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# Methods for the diagnosis and control of dermatomycosis (saprolegniosis) in snakehead fish

**Ilonbosh baliqlarida dermatomikoz (saprolegniosis)ni aniqlash va qarshi kurash usullari****Методы выявления и борьбы с дерматомикозом (сапролегниозом) у рыб-змееголовов****Sh. K. BALIYEV<sup>1</sup> , N. A. SULAYMANOVA<sup>1</sup>**<sup>1</sup> Scientific-Research Institute of Veterinary, Uzbekistan**ARTICLE INFO****ARTICLE TYPE**

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**AUTHOR, TITLE AND ABSTRACT METADATA (EN / UZ / RU)****ENGLISH****Sh. K. BALIYEV<sup>1</sup> , N. A. SULAYMANOVA<sup>1</sup>**<sup>1</sup> Scientific-Research Institute of Veterinary, Uzbekistan

**Abstract.** This article comprehensively analyses the biology of snakehead and eel-like fish (representatives of the Channidae family and the Anguilliformes order), as well as their high economic and dietary importance in modern intensive fisheries and aquaculture. The article provides a general description of the main fish species cultivated industrially worldwide and discusses in detail the chemical composition of fish meat, including amino acids essential for human health, omega-3 fatty acids, and the balance of micro- and macrolelements. The main part of the study is devoted to one of the most pressing problems in eel fish farming today — fungal diseases, particularly dermatomycosis (saprolegniosis) caused by representatives of the Saprolegnia family. The article scientifically describes the course of this infection in eel-like fish, the patterns of its spread in aquatic environments, the ecological and ethological factors contributing to the disease, and its specific clinical signs. In addition, modern ichthyopathological methods for combating dermatomycosis in snakehead and eel-like fish, as well as technologies for the application of chemical and biological preparations, are systematized. Practical recommendations have been developed for fish farms aimed at improving water quality, carrying out liming procedures (using calcium oxide and calcium hydroxide), implementing disinfection measures, and enhancing fish immunity, thereby increasing production efficiency.

**Keywords:** eel; snakehead fish; aquaculture; fish farming; dermatomycosis; saprolegniosis; Saprolegnia; fungus; ichthyopathology; fish meat composition; omega-3; amino acids; intensive fish farming; water reservoir sanitation; liming; calcium oxide; prevention; clinical signs; pathogenesis; mycelium; zoospore; fish diseases; treatment methods; antiseptic; therapy

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**Annotatsiya.** Ushbu ilmiy maqolada ilonbosh va ilonbaliqlar (Channidae oilasi va Anguilliformes turkumi vakillari) biologiyasi, ularning zamonaviy intensiv baliqchilikdagi va akvakulturadagi yuqori iqtisodiy hamda dietik ahamiyati kompleks ravishda tahlil qilingan. Maqolada dunyo miqyosida sanoat usulida yetishtirilayotgan asosiy baliq turlarining umumiy tavsifi va baliq go'shtining kimyoviy tarkibi, inson salomatligi uchun zarur bo'lgan aminokislotalar, omega-3 kislotalari, mikro- va makroelementlar balansi batafsil yoritilgan. Tadqiqotning asosiy qismi ilonbaliqchilik tarmog'ining bugungi kundagi dolzarb muammolaridan biri bo'lgan zamburug'li kasalliklarga, xususan, Saprolegnia oilasi vakillari tomonidan qo'zg'atiladigan dermatomikoz (saprolegniosis) kasalligiga bag'ishlangan. Maqolada ushbu infeksiyaning ilonbaliqlar organizmida kechishi, suv havzalari bo'ylab tarqalish qonuniyatlari, kasallikni keltirib chiqaruvchi ekologik va etologik omillar hamda o'ziga xos klinik belgilari ilmiy asoslangan holda bayon etilgan. Shuningdek, ilonbosh va ilonbaliqlarda dermatomikoz patologiyasiga qarshi kurashishda zamonaviy ixtiopatologik usullar, kimyoviy va biologik preparatlarni qo'llash texnologiyalari tizimlashtirilgan. Baliqchilik xo'jaliklari uchun suv muhitini sog'lomlashtirish, ohaklash (kalsiy oksidi va gidroksidi), dezinfeksiya tadbirlarini o'tkazish va

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baliqlar immunitetini oshirishga qaratilgan amaliy tavsiyalar ishlab chiqilgan bo'lib, ular ishlab chiqarish samaradorligini oshirishga xizmat qiladi.

