic monitoring of the pest with Arends tube and cardboard traps and treatment with cypermethrin-based preparations during the technological break, when the population increases massively, ensure high epizootological and economic efficiency and allow the insecticide to be applied only when the population exceeds the threshold.

ADABIYOTLAR RO'YXATI

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RESEARCH ARTICLE • PEER-REVIEWED • OPEN ACCESS • **SERIES C** • HAC/OAK 16.00.00 — VETERINARY SCIENCES • UDC: 638.15:615.32:615.9

Comparative efficacy of chemical and phytopreparations against invasive diseases of honey bees and a scientifically justified optimal scheme of treatment and prevention

Asalarilar invazion kasalliklarida kimyoviy va fitopreparatlarning qiyosiy samaradorligi hamda davolash-profilaktika tadbirlarining ilmiy asoslangan optimal sxemasi

Сравнительная эффективность химических препаратов и фитопрепаратов при инвазионных болезнях пчёл и научно обоснованная оптимальная схема лечебно-профилактических мероприятий

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AUTHOR, TITLE AND ABSTRACT METADATA (EN / UZ / RU)

ENGLISH

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Abstract. This article presents a comparative evaluation of the therapeutic efficacy of the chemical preparations Bipin-T and Flutsin and an infusion of asafoetida (*Ferula assa-foetida*) against varroosis and tropilaelapsosis in honey bees. Based on changes in the number of Varroa destructor and Tropilaelaps mites, the acaricidal activity, specific effects, and potential application of the preparations in therapeutic and preventive measures were analyzed. Taking into account the advantages and limitations of chemical acaricides and the phytopreparation, scientifically justified approaches to an integrated treatment and prevention scheme for invasive diseases of honey bees are presented.

Keywords: honey bees; varroosis; tropilaelapsosis; Varroa destructor; Tropilaelaps clareae; Bipin-T; Flutsin; asafoetida; phytopreparation; comparative efficacy; acaricidal activity; treatment and prevention; scheme

O'ZBEKCHA

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Annotatsiya. Ushbu maqolada asalarilarning varroatoz va trapilelapsoz kasalliklariga qarshi kimyoviy preparatlar - Bipin-T va Flutsin hamda kavrak (*Ferula assa-foetida*) damlamasining terapevtik samaradorligi qiyosiy baholandi. Varroa destructor va Tropilaelaps kanalari sonining o'zgarishi asosida preparatlarning akaritsid faolligi, ta'sir xususiyatlari va davolash-profilaktika tadbirlarida qo'llash imkoniyatlari tahlil qilingan. Kimyoviy akaritsidlar va fitopreparatning afzalliklari hamda cheklovlarini hisobga olgan holda, asalarilar invazion kasalliklariga qarshi kurashishning ilmiy asoslangan kompleks davolash-profilaktika sxemasi haqida ma'lumotlar keltirilgan.

Kalit so'zlar: asalarilar; varroatoz; trapilelapsoz; Varroa destructor; Tropilaelaps clareae; Bipin-T; Flutsin; kavrak; fitopreparat; qiyosiy samaradorlik; akaritsid faollik; davolash-profilaktika; sxema

РУССКИЙ

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Аннотация. В статье проведена сравнительная оценка терапевтической эффективности химических препаратов Бипин-Т и Флуцин, а также настоя каврака (*Ferula assa-foetida*) при варроатозе и тропилелапозе пчёл. На основании изменения численности клещей *Varroa destructor* и *Tropilaelaps* проанализированы акарицидная активность препаратов, особенности их действия и возможности применения в лечебно-профилактических мероприятиях. С учётом преимуществ и ограничений химических акарицидов и фитопрепарата представлены научно обоснованные подходы к комплексной системе лечебно-профилактических мероприятий против инвазионных болезней пчёл.

Ключевые слова: пчёлы; варроатоз; тропилелапоз; *Varroa destructor*; *Tropilaelaps clareae*; Бипин-Т; Флуцин; каврак; фитопрепарат; сравнительная эффективность; акарицидная активность; лечебно-профилактические мероприятия; схема

1. KIRISH

Introduction

Asalarilarning varroatoz va trapilelapsoz invazion kasalliklari asalarichilik tarmog'ining samaradorligi, asalari oilalarining hayotchanligi va mahsuldorligiga salbiy ta'sir ko'rsatuvchi muhim muammolardan hisoblanadi. Ushbu kasalliklarga qarshi kurashishda kimyoviy akaritsidlar keng qo'llanilsa-da, ularning samaradorligi, qo'llash davomiyligi va xavfsizligini hisobga olgan holda muqobil fitopreparatlarni o'rganish dolzarb ahamiyatga ega. Shu jihatdan, Bipin-T va Flutsin preparatlari hamda kavrak (*Ferula assa-foetida*) damlamasining *Varroa destructor* va *Tropilaelaps* kanalari soniga ta'sirini qiyosiy baholash, ularning terapevtik samaradorligi va qo'llash imkoniyatlarini aniqlash muhim ilmiy-amaliy vazifa hisoblanadi. Tadqiqotning maqsadi kimyoviy akaritsidlar va kavrak asosidagi fitopreparatning samaradorligini o'zaro taqqoslash hamda asalari invazion kasalliklariga qarshi ilmiy asoslangan davolash-profilaktika sxemasini ishlab chiqishdan iborat.

2. MUAMMONING O'RGANILGANLIK DARAJASI

Literature review

Olimlar tajriba davomida oksalat kislotasi, timol va neem (*Azadirachta indica*) ekstrakti asosidagi preparatlarning samaradorligini taqqoslagan. Oksalat kislotasi qo'llangan koloniyalarda davolashdan keyingi 21 kun davomida *Varroa* soni 92,1 foizga kamaygan. Timol preparati bilan ishlov berilgan oilalarda samaradorlik 84,6 foizni, neem ekstrakti qo'llangan guruhlarda esa 73,8 foizni tashkil qilgan. Tadqiqot davomida Fitopreparatlar sintetik akaritsidlarga nisbatan sekinroq ta'sir ko'rsatishi aniqlangan, biroq ular asal tarkibida zararli qoldiq moddalar hosil qilmasligi va asalari oilalari uchun xavfsizligi bilan ajralib turgan. Mualliflarning kuzatuvlariga ko'ra, *Varroa* bilan kuchli zararlangan koloniyalarda brood maydoni 21,3 foizga, asal mahsuldorligi esa 19,7 foizga kamaygan [1]. Olimlar *Thymus saturoideus* va *Origanum elongatum* o'simliklari efir moylarining kimyoviy tarkibi hamda *V. destructor* ga qarshi akaritsid xususiyatlarini o'rganagan. Tadqiqotda ushbu moylarning asalari uyasida fumigatsiya usulida qo'llanganda samarali ta'sir ko'rsatishi aniqlangan. Ayniqsa, tarkibida karvakrol ko'p bo'lgan efir moyining fumigant ta'siri yuqoriroq bo'lgan. Ushbu natijalar mahalliy dorivor o'simliklardan olinadigan biologik faol moddalarni varroatozga qarshi vositalar yaratishda o'rganish muhimligini ko'rsatadi [5].

Italiyalik olim Giuseppe Pietropaoli va hamkorlari asalari oilalarida *Varroa destructor* ga qarshi organik kislotalardan foydalanish samaradorligini o'rganagan. Tadqiqotlar asosan Italiya hududidagi tijorat va havaskor asalarichilik xo'jaliklarida olib borilgan. Mualliflar oksalat kislotasining turli qo'llash usullarini - tomchilash, purkash va sublimatsiya usullarini taqqoslaganlar. Tadqiqot natijalarida oksalat kislotasi ayniqsa brood mavjud bo'lmagan davrda qo'llanganda yuqori akaritsid ta'sir ko'rsatishi aniqlangan.

Sublimatsiya usulida kanalarning nobud bo'lish darajasi ayrim tajriba guruhlarida 95 % dan yuqori bo'lgan. Tomchilash usuli esa amaliy jihatdan qulayligi bilan ajralib turgan, ammo takroriy qo'llash talab qilingan.

Mualliflar oksalat kislotasining asosiy afzalligi sifatida: asal tarkibida uzoq muddatli qoldiq hosil qilmasligi; arilar uchun nisbatan xavfsizligi; ekologik tozaligi; rezistentlik rivojlanish ehtimoli pastligini ko'rsatganlar [4].

