плідні результати в аквакультурі в подальших перспективах. Майбутні дослідження, спрямовані на виділення і ідентифікацію активних речовин з етанольних фракцій різних видів Ficus, допоможуть також дослідити сполуки з кращою антибактеріальною цінністю. Скринінг всіх досліджуваних рослин щодо інших видів біологічної активності, включаючи імуностимулюючу і антиоксидантну, матиме важливе значення в практичній аквакультурі.

Ключові слова: Aeromonas hydrophila, Citrobacter freundii, Pseudomonas fluorescens, Yersinia ruckeri, антимікробна активність, диско-дифузійний метод Байєра-Кірбі, етанольний екстракт

УДК 597.08:628.394: 597.0/5–11

BIOMARKERS OF OXIDATIVE STRESS IN THE CARDIAC TISSUE OF BROWN TROUT (*SALMO TRUTTA* M. *FARIO* L.) AFTER CHLORAMINE-T DISINFECTION

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In this study, we have tested the use of Chloramine-T in dose 9 mg per L in disinfective procedures in brown trout (Salmo trutta m. fario L.). The aim of the present study was to examine the effects of disinfection by chloramine-T on the cardiac tissue of brown trout using oxidative stress biomarkers [levels of 2-thiobarbituric acid reactive substances (TBARS) and oxidatively modified protein products] to observe the its toxic effects. The endpoints obtained from this study will be useful to monitor the effects of disinfectant bathing with chloramine-T for this species of fish. This study opens a new perspective on the investigation of toxic effects of Chloramine-T, mainly with respect to the biochemical parameters in various tissues of brown trout. Significantly lower TBARS level (by 13 %, p>0.05) in trout disinfected by Chloramine-T compared to control group was observed. Aldehydic and ketonic derivatives of oxidatively modified proteins in the cardiac tissue of brown trout disinfected by chloramine-T were non-significantly lower compared to controls. The present work demonstrated changes in oxidative stress indices in the cardiac tissue of brown trout after disinfected action to Chloramine-T. During the disinfection, all parameters measured remained at control values with low concentration exposures. The parameters measured could provide useful information for evaluating the biochemical effects of Chloramine-T on fish, but needs more detailed investigation before these findings can be used to monitor the aquatic environment. Mechanisms of these physiological responses in fish need to be further studied.

Keywords: **Chloramine-T, disinfection, brown trout (*Salmo trutta* m. *fario* L.), cardiac tissue, lipid peroxidation, oxidatively modified proteins.**

Chloramine-T has been used as a disinfectant since the early 1900s in a wide variety of industries that range from hospital to agricultural use. It is effective against a

large number of bacteria and viruses without inducing drug resistance. The aquaculture industry has become very interested in developing Chloramine-T for use as a therapeutant against proliferative gill disease (PGD) and bacterial gill disease (BGD) [2]. Chloramine-T is easy to use and effective against many bacteria (both Gram-negative and Gram-positive), viruses (enveloped and naked), fungi, algae, yeast, and parasites [2]. Chloramine-T is effective for the control of bacterial gill disease, proliferative gill disease, and flexibacteriosis. Bacterial gill disease is caused by a variety of Gram-negative bacteria (myxobacteria, aeromonads, and pseudomonads [2, 12]. The disease is highly contagious among cultured salmonids and can lead to substantial fish losses. An approved therapeutant to control bacterial gill disease is needed to enable the production of salmonids for restoration of fish stocks and for sport and commercial fisheries. Flexibacteriosis is a generic term that includes columnaris disease, saddleback disease, bacterial cold water disease, tail rot, peduncle disease, and related infections caused by the disease organisms *Flexibacter columnaris* (*Cytophaga columnaris*) and *F. psychrophilus* in freshwater and *F. maritimus* in marine fish [2].

The mode of action of chloramine-T is thought to be through oxidative processes, quickly destroying cell material or disrupting essential cellular processes. Microorganisms do not develop resistances to chloramine-T as often happens with antibiotics. In addition, the chloramine-T ion is highly stable and remains active over an extended period of time. Because chloramine-T is effective at low concentrations (200 to 300 ppm [710 to 1070 μM]), it is an effective disinfectant without causing tissue cytotoxicity. It may be used as a disinfectant for both skin and for wounds [2].