**Kalit so'zlar:** ilonbaliq; ilonbosh; akvakultura; baliqchilik; dermatomikoz; saprolegnioz; Saprolegnia; zamburug'; ixtiopatologiya; baliq go'shti tarkibi; omega-3; aminokislotalar; intensiv baliqchilik; suv havzalari sanitariyasi; ohaklash; kalsiy oksidi; profilaktika; klinik belgilar; patogenez; mitseliy; zoospora; baliq kasalliklari; davolash usullari; antiseptik; terapiya

## РУССКИЙ

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**Аннотация.** В данной научной статье комплексно проанализированы биология змееголовых и угреобразных рыб (представителей семейства Channidae и отряда Anguilliformes), а также их высокая экономическая и диетическая значимость в современной интенсивной рыболовецкой отрасли и аквакультуре. В статье приведена общая характеристика основных видов рыб, выращиваемых в промышленных масштабах во всём мире, подробно освещены химический состав рыбного мяса, содержание необходимых для здоровья человека аминокислот, жирных кислот омега-3, а также баланс микро- и макроэлементов. Основная часть исследования посвящена одной из актуальных проблем современной отрасли разведения угреобразных рыб — грибковым заболеваниям, в частности дерматомикозу (сaprolegниозу), вызываемому представителями семейства Saprolegnia. В статье научно обоснованно изложены особенности течения данной инфекции в организме угреобразных рыб, закономерности её распространения в водоёмах, экологические и этологические факторы, способствующие возникновению заболевания, а также характерные клинические признаки. Кроме того, систематизированы современные иктиопатологические методы борьбы с дерматомикозом у змееголовых и угреобразных рыб, технологии применения химических и биологических препаратов. Разработаны практические рекомендации для рыболовецких хозяйств, направленные на оздоровление водной среды, проведение известкования (оксидом и гидроксидом кальция), дезинфекционных мероприятий и повышение иммунитета рыб, что способствует повышению эффективности производства.

**Ключевые слова:** угреобразные рыбы; змееголов; аквакультура; рыбоводство; дерматомикоз; saprolegnioz; Saprolegnia; грибок; иктиопатология; состав рыбного мяса; омега-3; аминокислоты; интенсивное рыбоводство; санитария водоёмов; известкование; оксид кальция; профилактика; клинические признаки; патогенез; мицелий; зооспора; болезни рыб; методы лечения; антисептик; терапия

## 1. KIRISH

### Introduction

Zamonaviy global oziq-ovqat xavfsizligini ta'minlashda akvakultura va intensiv baliqchilik tarmoqlari yetakchi o'rinlardan birini egallab kelmoqda. Dunyo aholisining tez sur'atlar bilan o'sib borishi, tabiiy suv havzalaridagi baliq zaxiralarning kamayishi va to'g'ri ovqatlanish madaniyatining yuksalishi sanoat usulida baliq yetishtirish texnologiyalarini jadal rivojlantirishni talab etmoqda. Bugungi kunda dunyo miqyosida sanoat usulida boqilayotgan baliq turlari juda rang-barang bo'lib, ular asosan iqlim sharoiti, suvning sho'rlanish darajasi, harorati va sun'iy oziqlantirish tizimlariga moslashuvchanligiga qarab tanlab olinadi. Global akvakulturaning asosiy qismini karpsimonlar (Cyprinidae), losossimonlar (Salmonidae), tilapiyalar (Cichlidae) va laqqasimonlar (Siluriformes) tashkil etadi. Shuningdek, so'nggi yillarda o'zining yuqori gastronomik qiymati va tashqi muhit noqulayliklariga chidamliligi bilan ajralib turadigan ilonbaliqlar (Anguillidae) va ilonboshlar (Channidae) sanoat usulida yetishtirish obyekti sifatida ommalashmoqda.

Har bir baliq turining sanoat akvakulturasidagi ulushi ularning biologik xususiyatlari va o'sish sur'atiga bog'liq. Masalan, oq amur (Ctenopharyngodon idella), do'ngpeshona (Hypophthalmichthys) va oddiy karp (Cyprinus carpio) kabi turlar o'zining o'txo'rliigi va oziqa bazasining arzonligi sababli Osiyo va Yevropa mamlakatlarida keng tarqalgan bo'lsa, kamalaksimon forel (Oncorhynchus mykiss) va Atlantika lososi (Salmo salar) yuqori harorat nazorati va kislorod resurslarini talab qiluvchi intensiv resirkulyatsion tizimlarda (UZV) yetishtiriladi. Tilapiya turlari esa issiq iqlimli hududlarda, yuqori zichlikda va antropogen yuklamalarga chidamliligi tufayli hovuzlarda hamda qafaslarda (sadoq) muvaffaqiyatli parvarish qilinmoqda.

Baliq mahsulotlarining inson ratsionidagi o'rni ularning ozuqaviy qiymati va o'ziga xos kimyoviy tarkibi bilan belgilanadi. Baliq go'shti — yuksak darajada hazm bo'luvchi, to'laqonli oqsillar, hayotiy muhim lipidlar, vitaminlar va mineral moddalarning bebaho manbayidir. Issiqlik bilan ishlov berilganda baliq oqsillari inson organizmi tomonidan 93–98 % gacha o'zlashtiriladi; bu ko'rsatkich qoramol yoki parrandachilik mahsulotlariga nisbatan sezilarli darajada yuqoridir. Baliq go'shti tarkibidagi oqsil miqdori turning biologik xususiyatlariga qarab 16 % dan 22 % gacha o'zgarib turadi. Bu oqsillar tarkibida inson organizmi mustaqil sintez qila olmaydigan barcha muhim aminokislotalar — lizin, metionin, triptofan, treonin, valin, fenilalanin, leytsin va izoleytsin optimal proporsiyalarda mavjud.