Olimning "Средства неспецифической профилактики варроатоза пчёл на основе растительного сырья и научные основы их применения" mavzusidagi dissertatsiyasida varroatozga qarshi o'simlik xomashyosidan foydalanishning ilmiy asoslari o'rganilgan. Tadqiqotda achchiq shuvoq (*Artemisia absinthium*) va qarag'ay kurtaklari asosida tayyorlangan KAS-81 preparatining terapevtik-profilaktik xususiyatlari baholangan. Muallif ma'lumotlariga ko'ra, preparatni oziqlantirish orqali qo'llash asalari oilalarining kanalarga zararlanish darajasini kamaytirishga yordam bergan. Ishda preparatning asalari oilalarining qishlashi, nasl rivojlanishi va hayotchanligiga ta'siri ham o'rganilgan [7]. Tadqiqot Hindistonning Himachal-Pradesh shtatidagi Kangra vodiysi va Rajasthan hududlarida *Tropilaelaps clareae* bilan zararlangan asalari oilalarida olib borilgan. Uch marta ishlov berilgandan so'ng, kekik (*Thymus vulgaris*) moyi nasldagi zararlanishni 42,33% dan 2,00% gacha kamaytirgan, ya'ni 94,83% samaradorlik qayd etilgan. Evkalipt (*Eucalyptus globulus*) moyi qo'llangan guruhda zararlanish 3,00% gacha tushib, 91,36% kamayish kuzatilgan. Ish ushbu ikki o'simlik moyining trapilelapsozga qarshi istiqbolli ekanligini ko'rsatadi [2]. Mualliflar *V. destructor* va *T. clareae* bilan birgalikda zararlangan *Apis mellifera* oilalarida kekik, evkalipt, qalampirunchoq va limon o'ti (lemongrass) efir moylarini laboratoriya hamda dala sharoitida tekshirgan. *T. clareae* ga qarshi nisbiy samaradorlik kekik moyida 81,70%, qalampirunchoq moyida 76,95%, evkalipt moyida 74,53% va limon o'ti moyida 69,74% bo'lgan. Kekik moyi eng yuqori natijani ko'rsatgan; uning qo'llanilishi nasl maydonining sezilarli oshishi bilan ham bog'langan [6].

Mualliflar *Tropilaelaps mercedesae* biologiyasi, tarqalishi va unga qarshi kurash usullarini umumlashtirgan sharh maqola tayyorlagan. Unda timol, limonen va limon o'ti moyi kabi o'simliklardan olinadigan birikmalarning akaritsid imkoniyatlari yoritilgan. Shu bilan birga, laboratoriyada kuzatilgan ta'sir har doim ham dala sharoitida takrorlanmasligi, optimal konsentratsiya va qo'llash usullarini yanada takomillashtirish zarurligi ta'kidlangan [3].

Xulosa qilib aytganda, xorijiy va mahalliy tadqiqotchilar tomonidan olib borilgan tadqiqotlar asalari invazion kasalliklariga qarshi kimyoviy akaritsidlar, organik kislotalar va dorivor o'simliklar asosidagi fitopreparatlarning samaradorligini tasdiqlaydi. Biroq ularning ta'sir tezligi, xavfsizligi va qo'llash sharoitlari o'zaro farqlanadi. Shu sababli kimyoviy preparatlar va fitopreparatlarning qiyosiy samaradorligini baholash, optimal dozalar hamda qo'llash muddatlarini belgilash asosida ilmiy

asoslangan davolash-profilaktika sxemasini ishlab chiqish muhim ilmiy-amaliy ahamiyatga ega.

3. MATERIALLAR VA TADQIQOT USULLARI

Tadqiqotlar davomida asalarilarning invazion kasalliklari - varroatoz va trapilelapsozga qarshi qo'llaniladigan kimyoviy preparatlar hamda dorivor o'simliklar asosidagi fitopreparatlarning terapevtik va profilaktik samaradorligi qiyosiy o'rganildi. Bunda kavrak (Ferula assa-foetida) o'simligidan tayyorlangan suvli damlamaning akaritsid faolligi, kimyoviy akaritsidlar bilan taqqoslagandagi samaradorligi hamda asalari oilalari uchun xavfsizligi baholandi.

Preparatlar asalari oilalariga romlar oralig'iga purkash usulida qo'llanildi. Tadqiqotlarda parazitlar bilan zararlanish darajasining o'zgarishi, preparatlarning terapevtik ta'siri, asalari oilalarining fiziologik holati va nasl rivojlanishiga ta'siri asosiy baholash

1-jadval

Kimyoviy va fitopreparatlarning Varroa destructor kanalari soniga qiyosiy ta'siri / **Table 1.** Comparative effect of chemical preparations and phytopreparations on the number of Varroa destructor mites

№	Preparat	Preparat konsentratsiyasi / dozasi	Tajriba davomiyligi, kun	Boshlang'ich kanalar soni, dona (M±m)	Yakuniy kanalar soni, dona (M±m)	Kanalar sonining kamayishi, %	Nazorat guruhida yakuniy ko'rsatkich, dona (M±m)
1	Bipin-T	Tajriba dozasi	14	34,0±0,5	3,0±0,6	91,2	38,0±0,3
2	Flutsin	Tajriba dozasi	21	35,0±0,2	4,0±0,6	88,6	39,0±0,4
3	Kavrak damlamasi	Tajriba dozasi	21	32,0±0,2	6,0±0,1	81,2	39,0±0,4

Yuqoridagi jadval ma'lumotlari kimyoviy va Fitopreparatlarning Varroa destructor kanalari soniga yuqori darajada ta'sir ko'rsatganligini ko'rsatadi. Tajriba boshida barcha guruhlarda kanalar soni nisbatan yaqin bo'lib, Bipin-T guruhida 34,0±0,5, Flutsin guruhida 35,0±0,2 va kavrak damlamasi guruhida 32,0±0,2 donani tashkil etgan. Kuzatuv yakunida kanalar soni mos ravishda 3,0±0,6; 4,0±0,6 va 6,0±0,1 donagacha kamaygan. Hisob-kitoblarga ko'ra, kanalar sonining eng yuqori kamayishi Bipin-T guruhida 91,2% va Flutsin guruhida 88,6% va 15% li kavrak damlamasi qo'llanilgan guruhda 81,2%, ni tashkil etdi.

Demak, berilgan tajriba sharoitida kavrak damlamasi Flutsinga nisbatan 5,2 foiz punkt, Bipin-Tga nisbatan esa 2,6 foiz punkt yuqori natija ko'rsatgan. Nazorat guruhlarida esa 14-21 kun davomida kanalar sonining kamayishi kuzatilmagan, aksincha, ularning soni 38,0-39,0 donagacha oshgan. Bu holat tajriba guruhlaridagi ijobiy o'zgarishlar preparatlarning akaritsid ta'siri bilan bog'liqligini ko'rsatadi.

2-jadval ma'lumotlari kimyoviy va Fitopreparatlarning Tropilaelaps kanalari soniga sezilarli akaritsid ta'sir ko'rsatganligini ko'rsatadi.

Tajriba boshida kanalar soni Bipin-T guruhida 32,0±0,3, Flutsin guruhida 28,0±0,2 va kavrak damlamasi guruhida 29,0±0,2 donani tashkil etgan. Kuzatuv yakunida ushbu ko'rsatkichlar mos ravishda 5,0±0,6; 3,0±0,1 va 6,0±0,1 donagacha kamaygan. Hisoblangan kamayish darajasi Flutsin guruhida 89,3%, 15% li kavrak damlamasi guruhida 79,3%, Bipin-T guruhida esa 84,3% ni tashkil

2-jadval

Kimyoviy va fitopreparatlarning Tropilaelaps kanalari soniga qiyosiy ta'siri / **Table 2.** Comparative effect of chemical preparations and phytopreparations on the number of Tropilaelaps mites

№	Preparat	Preparat konsentratsiyasi / dozasi	Tajriba davomiyligi, kun	Boshlang'ich kanalar soni, dona (M±m)	Yakuniy kanalar soni, dona (M±m)	Kanalar sonining kamayishi, %	Nazorat guruhida yakuniy ko'rsatkich, dona (M±m)
1	Bipin-T	Tajriba dozasi	14	32,0±0,3	5,0±0,6	84,3	36,0±0,1
2	Flutsin	Tajriba dozasi	21	28,0±0,2	3,0±0,1	89,3	33,0±0,4
3	Kavrak damlamasi	Tajriba dozasi	21	29,0±0,2	6,0±0,1	79,3	37,0±0,4

mezonlari sifatida belgilandi. Olingan natijalar asosida kimyoviy preparatlar va fitopreparatlarning qiyosiy samaradorligini aniqlash hamda davolash-profilaktika tadbirlarining maqbul sxemasini asoslash ko'zda tutildi.

4. TADQIQOT NATIJALARI

Results

Varroatoz va trapilelapsozga qarshi kurashishda qo'llaniladigan preparatlarning terapevtik va profilaktik samaradorligini to'g'ri baholash kasalliklarni nazorat qilishning ilmiy asoslangan tizimini ishlab chiqishda muhim ahamiyatga ega. Tadqiqotlar jarayonida dastlab kimyoviy preparatlar, keyingi qismda esa o'simlik xomashyosi asosida tayyorlangan fitoterapevtik vositalarning samaradorligi o'rganildi. Mazkur tadqiqot natijalarini qiyosiy tahlil qilish orqali preparatlarning parazitlarga ta'sir tezligi, akaritsid samaradorligi, asalarilar uchun xavfsizligi va ularni davolash-profilaktika tadbirlarida qo'llash imkoniyatlari baholandi.

etdi. Demak, Tropilaelaps kanalari sonini kamaytirish bo'yicha eng yuqori natija Flutsin preparatida qayd etildi.