Impacts of chloramine-T have been assessed in a variety of freshwater and marine life. In spotted sea trout eggs and larvae, 48-hour medium tolerance limits were 14.14, 0.57 and 5.75 ppm [50.20, 2.0, and 20.4 μM] for two-hour- and ten-hour-old eggs, and one-hour post-hatch larvae, respectively. Exposure of larval lobsters to 1.0 mg/L [3.6 μM] chloramine-T resulted in a reduction in dry weight increase, standard respiration rate, growth, and metabolic activity (Chloramine-T [127-65-1] and Metabolite p-Toluenesulfonamide [70-55-3]).

In intermittent exposures of rainbow trout to chloramine-T at the therapeutic concentration (10 mg/L [36 μM]), the fish exhibited behaviors that were consistent with respiratory distress (i.e., fish crowing at the surface and appeared to hyperventilate (study details not provided) (Powell and Perry 1996). Additional studies were performed to investigate the impact of a single exposure to chloramine-T. One-hour exposures of rainbow trout to chloramine-T (9 or 2 mg/L [30 or 7 μM]) or p-TSA (9 mg/L [50 μM]) through catheterized dorsal aorta resulted in a significant increase in both ventilation rates and PCO_2 levels. Both parameters returned to baseline levels within 90 minutes of removal from chloramine-T [2].

Crayfish were tolerant to short-term chloramine-T exposure, while rapid crayfish reaction to an increased chemical level indicated their high sensitivity, an essential attribute of real-time environmental assessment [7]. To assess whether narrow-clawed crayfish *Astacus leptodactylus* can respond by heart rate changes to presence in water of such biocide as chloramine-T, adult males in study of Kuklina and co-workers (2014) were exposed to its low (2 and 5 mg L^{-1}), moderate (10 mg L^{-1}, commonly used in industry and aquaculture) and exceeded (20 and 50 mg L^{-1}) concentrations. In addition, a physical stress test evaluated energy expenditure following the chemical trials. Three key reactions (cardiac initial, first-hour and daily prolonged exposure) were discussed with particular focus on crayfish initial reaction as the most meaningful in on-line water quality biomonitoring. After short-term exposure to both chloramine-T concentrations, crayfish were found to respond rapidly, within 2–5 min. According to heart rate chang-

es, the 1-h exposure did not adversely affect crayfish at either concentration, as well as during daily exposure to 10 mg L^{-1}. As assessed by the heart rate, the 24-h exposure to 50 mg L^{-1} of chloramine-T was toxic for crayfish and led to substantial loss of energy that became apparent during subsequently conducted physical stress. The results of Kuklina and co-workers (2014) supported a hypothesis that crayfish vital functions are connected with environment they inhabit closely enough to serve as biological monitors [7].

In this study, we have tested the use of Chloramine-T in dose 9 mg per L in disinfective procedures in brown trout (*Salmo trutta* m. *fario* L.). The aim of the present study was to examine the effects of disinfection by chloramine-T on the cardiac tissue of brown trout using oxidative stress biomarkers (levels of 2-thiobarbituric acid reactive substances and oxidatively modified protein products) to observe the its toxic effects. The endpoints obtained from this study will be useful to monitor the effects of disinfectant bathing with chloramine-T for this species of fish. This study opens a new perspective on the investigation of toxic effects of Chloramine-T, mainly with respect to the biochemical parameters in various tissues of brown trout.

Material and methods. ***Fish.*** Twenty clinically healthy brown trout (*Salmo trutta* m. *fario* L.) were used in the experiments. The study was carried out in a Department of Salmonid Research, Stanislaw Sakowicz Inland Fisheries Institute (Rutki, Poland). Experiments were performed at a water temperature of 16±2 °C and the pH was 7.5. The dissolved oxygen level was about 12 ppm with additional oxygen supply. All biochemical assays were carried out at Department of Zoology, Institute of Biology and Environmental Protection, Pomeranian University in Słupsk (Poland).

The fish were divided into two groups and held in 250-L square tanks (70 fish per tank) supplied with the same water as during the acclimation period (2 days). On alternate days, the water supply to each tank was stopped. In the disinfectant exposure, brown trout (n=10) were exposed to Chloramine-T in final concentration 9 mg per L. Control group of brown trout (n=10) were handled in the same way as Chloramine-T exposed groups. Fish were bathed for 20 min and repeated three times every 3 days. Two days after the last bathing fish were sampled. Fish were not anesthetized before tissue sampling.