Baliq go'shtining eng muhim komponentlaridan biri uning lipid qismidir. Qishloq xo'jaligi hayvonlari yog'idan farqli o'laroq, baliq yog'i xona haroratida suyuq holatda oson eriydi va tarkibida ko'p to'yinmagan yog' kislotalari, ayniqsa omega-3 guruhiga kiruvchi kislotalar juda ko'p. Ushbu kislotalar inson organizmida yurak-qon tomir tizimi faoliyatini yaxshilash, qondagi xolesterin miqdorini kamaytirish, miya to'qimalarining rivojlanishi va immun tizimining barqarorligini ta'minlashda fundamental rol o'ynaydi. Ayniqsa, losossimonlar, ilonbaliqlar va ayrim laqqasimonlar o'z tanasida yuqori miqdorda ushbu foydali yog'larni to'plash qobiliyatiga ega. Baliq go'shtidagi yog' miqdori turning yoshi, jinsi, mavsumi va oziqlanish xarakteriga ko'ra 0,5 % dan (kam yog'li turlar — sudak, treska) 30 % dan yuqorigacha (yog'li turlar — daryo ilonbalig'i, ayrim laqqalar) yetishi mumkin.

Kimyoviy tarkibning mikronutrientlar qismiga to'xtaladigan bo'lsak, baliq go'shti va a'zolari (ayniqsa, jigari) A, D, E kabi yog'da eruvchi vitaminlar hamda B guruhi (B<sub>1</sub>, B<sub>2</sub>, B<sub>6</sub>, B<sub>12</sub>) vita-

minlariga juda boy. Mineral moddalardan fosfor, kalsiy, kaliy, magniy, temir, rux, mis va selen elementlari organizm uchun biologik oson o'zlashtiriladigan shakllarda bo'ladi. Dengiz va okean akvakulturasida vakillarida, shuningdek, qalqonsimon bez faoliyati uchun o'ta zarur bo'lgan yod va fluor elementlarining konsentratsiyasi yuqoridir.

Sanoat usulida yetishtirilayotgan baliqlarning go'sht sifati va uning tarkibi bevosita qo'llanilayotgan ozuqa aralashmalarining tarkibiga bog'liq. Zamonaviy baliqchilikda yuqori samaradorlikka erishish uchun aminokislotalar va lipidlar muvozanati to'g'rilangan, granulalangan ozuqalardan foydalaniladi. Bu esa baliq go'shtining tarkibidagi namlik, oqsil va yog' nisbatini doimiy bir xil me'yorda saqlash, mahsulotning tovar ko'rinishi va ta'm xususiyatlarini iste'molchi talablariga mos ravishda shakllantirish imkonini beradi. Shunday qilib, sanoat akvakulturasida nafaqat yuqori sifatli oqsil manbai, balki funksional va parhez taomlar ishlab chiqarishning asosi hisoblanadi.

## 2. MAVZUNING DOLZARBLIGI

### *Relevance of the topic*

Ilonbaliqlar va ilonboshsimonlar keyingi yillarda jahon akvakulturasida eng yuqori iqtisodiy foyda keltiruvchi va istiqbolli obyektlar qatoridan mustahkam joy egalladi. Ilonbaliq (*Anguilla*) va mamlakatimiz iqlim sharoitiga moslashgan, chuchuk suv havzalarida jadal ko'payayotgan ilonbosh (*Channa argus*) baliqlari o'zining biologik xususiyatlari — atmosfera havosidan qo'shimcha nafas olish qobiliyati, suvda kislorod tanqisligiga o'ta chidamliligi va juda yuqori zichlikda yashay olish imkoniyatlari tufayli intensiv baliqchilikning eng sevimli obyekti aylandi. Biroq baliqchilik intensivlashgan sari, ya'ni sun'iy hovuzlarda va yopiq suv aylanma tizimlarida baliq o'tqazish zichligi oshirilganda, ekologik muvozanatning buzilishi natijasida turli yuqumli, parazitlar va mikotik (zamburug'li) kasalliklar epidemiyasi kelib chiqishi xavfi ortib bormoqda. Suv havzalarida baliqlarning zich joylashishi patogen mikroorganizmlarning yuqish zanjirini osonlashtiradi va bu holat mavzuning dolzarbligini belgilab beruvchi eng asosiy omildir.

Akvakultura sanoatida iqtisodiy zararining eng katta qismi aynan davolash qiyin bo'lgan yoki kech aniqlanadigan kasalliklar hisobiga to'g'ri keladi. Ilonboshlar tabiatan yirtqich va harakatchan bo'lib, intensiv sharoitda o'zaro raqobat, saralash (graduatsiya) jaryonlari yoki no'rin texnologik aralashuvlar natijasida ularning teri qoplamasi va suzgichlari tez-tez mexanik jarohatlanadi. Terining butunligi buzilishi esa atrof-muhitda, suv qatlamida va hovuz tubidagi organik qoldiqlarda doimiy mavjud bo'lgan shartli-patogen zamburug'lar uchun ochiq kirish darvozasini yaratadi. Ushbu kasalliklar ichida dermatomikozlar, aniqrog'i Saprolegniaceae oilasiga mansub quyi zamburug'lar qo'zg'atadigan patologiyalar ilonbaliqchilik va ilonboshchilik xo'jaliklariga global miqyosda og'ir zarbalar yetkazmoqda.