Kimyoviy hamda fito preparatlarning qiyosiy tahlili Varroa destructor va Tropilaelaps kanalari sonini kamaytirishda yuqori biologik faollikka ega ekanligini ko'rsatdi. V. destructor bo'yicha kanalar sonining kamayishi Bipin-T da 91,2%, Flutsinda esa 88,6%, 1:10 nisbatdagi kavrak damlamasi qo'llanilgan guruhda 81,2%, ni tashkil etib, Bipin-T eng yuqori natijani namoyon qildi. Tropilaelaps bo'yicha Flutsin 89,3%, kavrak damlamasi 79,3%, Bipin-T esa 71,9% kamayish ko'rsatkichini ta'minladi. Shunday qilib, ikkala parazit turi bo'yicha umumiy qiyosiy baholashda 1:10 nisbatdagi kavrak damlamasi kimyoviy preparatlar bilan teng darajada yuqori akaritsid faollikni namoyon etgani aniqlandi.

Bunda preparatning samaradorligi faqat parazitlar sonining kamayishi bilan emas, balki oldingi tajribalarda aniqlangan asalari oilalarining fiziologik holati, ona arining tuxum qo'yishi va nasl rivojlanishi bilan ham kompleks baholanishi lozim.

1:10 nisbatdagi kavrak damlamasida zaharlanish belgilari kuzatilmaganligi, ona arining tuxum qo'yish faolligi 1468 dona/kun, nasl maydoni esa 3590 sm² bo'lganligi ushbu variantning xavfsizlik profilini qo'llab-quvvatlaydi. 1:5 nisbatdagi kavrak damlamasi konsentratsiyada akaritsid ta'sir biroz kuchaygan bo'lsa-da, asalarilar nobud bo'lishining ortishi va yengil zaharlanish belgilarining paydo bo'lishi yuqori konsentratsiyaning terapevtik ustunligini cheklaydi.

Shu sababli eng yuqori konsentratsiya emas, balki samaradorlik va xavfsizlikning optimal nisbati davolash vositasini tanlashning asosiy mezonini sifatida qabul qilinishi ilmiy jihatdan maqsadga muvofiqdir. Bundan tashqari, sintetik akaritsidlarni muntazam qo'llashda *Varroa* populyatsiyalarida amitraz va fluvalinatga rezistentlik shakllanishi qayd etilgan bo'lib, bu kimyoviy preparatlarni almashlab qo'llash va muqobil vositalardan foydalanish zaruratini kuchaytiradi. *Ferula assa-foetida* efir moylarining *V. destructor* ga qarshi akaritsid faolligi laboratoriya sharoitida ham aniqlanganligi kavrak asosidagi fitoterapevtik yondashuvning biologik jihatdan asoslanganligini ko'rsatadi. Shu nuqtayi nazardan, 1:10 nisbatdagi kavrak damlamasini kimyoviy preparatlarga muqobil yoki integratsiyalashgan kurash tizimining fitoterapevtik komponenti sifatida qo'llash ilmiy-amaliy jihatdan istiqbolli hisoblanadi. Natijalarni umumlashtirib, varroatoz va trapilelapsozga qarshi kurashda monitoringga asoslangan, zaruratga ko'ra kimyoviy preparatlarni rotatsiya qiluvchi va 1:10 nisbatdagi kavrak damlamasidan fitoterapevtik vosita sifatida foydalanishni nazarda tutuvchi kompleks davolash-profilaktika sxemasini tavsiya etish mumkin. Bunday yondashuv parazitlarga qarshi samaradorlikni saqlash, rezistentlik xavfini kamaytirish va asalari oilalarining biologik barqarorligini ta'minlashga xizmat qiladi.

Shundan kelib chiqib, optimal sxema quyidagicha etib bayon etildi: invazion monitoring → invaziya darajasini aniqlash → asal yig'imi tugagach maqsadli kimyoviy ishlov → 1:10 nisbatdagi kavrak damlamasi bilan fitoterapevtik ishlov → 7 kunlik intervalda qayta nazorat → *V. destructor* va *T. clareae* sonini aniqlash → zarurat bo'lsa preparatlarni rotatsiya qilish → qishlash oldidan yakuniy nazorat.

Umuman olganda, varroatoz va trapilelapsozga qarshi eng maqbul yondashuv bitta preparatga tayanish emas, balki muntazam monitoring - invaziya darajasini aniqlash - maqsadli davolash - natijani nazorat qilish - preparatlarni navbatlab qo'llash - profilaktik fitoterapevtik ishlovlar tamoyiliga asoslangan integratsiyalashgan tizimni shakllantirishdan iborat. Bunday yondashuv parazitlar sonini barqaror ravishda kamaytirish, kimyoviy preparatlarga rezistentlik rivojlanishini cheklash, asalari oilalarining biologik barqarorligini saqlash va olinadigan asalarichilik mahsulotlarining veterinariya-sanitariya xavfsizligini ta'minlash uchun ilmiy-amaliy asos bo'lib xizmat qiladi.

5. XULOSALAR

Conclusions

1. *Varroa destructor* kanallari sonini kamaytirish bo'yicha eng yuqori samaradorlik Bipin-T preparatida 91,2 %, Flutsinda 88,6 % ni tashkil etdi. *Tropilaelaps* kanallari bo'yicha esa Flutsin 89,3 %, Bipin-T 84,3 % samaradorlik ko'rsatdi. Bu natijalar kimyoviy akaritsidlarning ta'siri parazit turiga bog'liq holda farqlanishini preparat tanlashda invaziya turini hisobga olish zarurligini ko'rsatadi.

2. Kavrak (*Ferula assa-foetida*) damlamasi *V. destructor* kanallari sonini 81,2 %, *Tropilaelaps* kanallari sonini esa 79,3 % ga kamaytirdi. Ushbu ko'rsatkichlar kavrak asosidagi fitopreparatning har ikki parazitga qarshi akaritsid faolligini tasdiqlaydi. Biroq uning samaradorligi kimyoviy preparatlarnikidan nisbatan past bo'lganligi sababli, kavrak damlamasini integratsiyalashgan davolash-profilaktika tizimining fitoterapevtik komponenti sifatida baholash maqsadga muvofiq.

3. Kavrak damlamasining maqbul konsentratsiyasini tanlashda akaritsid samaradorlik bilan bir qatorda asalari oilalarining fiziologik holatini saqlash muhimligi aniqlandi. Oldingi tajribalarda 1:10 nisbatdagi damlamada zaharlanish belgilari kuzatilmagan, ona arining tuxum qo'yishi 1468 dona/kun, nasl maydoni esa 3590 sm² ni tashkil etgan. Bu natijalar mazkur nisbatning samaradorlik va biologik xavfsizlik mutanosibligini baholash uchun istiqbolli ekanini ko'rsatadi.

4. Olingan natijalar asosida varroatoz va trapilelapsozga qarshi monitoring, invaziya darajasiga mos preparat tanlash, maqsadli davolash va natijalarni qayta nazorat qilishga asoslangan integratsiyalashgan kurash sxemasi taklif etildi. Bunda invazion monitoring → invaziya darajasini aniqlash → asal yig'imi tugagach maqsadli kimyoviy ishlov → 1:10 nisbatdagi kavrak damlamasi bilan fitoterapevtik ishlov → 7 kunlik intervalda qayta nazorat → *V. destructor* va *T. clareae* sonini aniqlash → zarurat bo'lsa preparatlarni rotatsiya qilish → qishlash oldidan yakuniy nazorat.

Ushbu yondashuvda kimyoviy preparatlarni asosli ravishda navbatlab qo'llash va kavrak damlamasidan fitoterapevtik vosita sifatida foydalanish nazarda tutiladi.

DECLARATIONS

Declarations

Author contributions CRediT

Conceptualization; Methodology; Investigation; Data curation; Writing – original draft; Writing – review & editing. All authors have read and agreed to the published version of the manuscript.

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Ethics approval

The work with animals was carried out within routine veterinary diagnostic, treatment and preventive practice in accordance with the veterinary-sanitary requirements in force in the Republic of Uzbekistan.

Informed consent

All authors have read and approved the final version of the manuscript and have given their consent to its submission and publication. The study involved no human participants and no personal data.

Data availability statement

The data obtained in the study are presented in the tables of this article; the primary records are available from the authors on reasonable request.

Conflict of interest

The authors declare no conflict of interest.

Generative AI disclosure

Generative AI (Claude, Anthropic) was used in the editorial preparation of this article: for language editing, translation of the title, abstract and keywords between Uzbek, Russian and English, preparation of the extended English summary from the authors' text, and formatting of the reference list. No data, results or conclusions were generated by AI. The authors are responsible for the content of the publication.

