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The National Scientific Center 'Institute of the Experimental and Clinical Veterinary Medicine' is the leading specialized research institution in Ukraine created for solving scientific and practical tasks of veterinary animal. NSC IECVM's basic research are focused on: immunogenesis and disease pathogenesis, indications, authentications, isolations and studies of biological features of their causative agents, developments of facilities and systems of monitoring, diagnostics, prophylaxis and prognostication of infectious diseases of animals, monitoring of quality and unconcern of agricultural produce and development of the normative basis for animal diseases control and biosafety. NSC IECVM coordinates implementation of scientific researches on questions veterinary medicine, that conduct scientific establishments of NAAS, State Service of Ukraine for Food Safety and Consumer Protection, and Higher educational establishments of Ukraine of agrarian profile.

New journal 'Journal for Veterinary Medicine, Biotechnology and Biosafety", discovered in 2015, aimed to consolidate and share the new developments and achievements in the area of biological science. This was recognized as the profile edition for veterinary medicine doctors and biologists in Ukraine. Our journal promotes the research of Ukrainian institutions, publishing their achievements in English, and sharing it among the scientific community. It includes cooperative veterinary and medical aspects, fitting to One Health Approach declared by WHO, OIE, and FAO. It was included in Index Copernicus and eLibrary scientific databases.

The Editorial board hopes, that our issue will be interesting for wide auditorium of scientists and practical specialists in veterinary medicine, biology, biotechnology and biosafety. We invite new authors for fruitful collaboration and joint development.

Sincerely yours,
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5. Tables and illustrations must be must be submitted as separate files and inserted in the text

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EFFICACY OF UDDER HYGIENE PRODUCTS OF 'FORTICEPT' LINE IN THE PREVENTION OF SUBCLINICAL MASTITIS IN COWS

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Summary. The aim of the research was to test experimental samples of udder hygiene products 'Forticept Udder Wash' and 'Forticept Udder Forte' in the prevention of subclinical mastitis in cows. To study the effect of experimental products for udder treatment before and after milking of the line 'Forticept', two groups of cows (n = 48) were formed in PE 'Demetra-2010' (Kamianets-Podilskyi District, Khmelnytskyi Region). Animals of the experimental group were treated with experimental samples of drug 'Forticept Udder Wash' before milking and 'Forticept Udder Forte' after milking. Cows of control group were treated with the drug for udder hygiene based on iodine — 'Uberaseptic SB'. The criteria for selection of animals into groups were the somatic cells count (SCC) in the milk of each quarter of the udder and the quantity of mesophilic aerobic and facultative anaerobic microorganisms (QMAFAnM) in milk. All animals of the experimental and control groups were diagnosed for the presence of a subclinical form of mastitis using the reagent 'Profilac Reagent N' (Westfalia). Examination of cattle for the presence of subclinical mastitis, just on the 10th day of drug application, revealed a 2.0-fold decrease in the percentage of sick animals in the group where the 'Forticept' complex was used in comparison with control animals. At the end of the experiment, this indicator among the animals of the control group treated with the water-containing drug 'Uberaseptic SB' was 2.9 times higher than in the experimental group. On the 30th day of the survey, the prevalence of subclinical mastitis increased to 18.3% in the group of animals treated with iodine and decreased to 59.0% when treated with 'Forticept Udder Wash' and 'Forticept Udder Forte', which was 2.4 times lower. Application of 'Forticept Udder Wash' and 'Forticept Udder Forte' improved the quality of milk, in particular, there was an increase in fat content by 16.4%, digestible protein content by 10.4% ($p < 0.05$) and a decrease in protein content by 26.5% ($p < 0.05$), dry matter content by 16.5% ($p < 0,01$), and 3.3 times decrease of SCC due to a decrease of QMAFAnM by 9.5% and total bacteria count to > 100 CFU/cm^3, and relevant inflammatory products. The use of 'Forticept' complex allows to obtain stable milk yields with a tendency to increase: gross yield in the experimental group increased by 1.3% during 30 days (with a decrease in the control group by 3.7%)

Keywords: 'Forticept Udder Wash', 'Forticept Udder Forte', prevention, milk, hyperkeratosis, subclinical mastitis

Introduction. The exclusive relationships of three separate biosystems — environment–macroorganism–infectious agent (pathogen) — play a role in the emergency of mastitis. The main route of penetration into the udder is through the teat canal, which remains open for 30 min after milking, and its complete closure, in some animals, lasts up to 2 h (Skliar and Skliar, 2015). It is necessary during this period to create an artificial barrier to the penetration of pathogens. According to scientists (Smoliar, 2014; Borodina and Nosevych, 2017; Paliy, 2017), treatment of teats with special drugs after each milking, reduces the risk of mastitis by 50–70%.