Dermatomikoz kasalligining dolzarbligi shundaki, u nafaqat tovar baliqlarining tashqi ko'rinishi va bozor qiymatini yo'qqa chiqaradi, balki inkubatsiya sexlarida baliq uvuldirig'i va chavoqlarining ommaviy qirilib ketishiga (ba'zan 80–100 % gacha) sabab bo'ladi. Zamburug' sporallari suv muhitida har qanday haroratda ham faollashishi mumkin bo'lib, ayniqsa bahor va kuz oylarida, baliqlarning immun tizimi qishki stress yoki harorat o'zgarishi sababli zaiflashgan davrda ommaviy epizootiya shaklini oladi. Bu esa o'z navbatida baliqchilik korxonalarining barqaror rivojlanishiga va sarmoyadorlarning daromadlariga to'g'ridan-to'g'ri tahdid soladi.

Ushbu muammoning yana bir jihati shundaki, uzoq yillar davomida akvakulturada dermatomikoz va boshqa mikroorganizmlarga qarshi kurashda eng samarali vosita sifatida qo'llanib kelingan malaxit yashili (malachite green) kabi kimyoviy birikmalar o'zining kanserogen va mutagen xususiyatlari tufayli butun dunyoda, jumladan O'zbekistonda ham baliqchilikda taqiqlangan. Bu taqiq ichki va eksport bozorlariga yetkazib berilayotgan baliq mahsulotlarining ekologik tozaligi va inson salomatligi xavfsizligini ta'minlash maqsadida kiritilgan. Malaxit yashilining

muomaladan chiqarilishi natijasida ixtiopatologiya to'g'ridan-to'g'ri yangi, xavfsiz, samarali va ekologik jihatdan toza bo'lgan muqobil preparatlarni hamda profilaktika usullarini qidirib topish muammosiga duch keldi. Bugungi kunda dermatomikozga qarshi kurashish uchun faqatgina kimyoviy ishlov berish emas, balki tizimli biotexnologik usullar, hovuzlar sanitariyasi, gidrokimyoviy rejimni boshqarish (masalan, ohak yordamida pH darajasini va dezinfektsiyani nazorat qilish) va innovatsion dori vositalarini joriy etish talab etiladi.

Shunday qilib, ilonboshlarda dermatomikoz kasalligining kelib chiqish sabablarini mexanizm darajasida o'rganish, uning klinikasini erta bosqichlarda aniqlash metodikasini mukammallashtirish hamda atrof-muhitga va iste'molchilarga zarar yetkazmaydigan qarshi kurashish texnologiyalarini ishlab chiqish zamonaviy baliqchilik fani va amaliyotining eng dolzarb vazifalaridan biri hisoblanadi. Ushbu mavzuning ilmiy asosda tadqiq etilishi respublikamizda baliq yetishtirish hajmini oshirish va eksport salohiyatini mustahkamlashga bevosita xizmat qiladi.

## 3. DERMATOMIKOZNING ETIOLOGIYASI VA KLINIK BELGILARI

### *Aetiology and clinical signs of dermatomycosis*

Ilonbosh baliqlarida dermatomikoz (amaliyotda ko'pincha saprolegnioz deb ham yuritiladi) — *Saprolegnia parasitica* tomonidan chaqiriladigan, teri, suzgichlar, ko'z va ba'zan chuqur mushak to'qimalarining shikastlanishi bilan tavsiflanuvchi ikkilamchi infeksiya kasalligidir.

### 3.1. Kasallikning tarqalishi va sabablari

Dermatomikozning keng tarqalishiga sabab bo'luvchi birlamchi omil baliq tanasining mexanik jarohatlanishidir. Ilonbaliqlar o'zlarining serharakatligi, xavf tug'ilganda hovuz tubiga yoki loyga tiqilish odati va intensiv boqilganda oziqa uchun agressiv kurashishi natijasida tez-tez bir-birini tishlaydi yoki hovuz devorlariga, moslamalariga ishqalanish orqali terisining shilliq qavatini va epidermisini shikastlaydi. Baliq terisidagi shilliq (mutsin) qavati tarkibida bakteritsid moddalar (lizotsim, immunoglobulinlar) bo'lib, u tabiiy himoya to'sig'i hisoblanadi. Shilliq qavat va epidermis shikastlanganda, suvda suzib yurgan zamburug' zoosporalari jarohatlangan joyga yopishadi (adgeziya) va bir necha soat ichida gifa (ipchalar) hosil qilib, to'qima ichiga qarab o'sa boshlaydi.