EXTENDED SUMMARY IN ENGLISH

Kengaytirilgan inglizcha xulosa / Расширенный реферат на английском языке

Purpose and research problem

Varroosis and tropilaelapsosis are invasive diseases of honeybees that reduce the efficiency of beekeeping and the viability and productivity of bee colonies. Chemical acaricides are widely used against them, but their efficacy, duration of use and safety make it relevant to study alternative phytopreparations. Published studies have compared oxalic acid, thymol and neem-based preparations, examined essential oils of *Thymus satureioides* and *Origanum elongatum*, evaluated different methods of oxalic acid application and described the biology and control of *Tropilaelaps mercedesae*; they confirm the efficacy of chemical acaricides, organic acids and plant-based preparations but show that their speed of action, safety and conditions of use differ. The aim of the study was to compare the efficacy of the chemical acaricides Bipin-T and Flutsin with an asafetida (*Ferula assa-foetida*)-based phytopreparation and to develop a scientifically substantiated treatment and prevention scheme against invasive diseases of honeybees.

Materials and methods

The therapeutic and prophylactic efficacy of chemical preparations and of an aqueous infusion of asafoetida (*Ferula assa-foetida*) against varroosis and tropilaelapsosis was studied comparatively. The acaricidal activity of the infusion, its efficacy compared with the chemical acaricides Bipin-T and Flutsin, and its safety for bee colonies were evaluated. All preparations were applied by spraying between the honeycomb frames. The main evaluation criteria were the change in the level of infestation, the therapeutic effect of the preparations, and the physiological condition and brood development of the colonies. The number of mites was determined at the beginning and at the end of the experiment (14 days for Bipin-T and 21 days for Flutsin and the infusion), and untreated colonies served as controls.

Results and discussion

At the beginning of the experiment the number of Varroa destructor mites was similar in all groups: 34.0 ± 0.5 with Bipin-T, 35.0 ± 0.2 with Flutsin and 32.0 ± 0.2 with asafoetida infusion. By the end of the observation it decreased to 3.0 ± 0.6 , 4.0 ± 0.6 and 6.0 ± 0.1 , respectively, i.e. by 91.2%, 88.6% and 81.2%, whereas in the control groups the number of mites increased to 38.0–39.0. For Tropilaelaps mites the initial numbers were 32.0 ± 0.3 , 28.0 ± 0.2 and 29.0 ± 0.2 and the final numbers 5.0 ± 0.6 , 3.0 ± 0.1 and 6.0 ± 0.1 , which corresponds to reductions of 84.3% with Bipin-T, 89.3% with Flutsin and 79.3% with the infusion; in the control groups the mite numbers rose to 33.0–37.0. Thus Bipin-T was the most effective against V. destructor and Flutsin against Tropilaelaps. In previous experiments, the 1:10 asafoetida infusion caused no signs of poisoning, and the queen's egg-laying (1468 eggs per day) and the brood area (3590 cm²) were preserved, whereas the 1:5 infusion slightly increased the acaricidal effect but raised bee mortality and caused mild poisoning. Taking into account reports of Varroa resistance to amitraz and fluvalinate and the laboratory acaricidal activity of *Ferula assa-foetida* essential oils, the authors propose a scheme: invasion monitoring → determination of the level of infestation → targeted chemical treatment after the honey harvest → phytotherapeutic treatment with the 1:10 asafoetida infusion → re-examination at 7-day intervals → counting of V. destructor and T. clareae → rotation of preparations if necessary → final examination before wintering.

Conclusion and contribution

Bipin-T (91.2%) and Flutsin (88.6%) were the most effective in reducing the number of Varroa destructor mites, and Flutsin (89.3%) and Bipin-T (84.3%) against Tropilaelaps mites, which shows that the effect of chemical acaricides depends on the parasite species and that the type of invasion should be taken into account when choosing a preparation. Asafoetida infusion reduced the numbers of V. destructor and Tropilaelaps mites by 81.2% and 79.3%, confirming its acaricidal activity against both parasites; since its efficacy is somewhat lower than that of the chemical preparations, it is best regarded as the phytotherapeutic component of an integrated treatment and prevention system. When choosing the concentration of the infusion, the preservation of the physiological condition of the colonies is as important as acaricidal efficacy, and the 1:10 ratio provides a balance between efficacy and biological safety. The proposed integrated scheme, based on monitoring, selection of preparations according to the level of infestation, targeted treatment, follow-up control and rotation of chemical preparations with phytotherapeutic treatments, is intended to reduce parasite numbers sustainably, limit the development of resistance and ensure the veterinary and sanitary safety of bee products.

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REVIEW • PEER-REVIEWED • OPEN ACCESS • SERIES D • 07.00.00 — HISTORICAL SCIENCES • UDC:
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Analysis of research by foreign scholars on the origins of the Hephthalites

Eftaliylarning kelib chiqishi bo'yicha xorijiy olimlar tadqiqotlarining tahlili**Анализ исследований зарубежных учёных о происхождении эфталитов****Diloromkhon ERGASHEVA^{1,*}**¹ Fergana State University, Fergana, Uzbekistan* Corresponding author: diloromergasheva1516@gmail.com**ARTICLE INFO****ARTICLE TYPE**

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AUTHOR, TITLE AND ABSTRACT METADATA (EN / UZ / RU)**ENGLISH****Diloromkhon ERGASHEVA^{1,*}**¹ Fergana State University, Fergana, Uzbekistan**Abstract.** This article discusses the research and opinions of foreign scholars on the origin and characteristics of the Hephthalites, and clarifies information about the rulers of the Hephthalites.**Keywords:** Hephthalites; Tokharistan; Central Asia; Richard Nelson Frye; Franz Altheim; Vakhshunvar; Faganish; Toraman; Hephthalite symbols**O'ZBEKCHA****Diloromkhon ERGASHEVA^{1,*}**¹ Farg'ona davlat universiteti, Farg'ona, O'zbekiston**Annotatsiya.** Maqolada xorijiy olimlarning eftaliylarning kelib chiqishi va o'ziga xos xususiyatlari haqidagi tadqiqotlari hamda qarashlari ko'rib chiqilgan, eftaliy hukmdorlari to'g'risidagi ma'lumotlar aniqlashtirilgan.**Kalit so'zlar:** eftaliylar; Toxariston; Markaziy Osiyo; Richard Nelson Frye; Frans Altxaym; Vaxshunvar; Faganish; Toraman; eftaliy ramzlari**РУССКИЙ****Дилоромхон ЭРГАСHEVA^{1,*}**¹ Ферганский государственный университет, Фергана, Узбекистан**Аннотация.** В статье рассматриваются исследования и взгляды зарубежных учёных на происхождение и особенности эфталитов, а также уточняются сведения об эфталитских правителях.**Ключевые слова:** эфталиты; Тохаристан; Центральная Азия; Ричард Нельсон Фрай; Франц Альтхайм; Вахшунвар; Фаганиш; Тораман; эфталитские символы

1. INTRODUCTION

The Imperial Hephthalites, based in Bactria, expanded eastwards to the Tarim Basin, westwards to Sogdia and southwards through Afghanistan, but they never went beyond the Hindu-Kush, which was occupied by the Alchon Huns, previously thought to be an extension of the Hephthalites. They were a tribal confederation and included both nomadic and settled urban communities. They

formed part of the four major states known collectively as Xyon (Xionites) or Huna, being preceded by the Kidarites and by the Alkhon, and succeeded by the Nezak Huns and by the First Turkic Khaganate. All of these Hunnic peoples have often been controversially linked to the Huns who invaded Eastern Europe during the same period, and/or have been referred to as "Huns", but scholars have reached no consensus about any such connection.

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The stronghold of the Hephthalites was Tokharistan (present-day southern Uzbekistan and northern Afghanistan) on the northern slopes of the Hindu Kush, and their capital was probably at Kunduz, having come from the east, possibly from the area of Pamir. By 479 the Hephthalites had conquered Sogdia and driven the Kidarites eastwards, and by 493 they had captured parts of Dzungaria and the Tarim Basin (in present-day Northwest China). The Alchon Huns, formerly confused with the Hephthalites, expanded into Northern India as well.

2. METHODS AND LITERATURE REVIEW

The sources for Hephthalite history are sparse and the opinions of historians differ. There is no king-list, and historians are not sure how the group arose or what language they initially spoke.

They seem to have called themselves Ebodalo (ηβοδαλο, hence Ephthal /Hephthal), often abbreviated Eb (ηβ), a name they wrote in the Bactrian script on some of their coins.[1:89]

The origin of the name “Hephthalites” is unknown, it may stem either from a Khotanese word Hitala meaning “Strong”, from hypothetical Sogdian Heṣṭalī, plural of Heṣṭalak, or from postulated Middle Persian haft āl “the Seven Al”.

There are several theories regarding the origins of the Hephthalites, with the Iranic and Altaic theories being the main ones. The most prominent theory at present seems to be that the Hephthalites were of Turkic origin, and later adopted the Bactrian language.

According to most specialists, the Hephthalites adopted Bactrian as their official language, just as the Kushans had done, following their settlement in Bactria/Tokharistan. [7:63] Bactrian was an Eastern Iranian language which was written in the Greek alphabet, a legacy of the Greco-Bactrian kingdom in the 3rd–2nd century BCE. Bactrian, beyond being an official language, was also the language of the local populations ruled by the Hephthalites.