Tissue isolation. Tissue samples were removed from fish after decapitation. One fish was used for each homogenate preparation. Briefly, tissue samples were excised, weighted and washed in ice-cold buffer. The minced tissue was rinsed clear of blood with cold isolation buffer and homogenized in a homogenizer H500 with a motor-driven pestle on ice. The isolation buffer contained 100 mM tris-HCl; pH of 7.2 was adjusted with HCl.

Analytical methods. All enzymatic assays were carried out at 25±0.5 °C using a Specol 11 spectrophotometer (Carl Zeiss Jena, Germany). The enzymatic reactions were started by adding the homogenate suspension. The specific assay conditions are presented subsequently. Each sample was analyzed in triplicate. The protein concentration in each sample was determined according to Bradford (1976) using bovine serum albumin as a standard [1].

Assay of 2-thiobarbituric acid reactive substances (TBARS). An aliquot of the homogenate was used to determine the lipid peroxidation status of the sample by measuring the concentration of 2-thiobarbituric-acid-reacting substances (TBARS), according to the method of Kamyshnikov (2004) [6]. Reaction mixture contained sample homogenate (2.1 mL, 10 % w/v) in tris-HCl buffer (100 mM, pH 7.2), 2-thiobarbituric acid (TBA; 0.8 %, 1.0 mL), and trichloracetic acid (TCA; 20 %, 1.0 mL). The total volume was kept in a water bath at 100°C for 10 min. After cooling, mixture was centri-

fuged at 3,000g for 10 min. The absorbance of the supernatant was measured at 540 nm. TBARS values were reported as nmoles malonic dialdehyde (MDA) per mg protein.

Assay of carbonyl groups of oxidatively modified proteins. Carbonyl groups were measured as an indication of oxidative damage to proteins according to the method of Levine and co-workers (1990) [8] in modification of Dubinina and co-workers (1995) [3]. Samples were incubated at room temperature for 1 h with 10 mM 2,4-dinitrophenylhydrazine (DNTP) in 2M HCl. Blanks were run without DNTP. Afterwards, proteins were precipitated with 20 % TCA and centrifuged for 20 min at 3,000 g. The protein pellet was washed three times with ethanol:ethylacetate (1:1) and incubated at 37°C until complete resuspension. The carbonyl content was measured spectrophotometrically at 370 nm (aldehydic derivatives, OMP_{370}) and at 430 nm (ketonic derivatives, OMP_{430}) (molar extinction coefficient 22,000 $M^{-1} \cdot cm^{-1}$) and expressed as nmol per mg protein.

Statistical analysis. Results are expressed as mean ± S.E.M. All variables were tested for normal distribution using the Kolmogorov-Smirnov test ($P>0.05$). Significance of differences in the oxidative stress biomarkers in the cardiac tissue of brown trout between control and Chloramine-T-exposed groups (significance level at $p<0.05$) was examined using Mann-Whitney *U* test according to Zar (1999) [22]. In addition, the relationships between oxidative stress biomarkers of all individuals were evaluated using Spearman's correlation analysis. All statistical calculations were performed on separate data from each individual with STATISTICA 8.0 software (StatSoft, Krakow, Poland).

Results. Influence of chloramine-T disinfection on lipid peroxidation biomarker, measured as 2-thiobarbituric acid reactive substances in the cardiac tissue of brown trout are presented in Fig. 1A. Significantly lower TBARS level (by 13%, $p>0.05$) in trout disinfected by Chloramine-T compared to control group was observed (Fig. 1A).

Aldehydic and ketonic derivatives of oxidatively modified proteins in the cardiac tissue of brown trout disinfected by chloramine-T were non-significantly lower compared to controls (Fig. 1B).

Discussion. Our results showed that Chloramine-T disinfection caused to decrease lipid peroxidation with non-significant reduce of aldehydic and ketonic derivatives of oxidative proteins (Fig. 1). Our studies indicated that chloramine-T in dose 9 mg per L could at least partly attenuate oxidative stress and can be used for prophylactic treatment of brown trout. However, more detailed studies on using of these specific biomarkers to monitor the disinfectant treatment in aquaculture are needed.