Kasallikning tarqalishida suv harorati va sifati muhim sabablardan biridir. *Saprolegnia* zamburug'lari past haroratlarda (4 °C dan 15 °C gacha) o'zlarining eng yuqori patogenlik xususiyatini namoyon etadi. Shu sababli kasallik ko'pincha qishdan keyingi bahor mavsumida, baliqlarning organizmi qishki uyqu va ochlikdan zaiflashgan, immun tizimi hali to'liq tiklanmagan davrda ommaviy tus oladi. Suvda organik moddalarning ko'payib ketishi, azotli birikmalar (ammiak, nitritlar) konsentratsiyasining ortishi, pH ko'rsatkichining keskin tebranishlari baliq uchun kuchli stress bo'lib, uning umumiy rezistentligini pasaytiradi va kasallikning hovuz bo'ylab tezkor tarqalishiga zamin yaratadi.

### 3.2. Klinik belgilari

Dermatomikozning klinik manzarasi o'ziga xos bo'lib, uni erta va kechki bosqichlarda vizual tarzda osongina tashxislash mumkin.

Boshlang'ich bosqich: baliq tanasining shikastlangan joylarida (ko'pincha bosh qismi, suzgichlar asosi, orqa qismi) ingichka, oqish yoki kulrang rangdagi iplar paydo bo'ladi. Tashqi ko'rinishidan bu iplar suv ostida tarqalgan mayda paxta tolasiga yoki momiqqa o'xshaydi. Baliq bu bosqichda bezovta bo'ladi, hovuz devorlariga va tubiga ishqalanib, qichishishni kamaytirishga harakat qiladi.

Rivojlangan bosqich: paxtasimon qoplamalar kengayib, o'zaro birlashadi va baliq tanasining katta qismini (ba'zan 50 % dan ortig'ini) qoplab oladi. Suv tarkibidagi loy va organik zarralar gifalarga yopishishi natijasida oq qoplama sarg'ish, jigarrang yoki to'q kulrang tusga kiradi. Suzgichlar yemirilib, faqat ularning qattiq nurlari qoladi (suzgichlar chirishi).

Og'ir bosqich: zamburug' ko'z sohasiga o'tganda ko'zning xiralashishi (katarakta) va ko'rlik kuzatiladi. Gifalar chuqur mushak qatlamlariga kirib borganda, terida yiringli, qontalash bo'lgan chuqur yaralar (yarali dermatomikoz) hosil bo'ladi. Baliq oziqlanishdan to'xtaydi, harakati sekinlashadi, suv yuzasiga yaqin joyda, oqim sust bo'lgan burchaklarda harakatsiz qalqib turadi. Nafas olishi qiyinlashadi, chunki patogen ko'pincha jabralarga ham o'tadi va nafas olish yuzasini yopib qo'yib, asfiksiyaga sabab bo'ladi. Oqibatda baliq organizmining osmoregulyatsiya (suv-tuz balansi) tizimi buzilishi va umumiy intoksikatsiya tufayli ommaviy o'lim yuz beradi.



**1-rasm.** Baliq tanasida zamburug' gifalarining ko'rinishi / **Fig. 1.** Appearance of fungal hyphae on the body of a fish

#### 4. QARSHI KURASH USULLARI

##### Control methods

Ilonbosh (*Channa argus*) baliq'ini intensiv yetishtirishda dermatomikozga qarshi kurashish murakkab va tizimli yondashuvni talab etadi, chunki bu tur o'zining biologik xususiyatlariga ko'ra an'anaviy karpsimon baliqlardan farq qiladi. Ilonbosh suv yuzasiga chiqib atmosfera havosidan nafas olishi sababli, suv yuzasida hosil bo'ladigan har qanday kimyoviy plyonkalar yoki o'tkir hidli dori vositalari uning nafas olish a'zolariga (suprabranxial organ) zarar yetkazishi mumkin. Shuning uchun qarshi kurash chorolari ehtiyotkorlik bilan, terapevtik dozalariga qat'iy rioya qilgan holda olib borilishi shart.

Qarshi kurash usullari uchta asosiy yo'nalishga bo'linadi: fizik-mexanik, kimyoviy-terapevtik va biologik usullar.

##### 4.1. Fizik va profilaktik usullar

Eng birinchi navbatda, hovuzlardagi suv almashinuvini jadallashtirish va filtrlash tizimlarining ishini optimallashtirish zarur. Suv tubidagi organik qoldiqlar, axlatlar va ozuqa qoldiqlari mexanik usulda muntazam tozalanib turilishi shart, chunki ular zamburug'lar ko'payishi uchun ideal substrat hisoblanadi. Kasallik belgilari aniqlangan baliqlar zudlik bilan umumiy hovuzdan ajratib olinishi (karantinga olinishi) kerak — bu infeksiya zanjirini uzishga yordam beradi. Shuningdek, baliqlarni saralash va ko'chirish jarayonida ishlatiladigan barcha anjomlar (to'rlar, chelaklar) har safar dezinfeksiya qilinishi lozim.

##### 4.2. Kimyoviy-terapevtik usullar (vannalar va ishlov berish)

Malaxit yashili taqiqlanganidan keyin, zamonaviy ixtiopatologiyada ilonboshlarni dermatomikozdan davolashda quyidagi ekologik xavfsiz va samarali kimyoviy birikmalardan foydalanilmoqda.