3. RESEARCH RESULTS

The Hephthalites inscribed their coins in Bactrian. The titles they held were Bactrian, such as *χσάδης* (khoodēo) or *šao* and of probable Chinese origin, such as *yabghu*. The names of Hephthalite rulers given in Ferdowsi's *Shahnameh* are Iranian and gem inscriptions and other evidence shows that the official language of the Hephthalite elite was East Iranian. In 1959, Kazuo Enoki proposed that the Hephthalites were probably (East) Iranians who originated in Bactria/Tokharistan, based on the fact that ancient sources generally located them in the area between Sogdia and the Hindu-Kush, and the Hephthalites had some Iranian characteristics. [1:92] Richard Nelson Frye cautiously accepted Enoki's hypothesis, while at the same time stressing that the Hephthalites “were probably a mixed horde” Frye writes:

Just as later nomadic empires were confederations of many peoples, we may tentatively propose that the ruling groups of these invaders were, or at least included, Turkic-speaking tribesmen from the east and north, although most probably the bulk of the people in the confederation of Chionites and then Hephthalites spoke an Iranian language. In this case, as normal, the nomads adopted the written language, institutions, and culture of the settled folks. [7:65]

A few scholars, such as Marquart and Grousset proposed Proto-Mongolic origins. Yu Taishan traced the Hephthalites' origins to the Xianbei and further to Goguryeo. [1:94]

Other scholars such as de la Vaissière, based on a recent reappraisal of the Chinese sources, suggest that the Hephthalites were of Turkic origin, and later adopted the Bactrian language, first for administrative purposes, and possibly later as a native language.

According to Rezakhani (2017), this thesis is seemingly the “most prominent at present”. [9:143]

According to Martin Schottky, the Hephthalites apparently had no direct connection with the European Huns, but may have been causally related with their movement. The tribes in question deliberately called themselves “Huns” in order to frighten their enemies. On the contrary, de la Vaissière considers that the Hephthalites were part of the great Hunnic migrations of the 4th century CE from the Altai region that also reached Europe, and that these Huns “were the political, and partly cultural, heirs of the Xiongnu”. [9:145] This massive migration was apparently triggered by climate change, with aridity affecting the mountain grazing grounds of the Altay Mountains during the 4th century CE. According to Amanda Lomazoff and Aaron Rabby, there is a high synchronicity between the “reign of terror” of Attila in the west and the southern expansion of the Hephthalites, with extensive territorial overlap between the Huns and the Hephthalites in Central Asia. [7:71]

The 6th-century Byzantine historian Procopius of Caesarea (*History of the Wars*, Book I. ch. 3), related them to the Huns in Europe, but insisted on cultural and sociological differences, highlighting the sophistication of the Hephthalites:

The Ephthalitae Huns, who are called White Huns [...] The Ephthalitae are of the stock of the Huns in fact as well as in name, however, they do not mingle with any of the Huns known to us, for they occupy a land neither adjoining nor even very near to them; but their territory lies immediately to the north of Persia [...] They are not nomads like the other Hunnic peoples, but for a long period have been established in a goodly land... They are the only ones among the Huns who have white bodies and countenances which are not ugly. It is also true that their manner of living is unlike that of their kinsmen, nor do they live a savage life as they do; but they are ruled by one king, and since they possess a lawful constitution, they observe right and justice in their dealings both with one another and with their neighbors, in no degree less than the Romans and the Persians. [1:95]

According to a recent reappraisal of the Chinese sources by de la Vaissière (2003), only the Turkic Gaoju origin of the Hephthalites should be retained as indicative of their primary ethnicity, and the mention of the Da Yuezhi only stems from the fact that, at the time, the Hephthalites had already settled in the former Da Yuezhi territory of Bactria, where they are known to have used the Eastern Iranian Bactrian language. The earliest Chinese source on this encounter, the near-contemporary chronicles of the Northern Wei (Weishu) as quoted in the later *Tongdian*, reports that they migrated southward from the Altai region circa 360 CE. [9:147]

The Hephthalite (White Hun) state (5th–6th centuries) had a system of government in which the throne was not inherited from father to son, but was given to the most worthy and powerful representative of the dynasty. [1:96] The most famous Hephthalite rulers and leaders preserved in historical sources and on coins are:

3.1. High rulers in Central Asia and Tokharistan

- Ephthalon (Vakhshunvar / Akhshunvar) (c. 450s–480s) — the founder and one of the greatest rulers of the Hephthalite state. The entire tribe and state began to be called “Hephthalites” after his name. He successfully defeated the Sasanian king Peroz and established a powerful empire.
- Kun-hi (c. 484) — A ruler mentioned in the sources in the period after Peroz's death.
- Yandai Yilituo (c. 516) — A Hephthalite king, preserved only in Chinese chronicles, who sent envoys to China.
- Ghaftar (Ghatfar / Varoz) (c. 550s–565) — The last great Hephthalite supreme ruler. In the 560s, he was defeated in a decisive battle near Bukhara against a coalition of the Turkic

Khaganate (Istami Khagan) and the Sassanids (Khusrav I Anushirvan), and the Hephthalite empire subsequently disintegrated.

- Faganish (after 565) — After the empire disintegrated, he united the small Hephthalite possessions in Tokharistan and Chaghaniyan and was recognized as a local tsar.

3.2. Hephthalite (Alkhan-Khun) rulers in Northern India and Gandhara

At the end of the 5th century, a part of the Hephthalites invaded India and formed a separate dynasty and state structure there:

- Khingila (Tunjina I) (455–484) - a leader who initiated the first campaigns into the Indian territories and consolidated Hephthalite power there.

- Turamon (484–515) - a king who brought the Hephthalite power to the peak in India, struck at the Gupta Empire and conquered vast territories.

- Mihirakula (515–533) - son of Turamon. An extremely harsh and warlike ruler, sources say that he destroyed Buddhist temples. After being defeated by a coalition of Indian rulers, he retreated to Kashmir.

- Pravarasena (537–597) was one of the last major rulers to rule Kashmir and the surrounding areas after Mihirakula.

Among them is the Hephthalite ruler Faganish, whose name appears in many sources. Faganish was a Hephthalite prince who ruled Chaghaniyan in the mid-6th century. Initially a vassal of the Hephthalites, Faganish became a vassal of the Sassanid state around 560. This happened after the Hephthalite Empire was defeated by the Sassanid-Turkish troops at Gol-Zarriun and broke up into several small kingdoms.

Faganish was a descendant of the powerful Hephthalite ruler Khushnawaz, who defeated and killed the Sasanian king Peroz in 484. [1:98] Faganish was a local ruler of Chaghaniyan, serving under the supreme ruler of the Hephthalites. Around 560, a combined Sasanian and Turkic army defeated the Hephthalite king Gadfar and his army at a place called Gol-Zarriun near Bukhara in Sogd. As a result, the Hephthalite empire collapsed and broke up into several small kingdoms. [7:65] Faganish became the ruler of Chaghaniyan. [9:148] Gadfar and his men fled south to Sasanian territory, where they found refuge. Meanwhile, the Turkish governor Istami reached an agreement with the Hephthalite nobles and appointed Faganish as the new king of the Hephthalites. [1:98] This was a very unpleasant situation for the Sasanian king Khosrow I Anushirwan (531–579 AD). He considered the cooperation of the Turks with the Hephthalites a threat to his rule in the east. Therefore, Khosrow I Anushirwan began to march towards the Sasanian-Turkish border in Jurjan. Arriving at the designated area, Anushirwan was met by the Turkish representative Istami and presented with gifts. There, Khosrow demonstrated his authority and military power and persuaded the Turks to form an alliance with him. According to an agreement contained in the alliance, Faganish was required to be sent to the Sasanian court in Ctesiphon and receive Khosrow's consent to receive the status of king of the Hephthalites. [1:94] Thus, Faganish and his Chaghaniyan kingdom became a vassal of the Sasanian Empire. As a result of this event, the Sasanians established the Oxus as the border between themselves and the Turks. [7:68] The subsequent fate of Faganish is unknown. It is possible that he was the founder of the Chaghaniyan principality, which ruled from the early 7th to the late 8th centuries.

4. CONCLUSION

The Hephthalites appear in several mural paintings in the area of Tokharistan, especially in banquet scenes at Balalyk tepe and as donors to the Buddha in the ceiling painting of the 35-meter Buddha

at the Buddhas of Bamyan. Several of the figures in these paintings have a characteristic appearance, with belted jackets with a unique lapel of their tunic being folded on the right side, a style which became popular under the Hephthalites, the cropped hair, the hair accessories, their distinctive physiognomy and their round beardless faces. The figures at Bamyan must represent the donors and potentates who supported the building of the monumental giant Buddha. These remarkable paintings participate “to the artistic tradition of the Hephthalite ruling classes of Tukharistan”.