Therefore, one of the elements of the mastitis prevention program on the farm is the application of udder treatment products, before and after milking.

Hygiene products used after the act of milking are subject to quite high requirements: the drugs must provide reliable protection of the teat canal from pathogenic microflora, have a stable and prolonged effect and have an emollient effect on the skin, must dry quickly, simply, easily and completely to be removed, and also be convenient and economic at use.

Today, the market of udder hygiene products is dominated by drugs based on three main active substances: chlorhexidine, iodine, and lactic acid.

Chlorhexidine-based preparations are relatively cheap and affordable, have a rapid biocidal effect, but have a somewhat narrow spectrum of action, dry the skin, and long-term use forms the resistance of pathogenic microflora.

Among the advantages over the previous group of iodine-based drugs is a wider range of antimicrobial action, the short duration of which does not cause addiction to pathogenic flora, and anti-inflammatory

properties. However, there are some disadvantages: iodine is reactive, it is difficult to combine with other substances, it harms the skin, overdrying it. Iodine preparations preferably do not have prolonged bactericidal, fungicidal, and sporicidal action (Prasanthi, Murty and Nirmal, 2012).

As for drugs based on lactic acid, they have good cosmetic properties: they have a preservative effect, moisturize the skin. However, their disadvantage is the weak antimicrobial action in skin-safe concentrations. In addition, many yeasts and molds can include lactic acid in their metabolism, which can cause fungal skin lesions (Tkachenko et al., 2017).

Currently, the line of hygienic products for udder treatment includes novelties: 'Forticept Udder Wash', which contains benzalkonium chloride and cosmetic components for skin care (chamomile and yarrow extracts) and 'Forticept Udder Forte', which includes active components of artificial (benzethonium chloride) and natural origin (thyme oil, lanolin, chamomile extracts and yarrow).

However, these drugs have not been tested in modern dairy farming in Ukraine, so the **aim of our research** was to test experimental samples of udder hygiene products 'Forticept Udder Wash' and 'Forticept Udder Forte' in the prevention of subclinical mastitis in cows.

Materials and methods. The work was carried out at PE 'Demetra-2010' (Boryshkivtsi, Kamianets-Podilskyi District, Khmelnytskyi Region) specializing in breeding Red-spotted, Black-spotted and Simmental cows.

To study the effect of experimental products for udder treatment before and after milking of the line 'Forticept' in PE 'Demetra-2010', two groups of cows were formed (n = 48). Animals of the experimental group were treated with experimental samples of drug 'Forticept Udder Wash' before milking and 'Forticept Udder Forte' after milking. Cows of control group were treated with the drug for udder hygiene based on iodine — 'Uberaseptic SB' produced by SE 'Sumy Biological Factory'.

Foaming and detergent product for hygienic treatment of the udder before milking 'Forticept Udder Wash' contains benzethonium chloride, thymol, and plant extracts. It is a product for cleaning, protection and preparation of udder teats for the act of milking. Stable foam of the drug provides long-lasting biocidal and cleansing effect.

The product was diluted before use according to the instructions, teats and udder base were treated just before milking with an exposure of 15 s, followed by thorough drying of the udder with a paper towel.

'Forticept Udder Forte' is designed for hygienic treatment of udder nipples after milking. It contains benzalkonium chloride, plant extracts of chamomile and yarrow. The prophylactic effect of the drug is to create a film barrier that accelerates the closure of the teat canal after milking, protects the nipples from adverse environmental factors and the penetration of pathogenic microflora. The drug helps to heal wounds and cracks of teats, softens the skin of teats, relieves itching and inflammation after insect bites.

The drug was applied at the end of milking, immediately after removing the milking cups, by immersing the nipples of the udder for 1–3 s in a dipper (glass for processing).