1. Osh tuzi (NaCl) vannalari — kasallikning boshlang'ich bosqichida eng samarali va xavfsiz usul. Baliqlarni 2–3 % li osh tuzi eritmasida (1 litr suvga 20–30 gramm tuz) 15–20 daqiqa davomida ushlab turish (vanna qilish) tavsiya etiladi. Tuz eritmasi zamburug' gifalarini suvsizlantiradi (plazmoliz), ularni o'ldiradi va ayni paytda baliq tanasida shilliq ajralishini kuchaytirib, jarohatlarning bitishini tezlashtiradi. Bu muolaja 3–5 kun davomida har kuni takrorlanadi.

2. Kaliy permanganat ( $\text{KMnO}_4$ ) — kuchli oksidlovchi xususiyatga ega bo'lib, zamburug' mitseliylarini yo'q qiladi. Davolash vannalari uchun 1 : 100 000 nisbatda (100 litr suvga 1 gramm) eritma tayyorlanadi va baliqlar unda 15–30 daqiqa davomida

cho'miltiriladi. Hovuzning o'ziga to'g'ridan-to'g'ri ishlov berilganda esa konsentratsiya 1,5–2 mg/l dan oshmasligi kerak.

##### 4.3. Biologik va immunologik usullar

Ilonboshlarning dermatomikozga chidamliligini oshirish uchun ularning ozuqa ratsioniga maxsus immunomodulyatorlar, masalan, probiotiklar va vitamin komplekslari (ayniqsa, C va E vitaminlari) qo'shiladi. Bu moddalar baliqning tabiiy immun javobini faollashtiradi, terining shilliq qavatidagi bakteritsid oqsillar sintezini kuchaytiradi; natijada jarohatlar o'z-o'zidan tez bitadi va zamburug' sporalari to'qimaga o'rnatilmaydi.

#### 5. AMALIY TAVSIYALAR

##### Practical recommendations

Baliqchilik xo'jaliklarida, xususan ilonbaliq va ilonbosh yetishtiriladigan intensiv hovuzlarda dermatomikoz kasalligining oldini olish va paydo bo'lganda to'g'ri choralar ko'rish uchun quyidagi amaliy tavsiyalarga qat'iy rioya qilish lozim.

Baliqlarni tutish, saralash, bir hovuzdan ikkinchisiga o'tkazish va tashish jarayonlarida mexanik jarohatlar yetkazishni maksimal darajada kamaytirish zarur. Ishlatiladigan to'rlar turg'un, tugunsiz va yumshoq materiallardan tayyorlangan bo'lishi shart. Har qanday texnologik jarayondan so'ng, profilaktika maqsadida hovuzga past konsentratsiyali osh tuzi (0,1–0,2 %) qo'shish maqsadga muvofiq.

Hovuzlarni muntazam va to'g'ri ohaklash. Ohak (kalsiy oksidi —  $\text{CaO}$  yoki kalsiy gidroksidi —  $\text{Ca(OH)}_2$ ) akvakulturada eng arzon, xavfsiz va samarali dezinfeksiyalovchi vositadir. Bahorgi va kuzgi mavsum boshlanishidan oldin, hovuzlar bo'shatilganda, ularning tubi va devorlariga 1 gektar maydonga 150–200 kg hisobidan so'ndirilmagan ohak sepilishi shart. Baliq bor hovuzlarda esa suvning pH darajasini nazorat qilgan holda, har 2 haftada bir marta kichik dozalarda (10–15 kg/ga) so'ndirilgan ohak suti ko'rinishida kiritish tavsiya etiladi. Bu suvning muhitini biroz ishqoriy tomonga suradi (pH 7,5–8,2), bu esa kislotali muhitni sevuvchi *Saprolegnia* zamburug'larining rivojlanishini tormozlaydi va suvni organik moddalardan tozalaydi.

Gidrokimyoviy monitoring. Suv tarkibidagi erigan kislorod miqdori doimiy ravishda 5 mg/l dan yuqori bo'lishi, ammiak ( $\text{NH}_3$ ) miqdori 0,05 mg/l dan oshmasligi nazorat qilinishi shart. Organik moddalar to'planib qolishining oldini olish uchun hovuz tubidagi suvni va loyni davriy ravishda chiqarib tashlash (sifonlash) tizimini yo'lga qo'yish lozim.

Zichlikni me'yorlashtirish. Hovuz yoki hovuzchalarda baliq o'tqazish zichligini belgilangan normativlardan oshirib yubormaslik kerak. Haddan tashqari yuqori zichlik baliqlar o'rtasida stressni kuchaytiradi va kasallikning qisqa vaqt ichida tarqalishiga sabab bo'ladi.

Karantin va sanitariya tadbirlari. Xo'jalikka tashqaridan olib kelingan har bir yangi baliq partiyasi kamida 14–21 kun davomida alohida karantin hovuzlarida saqlanishi va ularga 5 % li tuzli vannalar yordamida antiparazitar hamda antimikotik ishlov berilishi shart. Kasallik oqibatida o'lgan baliqlar zudlik bilan hovuzdan yig'ib olinishi va xavfsiz joyda kuydirilishi yoki ohak ko'milgan chuqurlarda utilitatsiya qilinishi shart; ularning suvda qolib ketishiga yo'l qo'ymaslik kerak.