The paintings related to the Hephthalites have often been grouped under the appellation of “Tokharistan school of art” or the “Hephthalite stage in the History of Central Asia Art”. The paintings of Tavka Kurgan, of very high quality, also belong to this school of art, and are closely related to other paintings of the Tokharistan school such as Balalyk tepe, in the depiction of clothes, and especially in the treatment of the faces. This “Hephthalite period” in art, with the caftans with a triangular collar folded on the right, the particular cropped hairstyle, the crowns with crescents, have been found in many of the areas historically occupied and ruled by the Hephthalites, in Sogdia, Bamyan (modern Afghanistan), or in Kucha in the Tarim Basin (modern Xinjiang, China). This points to a “political and cultural unification of Central Asia” with similar artistic styles and iconography, under the rule of the Hephthalites.

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Author contributions CRedit

Conceptualization; Methodology; Investigation; Writing – original draft; Writing – review & editing. The author has read and agreed to the published version of the manuscript.

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Ethics approval

The article is a review of published historical sources and scholarly literature. The work involved no experiments on animals and no human participants, and therefore required no separate ethics committee approval.

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Conflict of interest

The author declares no conflict of interest.

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RESEARCH ARTICLE • PEER-REVIEWED • OPEN ACCESS • SERIES D • 13.00.00 — PEDAGOGICAL SCIENCES • UDC: 796.386:015:012.1:372

Effectiveness of developing physical qualities of table tennis players aged 10–12 years old based on the circular training method

Aylanma mashg'ulot usuli asosida 10–12 yoshli stol tennischilarning jismoniy sifatlarini rivojlantirish samaradorligi

Эффективность развития физических качеств у столтеннисистов 10–12 лет на основе кругового метода тренировки

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ENGLISH

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Abstract. This study examined the effectiveness of circuit training for developing speed, agility and flexibility in 10–12-year-old table tennis players during the initial training stage. A total of 150 young players from sports schools in the Fergana, Namangan and Andijan regions were assigned to experimental (EG) and control (CG) groups. The EG followed a program of three-day circuit-training complexes with a three-stage progressive load. After the intervention, the mean improvement in the EG was 16.77%, 17.98% and 19.05% in the 10-, 11- and 12-year-olds, compared with 9.06%, 9.14% and 10.41% in the CG (EG: $P < 0.01–0.001$). Circuit training developed the physical qualities of young table tennis players nearly twice as effectively as conventional training.

Keywords: table tennis; circuit training; speed; agility; flexibility; initial training stage; young athletes; pedagogical experiment

O'ZBEKCHA

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Annotatsiya. Maqolada 10–12 yoshli stol tennischilarning boshlang'ich tayyorgarlik davrida tezkorlik, chaqqonlik va egiluvchanlik sifatlarini aylanma mashg'ulot usuli asosida rivojlantirish samaradorligi tajribaviy asoslangan. Tadqiqotda Farg'ona, Namangan va Andijan viloyatlari sport maktablarining 150 nafar yosh stol tennischisi tajriba (TG) va nazorat (NG) guruhlariga ajratilib ishtirok etdi. Tajriba guruhida yuklamasi uch bosqichda oshirib borilgan, uch kunlik aylanma mashqlar majmuasiga asoslangan dastur qo'llanildi. Tajriba yakunida TG da natijalarning o'rtaacha o'sishi 10, 11 va 12 yoshlilarda mos ravishda 16,77%, 17,98% va 19,05% ni, NG da esa 9,06%, 9,14% va 10,41% ni tashkil etdi (TG da $P < 0,01–0,001$). Olingan natijalar aylanma mashg'ulot usuli yosh stol tennischilarning jismoniy sifatlarini an'anaviy mashg'ulotga nisbatan qariyb ikki baravar samaraliroq rivojlantirishini ko'rsatadi.

Kalit so'zlar: stol tennisi; aylanma mashg'ulot; tezkorlik; chaqqonlik; egiluvchanlik; boshlang'ich tayyorgarlik; yosh sportchilar; pedagogik tajriba

РУССКИЙ

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Аннотация. В статье экспериментально обоснована эффективность развития быстроты, ловкости и гибкости у теннисистов 10–12 лет на этапе начальной подготовки методом

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круговой тренировки. В исследовании приняли участие 150 юных теннисистов спортивных школ Ферганской, Наманганской и Андижанской областей, распределённых на экспериментальную (ЭГ) и контрольную (КГ) группы. В ЭГ применялась программа трёхдневных комплексов круговой тренировки с трёхэтапным повышением нагрузки. По итогам эксперимента средний прирост результатов в ЭГ у 10-, 11- и 12-летних составил 16,77%, 17,98% и 19,05%, в КГ — 9,06%, 9,14% и 10,41% (в ЭГ $P < 0,01-0,001$). Круговая тренировка развивает физические качества юных теннисистов почти в два раза эффективнее традиционной методики.

Ключевые слова: настольный теннис; круговая тренировка; быстрота; ловкость; гибкость; начальная подготовка; юные спортсмены; педагогический эксперимент

1. KIRISH

Introduction

stol tennisi - yuqori tezlik, qisqa reaksiya vaqti va cheklangan maydonda tez-tez yo'nalish o'zgartirishni talab qiladigan sport turi. O'yinchidan bir soniyaning ulushlarida qaror qabul qilish, stol atrofida portlovchi harakatlanish va zarbani aniq bajarish talab etiladi. Shu sababli tezkorlik, chaqqonlik va egiluvchanlik stol tennischi jismoniy tayyorgarligining asosiy tarkibiy qismlari hisoblanadi.

10–12 yosh bu sifatlarni rivojlantirish uchun sensitiv davr hisoblanadi: bu yoshda harakat koordinatsiyasi va tezkorlik mashqlarga ayniqsa yuqori sur'atda javob beradi. Biroq boshlang'ich tayyorgarlik bosqichida ko'plab murabbiylar mashg'ulotning asosiy qismini texnik tayyorgarlikka ajratadi, jismoniy sifatlarga esa tizimsiz, alohida mashqlar orqali rivojlantiriladi. Natijada mashg'ulot vaqtidan foydalanish samaradorligi pasayadi.

Aylanma mashg'ulot usuli bir mashg'ulot davomida bir necha jismoniy sifatlarni stansiyalar bo'yicha navbatma-navbat rivojlantirish, yuklamani aniq me'yorlash va guruh bilan bir vaqtda ishlash imkonini beradi. Ammo ushbu usulni aynan 10–12 yoshli stol tennischilarning yoshga xos xususiyatlari va sport turi talablariga moslashtirilgan, yuklamasi bosqichma-bosqich oshiriladigan dasturi ilmiy jihatdan yetarli asoslanmagan.

O'zbekiston Respublikasi Prezidentining 2020-yil 24-yanvardagi PF-5924-son va 2020-yil 30-oktabrdagi PF-6099-son farmonlarida bolalar sportini rivojlantirish va sport zaxirasini tayyorlash tizimini takomillashtirish ustuvor vazifa sifatida belgilangan. Mazkur tadqiqot shu vazifalarni ilmiy-uslubiy jihatdan ta'minlashga qaratilgan.

Tadqiqot maqsadi - aylanma mashg'ulot usuli asosida 10–12 yoshli stol tennischilarning tezkorlik, chaqqonlik va egiluvchanlik sifatlarini rivojlantirish dasturini ishlab chiqish va uning samaradorligini tajribada asoslash.

2. ADABIYOTLAR TAHLILI

Literature review

Sport mashg'ulotini davrlashtirish nazariyasi L.P. Matveyev va V.N. Platonov ishlarida asoslangan bo'lib, unga ko'ra yuklama moslashuv, rivojlantiruvchi va mustahkamlovchi bosqichlar orqali izchil oshirilishi kerak. T. Bomp va C. Buzzichelli yosh sportchilar uchun ham yuklamani bosqichma-bosqich oshirish tamoyilini asosiy shart sifatida ko'rsatadi.

Stol tennisining fiziologik talablari M. Kondrič va hammualliflar hamda A. Zagatto va hammualliflar tomonidan tahlil qilingan. Ular o'yinning qisqa, yuqori intensiv harakatlar va qisqa tiklanish oraliqlari almashinuvidan iboratligini, shuning uchun tezkorlik va chaqqonlik natija uchun hal qiluvchi ekanini ta'kidlaydi.

F. Pradas de la Fuente va hammualliflar 9–13 yoshli 352 nafar stol tennischini tekshirib, yosh ortishi bilan tezkorlik, kuch va portlovchi kuch ko'rsatkichlari sezilarli yaxshilanishini, egiluvchanlik esa o'yin uslubiga bog'liqligini aniqlagan. Q. Chen

va hammualliflar yosh stol tennischilarda 8 haftalik ko'p yo'nalishli harakat va muvozanat mashqlari yo'nalish o'zgartirish tezligini ishonchli oshirishini ko'rsatgan.

R. Lloyd va J. Oliver yoshlar jismoniy rivojlanish modelida 10–12 yoshni tezkorlik va chaqqonlikni rivojlantirishning qulay davri deb baholaydi. A. Faigenbaum va hammualliflar esa to'g'ri me'yorlangan kuch mashqlari bolalar uchun xavfsiz va samarali ekanini isbotlagan.