In our previous study [14-21], we assessed the influence of chloramine-T on oxidative stress biomarkers and metabolic alterations in various tissues of grayling and rainbow trout (*Oncorhynchus mykiss* Walbaum). Chloramine-T bathing markedly decrease aldehydic and ketonic derivatives of oxidative protein, and aminotransferases activity only in rainbow trout liver, and their elevation is a compensatory mechanism to impaired metabolism. No significant changes were found in oxidative stress biomarkers between control and chloramine-treated brown trout. For grayling, Chloramine-T exposure caused significantly elevation in the levels of severe oxidative stress biomarkers in the liver. Increased aldehydic and ketonic derivatives of oxidative protein could modify lactate and pyruvate levels, aminotransferases and lactate dehydrogenase activities, principally causing increased enzymes activity due to oxidative stress in the liver of chloramine-exposed fish [21]. Our results also showed that chloramine-T bathing markedly increase aldehydic and ketonic derivatives of oxidative protein in hepatic tissue, while significantly decrease of carbonyl derivatives in cardiac tissue of grayling was observed [14, 17]. In the muscle tissue of grayling, chloramine-T bathing markedly de-

crease lipid peroxidation with non-significant decrease of aldehydic and ketonic derivatives of oxidative proteins. However, reduced lipid peroxidation results in decrease of total antioxidant capacity. Moreover, decreased lipid peroxidation level causes decrease of aldehydic and ketonic derivatives of oxidatively modified proteins [18]. Our results also showed that Chloramine-T non-significantly decrease lipid peroxidation as well as aldehydic and ketonic derivatives of oxidative proteins in the gills of grayling. No statistically significant alterations in the activities of antioxidant defenses instead catalase and superoxide dismutase activity in the gill tissue of grayling disinfected by Chloramine-T were noted [16].