#### 6. XULOSA

##### Conclusion

Ilonbaliqlar va ilonboshlar zamonaviy sanoat baliqchiligining yuqori rentabellikka ega, parhezboq va tez o'suvchi qimmatli obyektlari hisoblanadi. Ularning go'shti inson salomatligi uchun zarur bo'lgan mukammal aminokislotalar balansi hamda omega-3 ko'p to'yinmagan yog' kislotalarining boy manbayidir. Biroq ushbu baliqlarni intensiv sharoitlarda yuqori zichlikda yetishtirish texnologiyasi ularning salomatligini doimiy nazorat qilishni va birinchi navbatda mikotik kasalliklarning oldini olishni talab etadi.

Dermatomikoz kasalligi baliqlarning mexanik jarohatlanishi, past suv harorati va noqulay gidrokimyoviy sharoitlar oqibatida

rivojlanuvchi jiddiy patologiyadir. Kasallik erta bosqichlarda oq paxtasimon qoplamalar ko'rinishida namoyon bo'lib, kechki bosqichlarda chuqur to'qima nekrozlari, osmoregulyatsiyaning buzilishi va baliqlarning ommaviy nobud bo'lishiga olib keladi. Malaxit yashili kabi zararli kimyoviy moddalarning taqiqlanganligi sharoitida, dermatomikozga qarshi kurashda osh tuzi va kaliy permanganatdan to'g'ri dozalarda foydalanish hamda ozuqa ratsioniga immunomodulyatorlarni kiritish yuqori samara beradi.

Xo'jaliklarda muvaffaqiyatga erishishning bosh omili davolash emas, balki tizimli profilaktikadir. Hovuzlar tubini davriy ravishda so'ndirilmagan ohak bilan dezinfeksiya qilish, suv muhitining barqarorligini ta'minlash va baliqlarga yumshoq munosabatda bo'lish orqali dermatomikoz xavfini minimal darajaga tushirish mumkin. Ushbu ilmiy-amaliy tavsiyalarning ishlab chiqarishga to'g'ri joriy etilishi respublikamiz baliqchilik tarmoqlarining barqarorligi va iqtisodiy samaradorligini ta'minlashda muhim poydevor bo'lib xizmat qiladi.

## 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

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#### Ethics approval

The study was conducted in accordance with the veterinary-sanitary and biosecurity requirements in force in the Republic of Uzbekistan, within the framework of routine diagnostic and practical observations carried out in fish-farming enterprises. The work involved no human participants and no experiments on regulated vertebrate animals.

#### 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 data supporting the findings of this study are presented in the article and are available from the authors upon reasonable request.

#### Conflict of interest

The authors declare no conflict of interest.

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#### Generative AI disclosure

Generative AI was used only partially. The authors used Claude (Anthropic, Opus 5) for language editing, formatting of the reference list and preparation of the English and Russian metadata. No text, data, figures or conclusions were generated by AI. The authors reviewed and verified all output and take full responsibility for the content of the publication.

## EXTENDED SUMMARY IN ENGLISH

**Kengaytirilgan inglizcha xulosa / Расширенный реферат на английском языке**

### Purpose and research problem

Aquaculture and intensive fish farming occupy a leading place in ensuring modern global food security. Rapid population growth, the decline of fish stocks in natural water bodies and rising nutritional awareness all demand the accelerated development of industrial fish production technologies. Global aquaculture is dominated by cyprinids (Cyprinidae), salmonids (Salmonidae), tilapias (Cichlidae) and catfish (Siluriformes), while eels (Anguillidae) and snakehead fish (Channidae) have recently become popular objects of industrial cultivation be-

cause of their high gastronomic value and their tolerance of unfavourable environmental conditions. Snakehead fish (*Channa argus*), which is well adapted to the climate of Uzbekistan and multiplies rapidly in freshwater bodies, is particularly attractive: it can take additional oxygen from atmospheric air, tolerates oxygen deficiency in water and survives at very high stocking densities. However, as farming intensifies and stocking density rises in artificial ponds and recirculating systems, the ecological balance is disturbed and the risk of infectious, parasitic and mycotic disease outbreaks grows. Among these, dermatomycosis — commonly called saprolegniosis and caused by lower fungi of the family Saprolegniaceae, above all *Saprolegnia parasitica* — inflicts severe damage on eel and snakehead farms worldwide. The problem is aggravated by the fact that malachite green, for many years the most effective agent against mycoses in aquaculture, has been banned in fish farming worldwide, including in Uzbekistan, because of its carcinogenic and mutagenic properties. The purpose of this article is therefore to review the biology and economic importance of snakehead and eel-like fish, to analyse the causes, spread and clinical picture of dermatomycosis in these species, and to systematize the currently available safe and ecologically acceptable methods of diagnosis, treatment and prevention.