Aylanma mashg'ulot samaradorligi bo'yicha M. Blagojevič va hammualliflar 11–13 yoshli o'quvchilarda 15 haftalik aylanma mashg'ulot kuch chidamliligi va egiluvchanlikni ishonchli oshirganini, ammo 4×10 m chaqqonlik testida guruhlararo farq kuzatilmaganini qayd etgan. Bu natija aylanma mashg'ulot mazmuni sport turining o'ziga xos harakatlari bilan boyitilmasa, chaqqonlikka ta'siri cheklanishini ko'rsatadi.

Shunday qilib, adabiyotlarda stol tennisining jismoniy talablari va aylanma mashg'ulotning umumiy samarasi yoritilgan. Ammo aylanma mashg'ulotni stol tennisiga xos harakatlar bilan to'ldirilgan, yoshga qarab tabaqalashtirilgan va yuklamasi bosqichma-bosqich oshiriladigan dasturi 10–12 yoshli sportchilarda tekshirilmagan. Mazkur tadqiqot aynan shu bo'shliqni to'ldiradi.

3. TADQIQOT METODOLOGIYASI

Materials and methods

Asosiy pedagogik tajriba 2025-yil sentabridan 2026-yil sentabrigacha Farg'ona (asosiy tadqiqot obyekti), Namangan va Andijon viloyatlari sport maktablarining boshlang'ich tayyorlov guruhlarida o'tkazildi. Unda boshlang'ich tayyorgarlik guruhlarida shug'ullanuvchi 10, 11 va 12 yoshli jami 150 nafar stol tennischi ishtirok etdi. Har bir yosh guruhida sportchilar tajriba (TG, n=25) va nazorat (NG, n=25) guruhlariga ajratildi. Tajriba boshida TG va NG o'rtasida 24 ta solishtiruvning birortasida ham ishonchli farq aniqlanmadi: o'rtacha nisbiy farq 1,99–2,09% ($t=0,18-0,64$; $P>0,05$). Variatsiya koeffitsiyenti barcha testlarda 16–19% bo'lib, tanlanma bir jinsli ekanini ko'rsatdi.

3.1. Tadqiqot dizayni

Tajriba bir yillik mashg'ulot sikli davomida o'tkazildi. TG aylanma mashg'ulot usuliga asoslangan muallif dasturi bo'yicha haftasiga 3 marta (6 akademik soat) shug'ullandi. NG esa sport maktabining amaldagi an'anaviy yillik o'quv dasturi bo'yicha mashg'ulot qildi.

3.2. Aylanma mashg'ulot dasturi

Mashg'ulot 40–45 daqiqa davom etib, tayyorlov (8–10 daq), asosiy (26–28 daq) va yakuniy (6–7 daq) qismlardan iborat bo'ldi. Asosiy qismda 6 ta stansiya 3 aylana bo'yicha bajarildi: tezkorlik, chaqqonlik, egiluvchanlik, koordinatsiya, muvozanat va stol tennisiga xos maxsus harakatlar stansiyalari. Har bir stansiyada 30–40 soniya ish va 20–30 soniya dam olish belgilandi, yuklama yurak urish chastotasi (YuQCh) bo'yicha nazorat qilindi.

Haftalik siklda mashg'ulotlarning ustuvor yo'nalishi navbatlashtirildi: dushanba — tezkorlik, chorshanba — chaqqonlik,

juma — egiluvchanlik. Mashqlar oddiydan murakkabga tamoyili asosida tartiblandi va o'yin elementlari bilan boyitildi. Masalan, tezkorlik uchun "Joyida tez tizza ko'tarib yugurish" va "5 m masofaga start", chaqqonlik uchun "Konuslar orasida zigzag yugurish" va "Svetofor" o'yini, egiluvchanlik uchun "Yelka aylantirish" va "Bilak-panja cho'zish" mashqlari qo'llanildi. Vositalar sifatida konuslar, ikki rangli fishkalar, koordinatsion yo'lakcha, gimnastika gilamchasi va to'plardan foydalanildi.

3.3. Nazorat testlari

Jismoniy tayyorgarlik tajriba boshida va oxirida 8 ta test bilan baholandi: 3×10 m makkisimon yugurish (chaqqonlik), 30 m ga yugurish (tezkorlik), 60 m ga yugurish (tezkorlik chidamliligi), gimnastika o'rindig'idan oldinga egilish (egiluvchanlik), 150 g sport anjomini uloqtirish (portlovchi kuch), kurakda yotgan holda korpus ko'tarish, yerga tayangan holda qo'l bukib yozish (kuch

chidamliligi) va 1 daqiqa arqonda sakrash (koordinatsion chidamlilik).

3.4. Statistik tahlil

Har bir ko'rsatkich uchun o'rtacha arifmetik qiymat ($\bar{x}$), standart og'ish (σ) va variatsiya koeffitsiyenti (V) hisoblandi. TG va NG o'rtasidagi farq bog'liq bo'lmagan tanlanmalar uchun, tajriba boshi va oxiri o'rtasidagi o'zgarish esa bog'liq tanlanmalar uchun Student t-mezoni bilan baholandi. Natijalarning nisbiy o'sishi (NO') hisoblandi.

4. NATIJALAR

Results

Tajriba yakunida TG natijalari barcha yosh guruhlarida NG ga nisbatan o'rtacha 1,88 baravar ko'p o'sdi (1-jadval). TG da 24 ta ko'rsatkichning barchasida o'sish ishonchli bo'ldi ($P<0,01-0,001$), NG da esa faqat 9 tasida ($P<0,05$).

1-jadval

Nazorat testlari bo'yicha nisbiy o'sish (NO', %) va uning ishonchliligi ($n=25$) / **Table 1.** Relative increase (RI, %) in control test results and its significance ($n=25$)

Test	Guruh	10 yosh NO', %	P	11 yosh NO', %	P	12 yosh NO', %	P
3×10 m makkisimon yugurish (s)	TG	13,28	<0,01	15,45	<0,01	15,77	<0,01
	NG	7,76	>0,05	8,12	>0,05	8,65	>0,05
30 m ga yugurish (s)	TG	13,98	<0,01	18,09	<0,001	14,95	<0,01
	NG	8,16	>0,05	9,13	<0,05	8,22	>0,05
60 m ga yugurish (s)	TG	13,33	<0,01	18,31	<0,001	19,52	<0,001
	NG	7,73	>0,05	9,65	<0,05	10,09	<0,05
Oldinga egilish (sm)	TG	16,43	<0,01	18,47	<0,01	18,50	<0,01
	NG	8,98	>0,05	9,45	>0,05	8,94	>0,05
150 g anjomni uloqtirish (m)	TG	21,13	<0,001	19,11	<0,01	23,75	<0,001
	NG	10,01	<0,05	9,94	>0,05	11,34	<0,05
Korpus ko'tarish (marta)	TG	22,31	<0,001	20,23	<0,001	22,60	<0,001
	NG	11,41	<0,05	9,49	<0,05	10,67	<0,05
Qo'l bukib yozish (marta)	TG	15,68	<0,01	15,75	<0,01	19,81	<0,01
	NG	8,97	>0,05	8,36	>0,05	9,46	>0,05
Arqonda sakrash, 1 daq (marta)	TG	17,99	<0,01	18,42	<0,01	17,48	<0,001
	NG	9,44	>0,05	8,95	>0,05	15,92	<0,05

4.1. Tezkorlik va chaqqonlik

Uchta yugurish testida TG da o'sish 13,28–19,52% ni, NG da 7,73–10,09% ni tashkil etdi. Tezkorlik ayniqsa 11 yoshda yaqqol rivojlandi: 30 m va 60 m ga yugurishda TG da 18,09% va 18,31% o'sish qayd etildi ($P<0,001$). 3×10 m makkisimon yugurishda NG ning o'zgarishi uchala yoshda ham ishonchsiz bo'ldi ($P>0,05$), TG da esa ishonchli ($P<0,01$).

4.2. Egiluvchanlik

Oldinga egilish testida TG da 16,43–18,50%, NG da 8,94–9,45% o'sish kuzatildi. NG da bu o'zgarish hech bir yoshda ishonchli darajaga yetmadi ($P>0,05$).

4.3. Kuch va chidamlilik

Eng yuqori o'sish kuch testlarida qayd etildi: 12 yoshli TG da anjomni uloqtirishda 23,75% va korpus ko'tarishda 22,60% ($P<0,001$). Faqat 12 yoshdagi arqonda sakrash testida guruhlar natijalari yaqin bo'ldi (17,48% va 15,92%).

5. MUHOKAMA

Discussion

Tadqiqot natijalari stol tennisiga moslashtirilgan aylanma mashg'ulot 10–12 yoshli sportchilarning jismoniy sifatlarini an'anaviy mashg'ulotga qaraganda qariyb ikki baravar samaraliroq rivojlantirishini ko'rsatdi. Bu natija yuklamani bosqichma-bosqich oshirish yosh sportchilarda ham barqaror moslashuv beradi, degan davrlashtirish nazariyasi xulosalariga mos keladi [3; 4; 10].

