

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**

¹ Scientific-Research Institute of Veterinary, Samarkand, Uzbekistan

* Corresponding author: yuldoshevhojiakbar7@gmail.com

ARTICLE INFO

ARTICLE TYPE

Review

LANGUAGE OF FULL TEXT

O'zbekcha (UZ)

SCIENTIFIC FIELD / OAK

☒ 16.00.00 – Veterinary Sciences

Veterinariya fanlari

HAC Presidium decision No. 371/5, 13.06.2025

Series C

UDC / UDK

639.3.09:619:616-091:614.31

ARTICLE HISTORY

Received: 2026-09-01

Revised: 2026-09-11

Accepted: 2026-09-18

Published: 2026-09-30

DOI

<https://doi.org/10.66073/ReFocus.V5I9.0912>

CONTACT

ReFocusJournal@gmail.com

LICENSE



Creative Commons Attribution 4.0 International (CC BY 4.0). This is an open access article distributed under the terms of the CC BY 4.0 licence.

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

ENGLISH

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

¹ Scientific-Research Institute of Veterinary, Samarkand, Uzbekistan

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

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

¹ Veterinariya ilmiy-tadqiqot instituti, Samarqand, O'zbekiston

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

РУССКИЙ

How to cite / Iqtibos keltirish / Как цитировать: YULDASHEV, X. T., SULAYMANOVA, N. A., IKROMOVA, S. O. (2026). Pathomorphological changes, etiopathogenesis, and veterinary-sanitary measures of non-infectious branchionecrosis in carp. Research Focus International Scientific Journal, 5(9), 96–100.
<https://doi.org/10.66073/ReFocus.V5I9.0912>

© 2026 The Author(s). Published by Research Focus International Scientific Journal. Open access article under the CC BY 4.0 licence.

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.

ЮЛДАШЕВ Хожиякбар Тошпулатович^{1*} , СУЛАЙМАНОВА Нафиса Абдимуниновна¹ , ИКРОМОВА Сарвиноз Орифжон кизи¹

¹ Научно-исследовательский институт ветеринарии, Самарканд, Узбекистан

Аннотация. В данной научной статье на основе анализа литературы изучены причины возникновения, тканевый патогенез и патоморфологические изменения на органном уровне неинфекционного некроза жабр (branchiononecrosis) - 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 ozuqalar 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 membranasi 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'paya 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 patogistologik 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.

Funding

This research received no external funding.

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.

ADABIYOTLAR RO'YXATI

References (original language)

- [1] Ro'ziqulov R.F. Baliqlar Fiziologiyasi va Toksikologiyasi: Oliy o'quv yurtlari uchun darslik. - Toshkent: Ideal Press, 2023. – 255 b.
- [2] Jumanov M.A., Mohammadiyev Z.N. Sun'iy havzalardagi gidrokimyoviy disbalans va uning karpsimon baliqlar sog'lig'iga ta'siri. // O'zbekiston veterinariya tibbiyoti jurnali, №2, 2025. - B. 14–18.
- [3] Farkas J., Oláh J. Gill necrosis — a complex disease of carp. // Aquaculture, vol. 58, no. 1-2, 1986, pp. 17–29. doi:10.1016/0044-8486(86)90153-5.

- [4] Svobodova Z., Lloyd R., Machova J., Vykusova B. Water Quality and Fish Health. // EIFAC Technical Paper, no. 54. Rome: FAO, 1993.
- [5] Zawisza A., Szwaczkowski T. Gill disorders in intensive aquaculture: environmental and infectious factors. // Reviews in Aquaculture, vol. 16, no. 3, 2024, pp. 1102-1119.

REFERENCES (ROMAN SCRIPT)

Transliterated list — required by Scopus and Web of Science

- [1] Ro'ziqulov R.F. Baliqlar Fiziologiyasi va Toksikologiyasi: Oliy o'quv yurtlari uchun darslik [Physiology and toxicology of fish: a textbook for higher education institutions]. - Toshkent: Ideal Press, 2023. – 255 b. (in Uzbek)
- [2] Jumanov M.A., Mahammadiyev Z.N. Sun'iy havzalardagi gidrokimyoviy disbalans va uning karpsimon baliqlar sog'lig'iga ta'siri [Hydrochemical imbalance in artificial ponds and its effect on the health of cyprinid fish]. // O'zbekiston veterinariya tibbiyoti jurnali, №2, 2025. - B. 14-18. (in Uzbek)
- [3] Farkas J., Oláh J. Gill necrosis — a complex disease of carp. // Aquaculture, vol. 58, no. 1-2, 1986, pp. 17-29. doi:10.1016/0044-8486(86)90153-5.
- [4] Svobodova Z., Lloyd R., Machova J., Vykusova B. Water Quality and Fish Health. // EIFAC Technical Paper, no. 54. Rome: FAO, 1993.
- [5] Zawisza A., Szwaczkowski T. Gill disorders in intensive aquaculture: environmental and infectious factors. // Reviews in Aquaculture, vol. 16, no. 3, 2024, pp. 1102-1119.