All animals of the experimental and control groups were diagnosed for the presence of a subclinical form of mastitis, using reagent 'Profilac Reagent N' (Westfalia) (which takes into account two indicators when adding the reagent: color change when the pH shifts and changes in milk consistency in the wells of the control plate).

For 30 days of the experiment, the condition of the skin of the udder teats was observed.

Qualitative and quantitative characteristics of milk were determined by control milking in both groups, before the experiment and on the 30th day of the experiment.

Qualitative indicators of milk were determined in the laboratory of PJSC 'Ternopil Dairy'.

A sampling of raw milk and its delivery to the laboratory was carried out according to DSTU 4834:2007 (DSSU, 2007) and DSTU IDF 122C:2003 (DSSU, 2003b).

Determination of the content of fat, protein, and dry matter in milk was performed on the device 'Lactan' according to DSTU 7057:2009 (DSSU, 2009).

Protein was determined by the Kjeldahl method according to DSTU 8063:2015 (UAS, 2015).

A number of ten-fold dilutions were prepared from the selected samples according to DSTU IDF 122C:2003 (DSSU, 2003b). The quantity of mesophilic aerobic and facultative anaerobic microorganisms (QMAFAnM) and the coliform count (CC) were determined according to DSTU 7357:2013 (MEDTU, 2013) and DSTU IDF 100B:2003 (DSSU, 2003a).

For determine the somatic cells count (SCC) in raw milk we used rapid tests using reagent 'Profilac Reagent N'. The reaction was recorded by controlling the formation of gel and discoloration of the milk sample due to changes in pH.

The study was performed on milk control plates directly near the animals. To do this, in each plate recess we milked 1 cm^3 of milk to the control line from the appropriate udder quarter and added 1 cm^3 of a solution of reagent 'Profilac Reagent N' from a bottle with an automatic pipette. The milk with the reagent was stirred with a glass rod for 10–15 s. The color of the mixture and the formation of a jelly-like clot were taken into account during the reaction.

The test results were evaluated according to the following criteria:

'–' — < 100,000 cells/cm^3. No coagulation of milk, liquid consistency. The samples are easily poured into small portions;

'+' — 100,000–300,000 cells/cm^3. There is a slight coagulation. Samples can be poured in portions;

'++' — 300,000–500,000 cells/cm^3. There is coagulation of milk with the formation of a small amount of gel. It is difficult to pour samples in portions;

'+++' — 500,000–1.5 million cells/cm^3. Coagulation with the formation of a gel from almost the entire sample. It is becoming increasingly difficult to pour samples into portions;

'++++' — > 1.5 million cells/cm^3. The sample was completely collapsed to form a gel. Pouring in portions is not possible.

Different ranges of SCC are classified by visible changes in the color and consistency of raw milk samples. The test responds to 100,000 somatic cells.

As for the color change, it is known that fresh milk from healthy cows has a slightly acidic reaction (pH 6.5–6.7 with fluctuations 6.3–6.9). In the case of inflammation of the udder, the reaction of milk in most cases becomes neutral or slightly alkaline (pH 7.0 and higher). However, due to the fact that the active acidity of milk in subclinical mastitis changes infrequently or insignificantly, this indicator was not considered reliable enough to detect them.

Determination of inhibitors in milk was performed using Brilliant Black Reduction Test and Rapid One Step Assay Milk Test according to DSTU ISO 13969:2005 (DSSU, 2005).

Statistical processing of the results was performed by methods of variation statistics using the program Statistica 6.0 (StatSoft Inc., USA). Nonparametric research methods were used (Wilcoxon, Mann-Whitney criteria). We determined the arithmetic mean (×), the standard error of the mean (SE). The difference between the two means was considered statistically significant at * — $p < 0.05$, ** — $p < 0.01$, *** — $p < 0.001$.

Results and discussion. Examination of cattle for the presence of subclinical mastitis, just on the 10th day of drugs application, revealed a decrease in the percentage of sick animals in the group where the complex 'Forticept' had been used. The indicators differed twice, compared to the initial mean value and the same indicator in the control group of animals.