M. Blagojević va hammualliflar umumiy aylanma mashg'ulotda 11–13 yoshli bolalarda chaqqonlik bo'yicha guruhlararo farq topmagan. Bizning tadqiqotimizda esa chaqqonlik ham ishonchli rivojlandi. Bu farqni dasturimizdagi mashqlar stol tennisiga xos harakatlar — stol atrofida yon qadamlar, signalga reaksiya, raketka va to'p bilan ishlash — bilan boyitilgani bilan izohlash mumkin. Xuddi shunday, Q. Chen va hammualliflar ham sport turiga xos ko'p yo'nalishtirish harakatlar yosh stol tennischilarda yo'nalishtirish o'zgartirish tezligini oshirishini ko'rsatgan.

TG natijalarining yosh bilan izchil oshib borishi (16,77% dan 19,05% gacha) F. Pradas de la Fuente va hammualliflar qayd etgan jismoniy sifatlarning yosh bilan rivojlanish qonuniyatiga mos keladi. Shu bilan birga, NG da o'sish uch yoshda ham 9–10% atrofida qoldi. Demak, TG dagi qo'shimcha o'sish yosh bilan bog'liq tabiiy rivojlanishdan emas, balki qo'llanilgan dastur ta'siridan kelib chiqqan.

Tajriba davomida dam olish nisbati hamda yuklamani YuQCh bo'yicha nazorat qilish 10–12 yoshli bolalar uchun xavfsiz, ammo rivojlantiruvchi yuklama berdi. Funktsional ko'rsatkichlardagi o'zgarishlar (Genchi +33,86%, Shtange +30,44%, YuQCh –14,32%) ham buni tasdiqlaydi. Bu yondashuv R. Lloyd va J. Oliver taklif etgan yoshga mos rivojlanish modeli tamoyillariga javob beradi.

5.1. Tadqiqot cheklovlari

Natijalar guruh o'rtaicha ko'rsatkichlari asosida tahlil qilindi; kelgusida individual ma'lumotlar asosida korrelyatsion tahlil o'tkazish maqsadga muvofiq. Shuningdek, tajriba faqat Farg'ona vodiysi sport maktablarida o'tkazilgan natijalarni boshqa hududlarga umumlashtirishda ehtiyotkorlikni talab qiladi.

6. XULOSA

Conclusion

Stol tennisiga xos harakatlar bilan boyitilgan, uch kunlik sikl (tezkorlik- egiluvchanlik - chaqqonlik) va uch bosqichli yuklama oshirishga asoslangan aylanma mashg'ulot dasturi 10–12 yoshli stol tennischilar uchun samarali ekani tajribada tasdiqlandi.

TG da natijalarning o'rtaicha o'sishi 10, 11 va 12 yoshda 16,77%, 17,98% va 19,05% ni, NG da 9,06%, 9,14% va 10,41% ni tashkil etdi (TG da $P < 0,01-0,001$); dastur an'anaviy mashg'ulotdan o'rtaicha 1,88 baravar samaraliroq bo'ldi.

Dastur funktsional holatni ham yaxshiladi: TG da Shtange sinovi 30,44%, Genchi sinovi 33,86% ga oshdi, YuQCh 14,32% ga pasaydi (NG da mos ravishda 10,13%, 8,91% va 4,61%).

Dasturni bolalar va o'smirlar sport maktablarining boshlang'ich tayyorgarlik guruhlarida jismoniy tayyorgarlik qismi sifatida qo'llash tavsiya etiladi. Aylanma mashg'ulot qismi 40–45 daqiqa davom etishi, mashqlar esa sport turiga xos harakatlar bilan to'ldirilishi lozim.

DECLARATIONS

Declarations

Author contributions *CRedit*

Conceptualization; Methodology; Investigation; Writing – original draft; Writing – review & editing. The author has read and agreed to the published version of the manuscript.

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Ethics approval

The pedagogical experiment was conducted within the regular training process of children's and youth sports schools and was approved by the ethics committee of the Uzbek State University of Physical Education and Sports.

Informed consent

Written informed consent for participation in the study was obtained from the parents or legal guardians of all participants; the author has read and approved the final version of the manuscript.

Data availability statement

The data obtained in the study are presented in the table of this article; the primary records are available from the author on reasonable request.

Conflict of interest

The author declares no conflict of interest.

Generative AI disclosure

Generative AI (Claude, Anthropic) was used in the editorial preparation of this article: for language editing, translation of the title, abstract and keywords between Uzbek, Russian and English, preparation of the extended English summary from the author's text, and formatting of the reference list. No data, results or conclusions were generated by AI. The author is responsible for the content of the publication.

EXTENDED SUMMARY IN ENGLISH

Kengaytirilgan inglizcha xulosa / Расширенный реферат на английском языке

Purpose and research problem

Table tennis requires high speed, short reaction time and frequent changes of direction in a limited space: the player has to make decisions within fractions of a second, move explosively around the table and execute strokes accurately. Speed, agility and flexibility are therefore the main components of a table tennis player's physical preparation, and the age of 10–12 years is regarded as a sensitive period for their development. Circuit training makes it possible to develop several physical qualities within one session through a sequence of stations, which suits the initial training stage, and national policy documents on physical education and sport (Presidential Decrees PF-5924 and PF-6099 of 2020) give priority to the development of children's sport. The aim of the study was to develop a circuit training programme for the speed, agility and flexibility of 10–12-year-old table tennis players and to verify its effectiveness experimentally.

Materials and methods

The main pedagogical experiment was carried out from September 2025 to September 2026 in the initial training groups of sports schools in the Fergana (main research site), Namangan and Andijan regions. It involved 150 table tennis players aged 10, 11 and 12 years; in each age group the athletes were divided into an experimental group (EG, $n=25$) and a control group (CG, $n=25$). At baseline none of the 24 comparisons between the groups showed a significant difference (mean relative difference 1.99–2.09%; $t=0.18-0.64$; $P>0.05$), and coefficients of variation of 16–19% indicated a homogeneous sample. During a one-year training cycle the EG trained three times a week (6 academic hours) according to the author's circuit training programme, while the CG followed the traditional annual curriculum of the sports school. Each session lasted 40–45 minutes and consisted of a preparatory (8–10 min), main (26–28 min) and final (6–7 min) part. In the main part six stations — speed, agility, flexibility, coordination, balance and table-tennis-specific movements — were completed in three circuits with 30–40 s of work and 20–30 s of rest, and the load was controlled by heart rate. The weekly emphasis alternated between speed (Monday), agility (Wednesday) and flexibility (Friday); exercises were arranged from simple to complex and enriched with game elements, using cones, two-coloured markers, an agility ladder, gymnastic mats and balls. Physical preparedness was assessed at the beginning and at the end of the experiment with eight tests: a 3×10 m shuttle run, 30 m and 60 m runs, a forward bend from a gymnastic bench, throwing a 150 g implement, sit-ups, push-ups and one-minute rope skipping. Means, standard deviations and coefficients of variation were calculated, differences were assessed with Student's t-test for independent and dependent samples, and the relative increase of the results was calculated for each test.

Results and discussion

At the end of the experiment the results of the EG improved on average 1.88 times more than those of the CG in all age groups. In the EG all 24 indicators improved significantly ($P<0.01-0.001$), whereas in the CG only 9 did ($P<0.05$). In the three running tests the increase was 13.28–19.52% in the EG and 7.73–10.09% in the CG; speed developed most markedly at the age of 11, with gains of 18.09% and 18.31% in the 30 m and 60 m runs ($P<0.001$), and the change in the 3×10 m shuttle run was not significant in the CG at any age but significant in the EG ($P<0.01$). In the forward bend test flexibility increased by 16.43–18.50% in the EG and by 8.94–9.45% in the CG, where the change did not reach significance at any age. The highest gains were recorded in strength tests: in 12-year-olds of the EG, 23.75% in implement throwing and 22.60% in sit-ups ($P<0.001$). Only in the rope-skipping test at the age of

12 were the results of the groups close (17.48% and 15.92%). The programme also improved the functional state: in the EG the Stange test increased by 30.44% and the Genchi test by 33.86%, and resting heart rate decreased by 14.32%, compared with 10.13%, 8.91% and 4.61% in the CG. The author explains the significant development of agility, which was not observed in studies of general circuit training, by the table-tennis-specific movements included in the programme (side steps around the table, reactions to signals, work with the racket and ball), and attributes the additional gain in the EG to the programme rather than to age-related development, because the gain in the CG remained at about 9–10% at all ages.

Conclusion and contribution

A circuit training programme enriched with table-tennis-specific movements, built on a three-day weekly cycle (speed, flexibility, agility) and a three-stage increase in load, proved effective for 10–12-year-old table tennis players. The mean increase in the results was 16.77%, 17.98% and 19.05% at the ages of 10, 11 and 12 in the EG, compared with 9.06%, 9.14% and 10.41% in the CG (EG: $P < 0.01$ – 0.001), so the programme was on average 1.88 times more effective than traditional training, and it also improved the functional state of the young athletes. The programme is recommended for the physical preparation of initial training groups in children's and youth sports schools, with a circuit part of 40–45 minutes and exercises supplemented by sport-specific movements. The results were analysed on the basis of group means and were obtained only in sports schools of the Fergana Valley, which should be taken into account when generalising them.

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