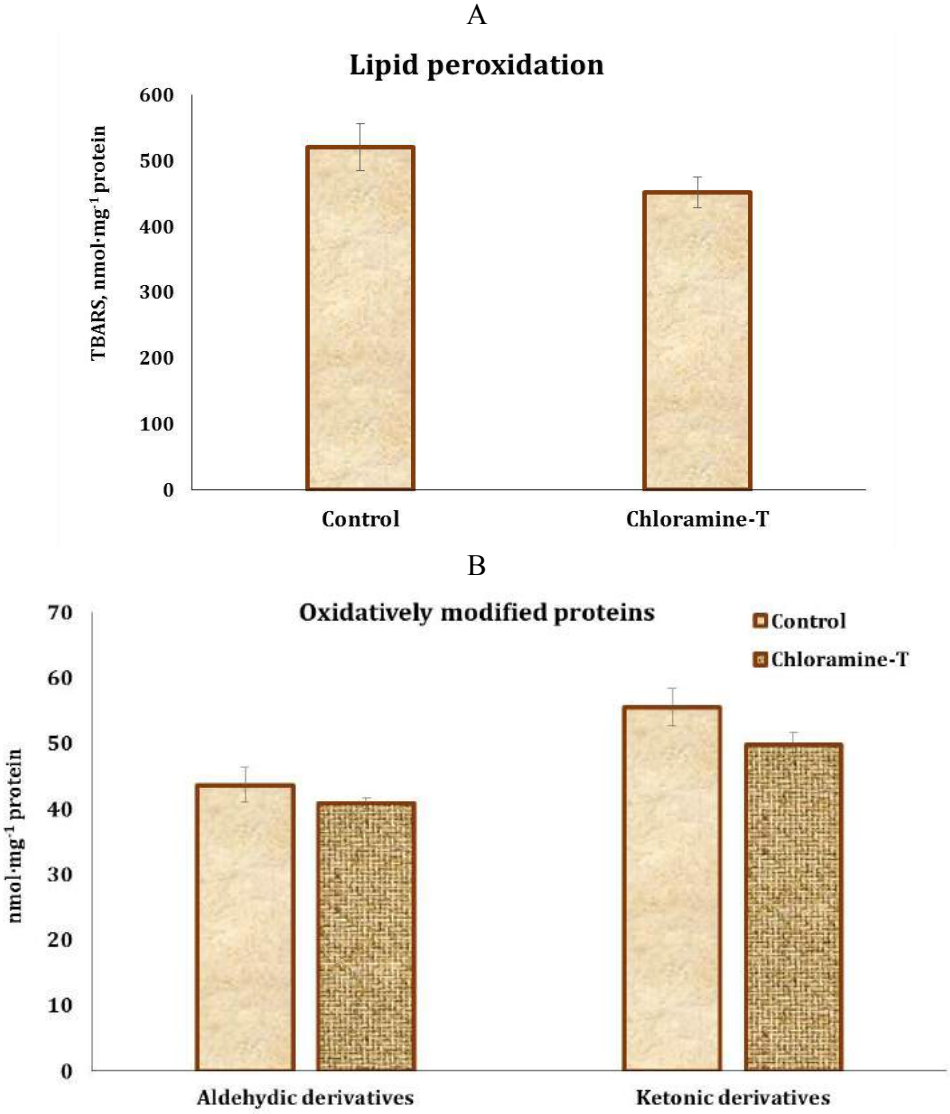

Fig. 1. Lipid peroxidation biomarker, measured as 2-thiobarbituric acid reactive substances (A), aldehydic and ketonic derivatives of oxidatively modified proteins (B) in the cardiac tissue of brown trout disinfected by Chloramine-T.
Data are represented as mean ± S.E.M.

The effects of disinfection by Chloramine-T using oxidative stress biomarkers (levels of 2-thiobarbituric acid reactive substances and derivatives of oxidatively modified proteins) and biochemical enzymes' activity [alanine- and aspartate aminotransferases (ALT and AST), lactate dehydrogenase (LDH)] were assessed in the muscle tissue of rainbow trout [15]. Our results showed that Chloramine-T bathing caused the decrease of the lipid peroxidation as well as ALT and AST activity and significant de-

crease of LDH activity (by 339 %, p = 0.017) compared to controls. Chloramine-T markedly affected on lactate and pyruvate metabolism and resulted to decrease of LDH activity. Correlative analysis revealed that the lipid peroxidation level is correlated with ALT and AST activity in the muscle tissue of unhandled control group. In the muscle tissue of trout disinfected by Chloramine-T, LDH activity is correlated positively with ALT and AST activity. Thus, the skeletal muscles of fish play an important role in the processing of lactate through the gluconeogenic and glycogenic pathways including a greater potential for biosynthesis [15, 19].

The effects of disinfection by Chloramine-T on the muscle tissue of grayling using oxidative stress biomarkers [levels of TBARS and oxidative modified protein (OMP) derivatives] and antioxidant defense (superoxide dismutase, catalase, glutathione reductase, glutathione peroxidase, total antioxidant capacity) was studied in our previous study [20]. Our results showed that Chloramine-T bathing markedly decrease lipid peroxidation with non-significant decrease of aldehydic and ketonic derivatives of oxidatively modified proteins. However, reduced lipid peroxidation results in decrease of total antioxidant capacity. Moreover, decreased lipid peroxidation level causes decrease of aldehydic ($r = 0.854$, $p = 0.002$) and ketonic derivatives of oxidatively modified proteins ($r = 0.852$, $p = 0.002$). Fish developed tissue-specific enzyme responses, such as decrease in superoxide dismutase and catalase activity as well as total antioxidant capacity in muscle tissue with decrease of lipid peroxidation as response to the Chloramine-T disinfection. Correlative analysis has revealed positive correlations between oxidative stress biomarkers (aldehydic and ketonic derivatives of oxidatively modified proteins, TBARS as marker of lipid peroxidation) and antioxidant defenses [20].

In fish aquaculture, disinfectants are used against bacterial and protozoal infections. These compounds cause oxidative stress that may stimulate the generation of reactive oxygen species, and subsequently the alteration in antioxidant systems of exposed organisms [13]. On the other hand, the results of Sirri and co-workers (2013) suggest a good tolerability of Doctor fish (*Garra rufa*) to the two disinfectants (chloramine T and peracetic acid) at the concentrations tested (2 mg/l and 10 mg/l of chloramine T and to 15 microl/l and 45 microl/l of peracetic acid in a 40-minute static bath up to six times a day for one week). The epidermis and gills were checked for histological changes and the number of epidermal mucous cells, club cells and taste buds were quantified; mucous cells were also characterized histochemically to detect alterations in mucin production. No mortality or severe histological changes were found in treated or control fish. Cell count showed a significant increase ($p < 0.05$) in mucous cells (mean 49.1 ± 6.7 vs 37.0 ± 13.1 of controls) in animals treated with peracetic acid independently of the dose. Club cell number showed a significant ($p < 0.05$) decrease in fish treated with 2 mg/l of chloramine T (mean 74.3 ± 15.6) and with 45 microl/l of peracetic acid (mean 78.17 ± 10.5) compared to controls (mean 107.0 ± 19.2). Histochemical evaluation of mucous cells did not reveal changes in mucin type in fish exposed to the two disinfectants [11].