The use of udder hygiene complex 'Forticept' significantly reduced the number of cows with a subclinical form of mastitis. It has been experimentally shown that the application of the hygiene products during one month decreased by half the number of cows with signs of the disease. At the end of the experiment, this figure among animals of the control group, which were treated with iodine-containing drug 'Uberaseptic SB' was 2.9 times higher than in the experimental group (Fig. 1).

Thus, during the survey, the average value of latent mastitis increased to 18.3% in the group of animals treated with iodine and decreased to 59.0% in animals treated with 'Forticept Udder Wash' and 'Forticept Udder Forte', which was 2.4 times lower (Fig. 2).

Among the animals of both groups there was a significant initial manifestation of the hyperkeratosis of the teat canal, which is one of the causes of mastitis. As can be seen from Fig. 3, the reduction of the disease manifestation after the application of iodine-containing agent in the control group for 30 days was only 3.1%, while in the experimental group it decreased by 20.6% with a tendency to further reduce the manifestation of hyperkeratosis.

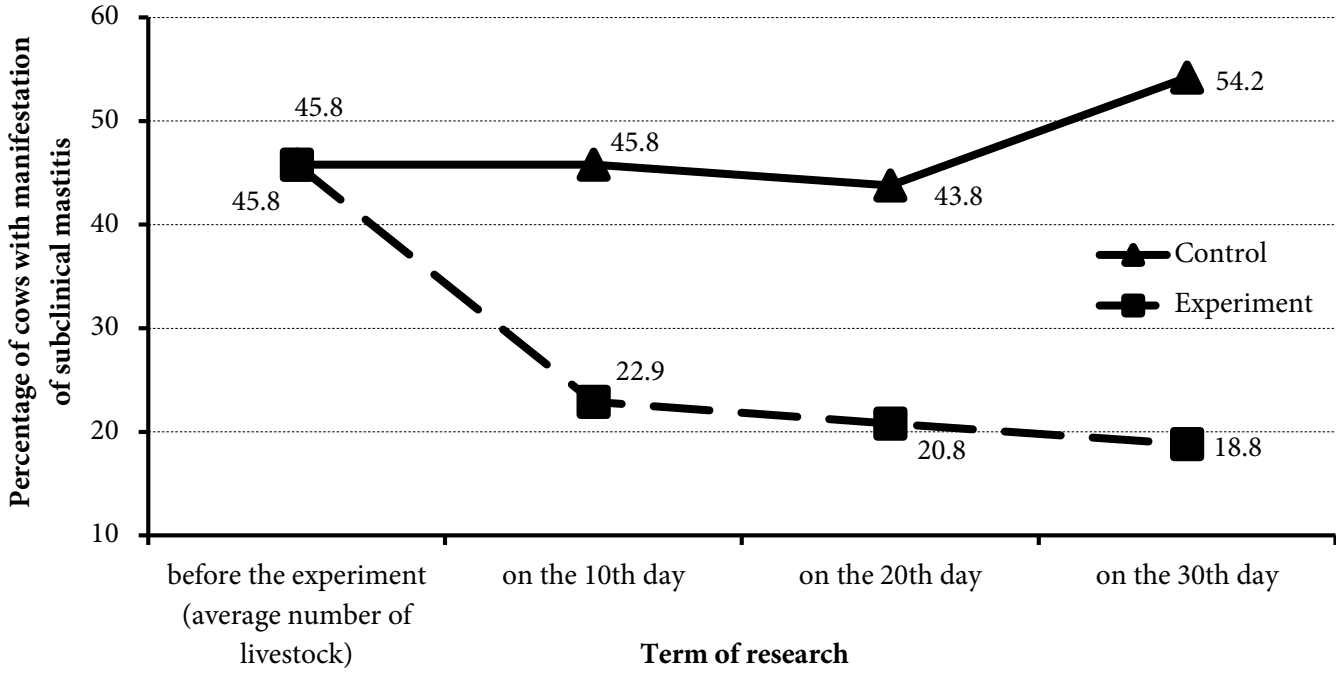

Figure 1. Dynamics of prevalence of subclinical mastitis among cows (M ± m, n = 48)