### Materials and methods

The article is an analytical review. It is based on published ichthyopathological literature on fish diseases and fish farming, on data concerning the chemical composition of fish meat and the requirements of industrial aquaculture, and on clinical observation of diseased snakehead fish in fish-farming ponds. Clinical assessment relied on the visual signs of the disease: the appearance, colour and extent of the cotton-like coating on the body and fins, the condition of the fins, the eyes and the gills, and the behaviour of the affected fish. The ecological and technological conditions associated with outbreaks were considered as well — water temperature, dissolved oxygen and ammonia content, pH, accumulation of organic matter and stocking density, together with the mechanical injuries caused by handling, grading and transfer. The control measures reviewed are grouped into three directions: physical and prophylactic measures, chemical-therapeutic treatments (baths and pond treatment) and biological or immunological approaches. Because the review does not report a controlled experiment, no experimental groups, doses tested against a control or statistical analysis are presented; the effectiveness of the measures is described qualitatively on the basis of the literature and practical observation.

### Results and discussion

Dermatomycosis in snakehead fish is a secondary infection caused by *Saprolegnia parasitica* that damages the skin, fins, eyes and sometimes the deep muscle tissue. The primary predisposing factor is mechanical injury: snakehead fish are active and predatory, they bite one another when competing for feed, hide in the pond bottom or mud when disturbed, and rub against pond walls and equipment, which damages the mucous layer and the epidermis. The mucus contains bactericidal substances such as lysozyme and immunoglobulins and forms the natural protective barrier; once it is broken, waterborne zoospores adhere to the wound and within a few hours form hyphae that grow into the tissue. Water temperature and quality are the second decisive factor: *Saprolegnia* shows its highest pathogenicity at low temperatures, between 4 °C and 15 °C, so outbreaks occur mainly in spring, after the winter period, when fish are weakened by fasting and their immune system has not yet fully recovered. Accumulation of organic matter, rising concentrations of ammonia and nitrites and sharp fluctuations of pH act as strong stressors that lower general resistance and accelerate spread through the pond. Clinically the disease is easy to recognize. At the initial stage thin whitish or greyish threads resembling cotton wool appear at injured sites, most often on the head, at the base of the fins and on the back, and the fish becomes restless and rubs against the walls and bottom. At the developed stage the cotton-like coatings merge and may cover more than half of the body; silt and organic particles adhering to the hyphae turn the coating yellowish, brown or dark grey, and the fins erode until only their hard rays remain. At the severe stage the fungus reaches the eye, causing opacity and blindness, hyphae penetrate the deep muscle layers and produce purulent, haemorrhagic ulcers, the fish stops feeding, moves slowly and floats motionless near the surface in areas of weak current. Breathing becomes difficult because the pathogen frequently spreads to the gills and covers the respiratory surface, causing asphyxia; mass mortality follows from disruption of osmoreg-

ulation and general intoxication. Losses are especially heavy in hatcheries, where mortality of eggs and fry may reach 80–100 per cent. Among the control measures, physical and prophylactic ones proved fundamental: intensifying water exchange, optimizing filtration, regularly removing organic residues and feed remains from the pond bottom, isolating diseased fish in quarantine and disinfecting all nets and buckets after each use. Of the chemical treatments that remain permissible after the ban on malachite green, sodium chloride baths are the most effective and the safest at the early stage — a 2–3 per cent solution (20–30 g of salt per litre of water) for 15–20 minutes, repeated daily for three to five days, dehydrates the hyphae by plasmolysis, kills them and at the same time stimulates mucus secretion and accelerates wound healing. Potassium permanganate acts as a strong oxidizer that destroys the mycelium; therapeutic baths are prepared at a ratio of 1 : 100 000 (1 g per 100 litres) with immersion for 15–30 minutes, while direct pond treatment must not exceed 1.5–2 mg/l. Biological and immunological measures — adding probiotics and vitamin complexes, particularly vitamins C and E, to the diet — activate the natural immune response and increase the synthesis of bactericidal proteins in the skin mucus, so that wounds heal faster and spores cannot establish themselves in the tissue. Care is required with all treatments because snakehead fish breathe atmospheric air at the water surface, and chemical films or pungent preparations on the surface may damage their suprabranchial respiratory organ.

### Conclusion and contribution

Eels and snakehead fish are highly profitable, fast-growing and dietetically valuable objects of modern industrial fish farming, and their meat is a rich source of a complete amino-acid balance and omega-3 polyunsaturated fatty acids. Intensive high-density cultivation, however, requires continuous health monitoring and, above all, prevention of mycotic disease. Dermatomycosis develops as a consequence of mechanical injury, low water temperature and unfavourable hydrochemical conditions; it appears at an early stage as white cotton-like coatings and at a late stage leads to deep tissue necrosis, disruption of osmoregulation and mass mortality. Now that harmful chemicals such as malachite green are banned, the correct use of sodium chloride and potassium permanganate at proper doses, together with the inclusion of immunomodulators in the diet, gives good results. The main factor of success on a farm is not treatment but systematic prevention: periodic disinfection of the pond bottom with quicklime, maintenance of a stable water environment and gentle handling of the fish can reduce the risk of dermatomycosis to a minimum. The contribution of this review lies in bringing together, for the conditions of fish farms in Uzbekistan, the biological, ecological, clinical and management aspects of saprolegniosis control, and in setting out a practical, malachite-green-free scheme of prevention and treatment that farms can apply directly.

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