Impacts of chloramine-T have been assessed in a variety of freshwater and marine life. In spotted sea trout eggs and larvae, 48-hour medium tolerance limits were 14.14, 0.57 and 5.75 ppm [50.20, 2.0, and 20.4 μM] for two-hour- and ten-hour-old eggs, and one-hour post-hatch larvae, respectively [5]. Exposure of larval lobsters to 1.0 mg/L [3.6 μM] chloramine-T resulted in a reduction in dry weight increase, standard respiration rate, growth, and metabolic activity [5]. In intermittent exposures of rainbow trout to chloramine-T at the therapeutic concentration (10 mg/L [36 μM]), the fish exhibited behaviors that were consistent with respiratory distress (i.e., fish crowing at the

surface and appeared to hyperventilate [9, 10]. Additional studies were performed to investigate the impact of a single exposure to chloramine-T. One-hour exposures of rainbow trout to chloramine-T (9 or 2 mg/L [30 or 7 μM]) or p-TSA (9 mg/L [50 μM]) through catheterized dorsal aorta resulted in a significant increase in both ventilation rates and PCO_2 levels. Both parameters returned to baseline levels within 90 minutes of removal from chloramine-T.

Chloramine-T also caused a reduction in arterial pH. p-TSA had no significant effect on ventilation rates, PCO_2, or PO_2 levels. A gradual decrease in pH was noted during the exposure period that persisted throughout the recovery period. No effects were found for either hematological parameters or serum catecholamine levels with any of the treatments [9]. Despite the increased ventilation rate in the chloramine-T treated fish, PCO_2 remained elevated. This suggested that a difference in the diffusive conductance of the gills, impairing CO_2 excretion, possibly by the secretion of mucous by the gills, increasing the blood to water diffusion distance and/or unstirred boundary layer of the gills. This effect could be a result of the release of hypochlorite from chloramine-T. Single exposures of therapeutic concentrations of chloramine-T appear to have little pathophysical impact on the health of rainbow trout [9]. Maximum tolerated levels for rainbow trout ranged from 325 mg/L [1150 μM] for 0.1-hour one-hour exposures to 20 mg/L [71 μM] for 12-hour exposures [4].

Conclusions. The present work demonstrated changes in oxidative stress indices in the cardiac tissue of brown trout after disinfected action to Chloramine-T. During the disinfection, all parameters measured remained at control values with low concentration exposures. The parameters measured could provide useful information for evaluating the biochemical effects of Chloramine-T on fish, but needs more detailed investigation before these findings can be used to monitor the aquatic environment. Mechanisms of these physiological responses in fish are not clear, and need to be further studied.

This work was supported by grant of the Pomeranian University for Young Scientists.

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БИОМАРКЕРЫ ОКИСЛИТЕЛЬНОГО СТРЕССА В СЕРДЕЧНОЙ ТКАНИ КУМЖИ (SALMO TRUTTA M. FARIO L.) ПОСЛЕ ДЕЗИНФЕКЦИИ ХЛОРАМИНОМ-Т

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В этом исследовании мы исследовали влияние дезинфицирующего средства Хлорамина-Т в дозе 9 мг/л у кумжи (Salmo trutta m. fario L.). Целью настоящего исследования было изучение последствий воздействия Хлорамина-Т на сердечную ткань кумжи, используя биомаркеры окислительного стресса [уровень реактивных соединений реагирующих с тиобарбитуровой кислотой (TBARS), альдегидные и кетоновые производные окислительно модифицированных белков]. Это исследование открывает новую перспективу для исследования токсических эффектов Хлорамина-Т, главным образом в отношении биохимических параметров в различных тканях кумжи. Наши результаты показали, что дезинфекция Хлорамином-Т несущественно снижает перекисное окисление липидов и содержание альдегидных и кетоновых производных окислительных белков. Наблюдался значительно более низкий уровень TBARS (на 13%, p>0,05) у кумжи после дезинфицирующих процедур с Хлорамином-Т по сравнению с контрольной группой. Альдегидные и кетоновые производные окислительно модифицированных белков в сердечной ткани кумжи, дезинфицированной Хлорамином-Т, были ниже по сравнению с значениями в контрольной группе. В настоящей работе были продемонстрированы изменения показателей окислительного стресса в сердечной ткани кумжи после дезинфицирующих процедур с Хлорамином-Т. Измеренные параметры могли бы предоставить полезную информацию для оценки биохимических эффектов Хлорамина-Т на рыбу, но для более детального изучения эти данные могут быть использованы также для мониторинга водной среды. Механизмы этих физиологических реакций у рыб нуждаются в дальнейшем изучении.