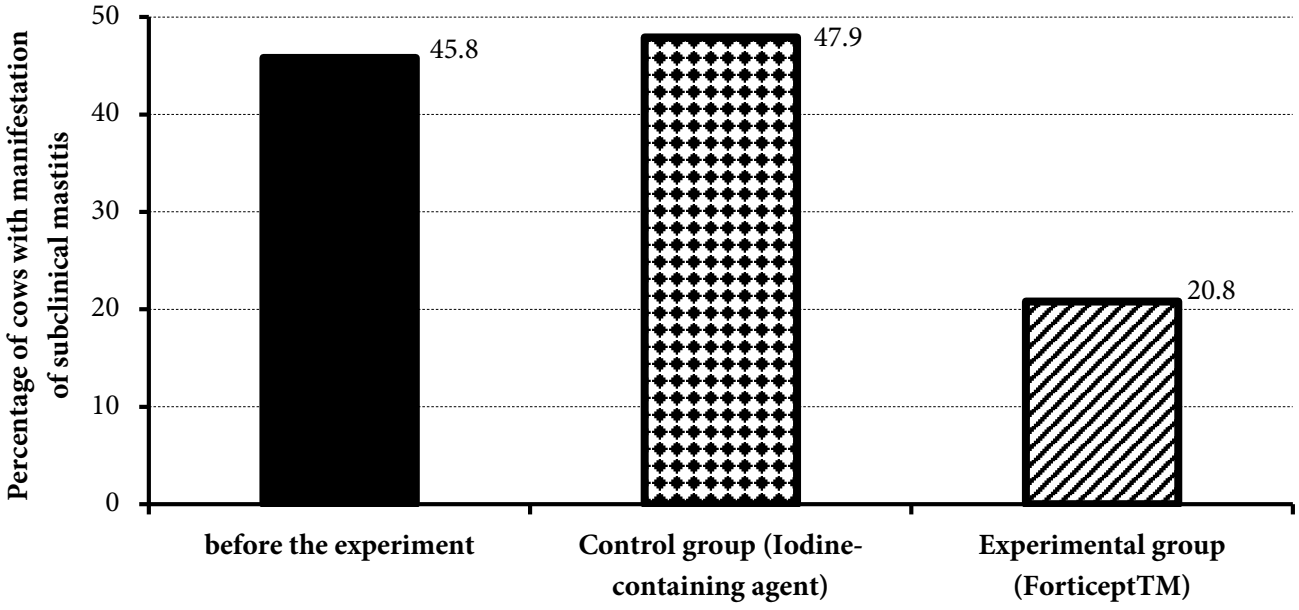

Figure 2. The average value of sick cows with subclinical mastitis for 30 days (M ± m, n = 48)