Ключевые слова: Хлорамин-Т, дезинфекция, кумжа (Salmo trutta m. fario L.), сердечная ткань, перекисное окисление липидов, окислительно модифицированные белки.

БІОМАРКЕРИ ОКИСНЮВАЛЬНОГО СТРЕСУ У СЕРЦЕВІЙ ТКАНИНІ СТРУМКОВОЇ ФОРЕЛІ (SALMO TRUTTA M. FARIO L.) ПІСЛЯ ДЕЗІНФЕКЦІЇ ХЛОРАМІНОМ-Т

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У цьому дослідженні ми оцінили вплив дезінфікуючого засобу хлораміну-Т в дозі 9 мг/л у струмкової форелі (Salmo trutta m. fario L.). Метою цього дослідження було вивчення наслідків впливу хлораміну-Т на серцеву тканину струмкової форелі, використовуючи біомаркери окиснювального стресу [вміст реактивних сполук, які реагують з 2-тіобарбітурової кислотою (TBARS), альдегідні і кетонові

похідні окислювально змодифікованих білків]. Це дослідження відкриває нові перспективи для дослідження токсичних ефектів хлораміну-Т, головним чином щодо біохімічних параметрів у різних тканинах струмкової форелі. Наші результати показали, що дезінфекція хлораміном-Т несуттєво знижує перекисне окиснення ліпідів і вміст альдегідних і кетонових похідних окиснювальних білків. Спостерігався значно нижчий рівень TBARS (на 13 %, p>0,05) у струмкової форелі після дезинфікуючих процедур з хлораміном-Т порівняно з контрольною групою. Альдегідні і кетонові похідні окиснювально модифікованих білків в серцевій тканини струмкової форелі після дезинфікуючих процедур з хлораміном-Т були нижчі в порівнянні із значеннями в контрольній групі риб. У даній роботі були продемонстровані зміни показників окиснювального стресу в серцевої тканини струмкової форелі після дезинфікуючих процедур з хлораміном-Т. Маркери оксидаційного стресу могли б надати корисну інформацію для оцінки біохімічних ефектів хлораміну-Т на рибу, але для більш детального вивчення ці дані можуть бути використані також для моніторингу водного середовища. Механізми цих фізіологічних реакцій у риб потребують подальшого вивчення.

Ключові слова: Хлорамін-Т, дезінфекція, струмкова форель (Salmo trutta m. fario L.), серцева тканина, перекисне окиснення ліпідів, окиснювально модифіковані білки.

УДК 636.2.082.24.083.314

ВПЛИВ МОНБЕЛЬЯРДСЬКИХ БУГАЇВ НА СЕЛЕКЦІЙНІ ПОКАЗНИКИ УКРАЇНСЬКОЇ ЧОРНО-РЯБОЇ МОЛОЧНОЇ ПОРОДИ В УМОВАХ БЕЗПРИВ'ЯЗНОГО УТРИМАННЯ

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У статті розглядається вплив аналізуючого схрещування монбельярдських бугаїв із українською чорно-рябою молочною породою в умовах безприв'язного утримання на довгонезмінній солом'яній підстилці. Встановлено, що отримані помісі характеризуються нижчими адаптаційними здатностями в порівнянні з нащадками голштинських бугаїв. Про це свідчить більша кількість абортів, кількість мертвонароджених телят у період тільності та нижча збереженість телиць до 6-місячного віку. У той же час дочки монбельярдських бугаїв мають вищу енергію росту. У 6-місячному віці вони перевищували ровесниць на 10,3 кг.

Ключові слова: **українська чорно-ряба молочна порода, монбельярдські бугаї, відтворювальна здатність, отелення, телиці.**

Одним із основних факторів інтенсифікації галузі молочного скотарства в сучасних умовах є цілеспрямована селекційно-племінна робота, яка сприяє генетичному зростанню продуктивності молочних порід. Останнім часом інтенсивне використання сперми голштинів за схемою поглинального схрещування, привело до появи у тварин із високою умовною часткою крові по голштинській породі, ряду проблем із відтворенням, продуктивним довголіттям і здоров'ям [1, 2]. Основним методом вдосконалення порід залишається чистопородне розведення із застосуванням в необхідних випадках спорідненого чистопородного схрещування [3, 4].