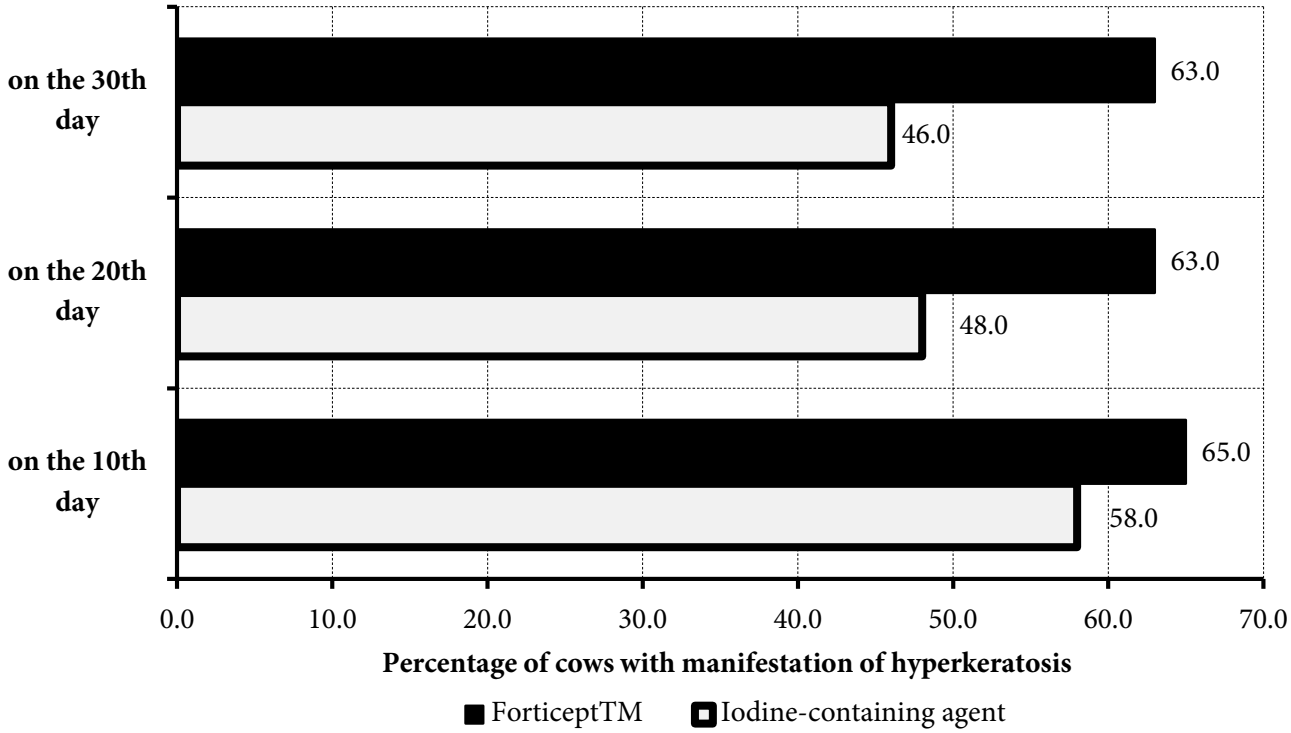

Figure 3. Dynamics of the condition of teats while using udder hygiene products in cows (M ± m, n = 48)

At the same time, on the 30th day of the experiment, there were 27.0% more animals with this pathology in the control group than in the experimental group. Laboratory studies showed that the content of fat and protein in the milk of cows of the experimental group on the 30th day after the use of drugs 'Forticept' increased by 16.4% and 10.4% ($p < 0.05$) relative to the data before the experiment, and content of protein and dry matter decreased by 26.5% and 16.5% ($p < 0.01$), respectively, whereas in the control group of animals after treatment of udder teats with iodine-containing drug reliable changes in content of fat, protein, and dry matter were not observed.

In addition to determining milk quality indicators, the antimastitis program in farms mainly depends on the control of SCC in milk and the total bacteria count (TBC) (Borodina and Nosevych, 2017; Shevchenko, Stravskyi and Sachuk, 2019). In our experiment, a significant difference in SCC in the samples of whole milk from lactating cows of the experimental and control groups was found. Thus, on the 30th day after the start of hygienic

treatments, SCC in the milk of animals treated with hygienic products 'Forticept' was 3.3 times lower, when treated with iodine-containing drug — 2.1 times.

The study of QMAFAnM in the milk of cows also revealed a reliable decrease by 9.5% ($p < 0.05$) for treatment with drugs of the series "Forticept', before treatment, this figure was $2.3 \pm 0.03 \times 10^5$ CFU/cm^3, after treatment — $2.1 \pm 0.03 \times 10^5$ CFU/cm^3, and in the control group after treatment with iodine-containing agent, this indicator increased by 31.8%. TBC in milk samples from cows of both groups before treatment was > 150 CFU/cm^3, and after treatment — > 100 CFU/cm^3. In this case, inhibitory substances in the milk samples of both groups were not detected (Table).

Table — Milk quality indicators (M ± m, n = 7)

Indicator	Experimental group		Control group	
	output data	on the 30th day	output data	on the 30th day
Fat, %	2.62 ± 0.10	3.05 ± 0.14*	2.96 ± 0.15	2.93 ± 0.13
Albumen, %	5.97 ± 0.40	4.39 ± 0.53*	3.14 ± 0.27	4.39 ± 0.61
Lactose, %	4.81 ± 0.03	4.89 ± 0.06	4.89 ± 0.04	4.79 ± 0.11
Dry matter, %	14.36 ± 0.42	11.99 ± 0.22**	13.27 ± 0.50	12.91 ± 0.56
Protein, %	2.89 ± 0.10	3.19 ± 0.14*	3.26 ± 0.13	3.18 ± 0.10
SCC, ×10^3 cells/cm^3	327.83 ± 95.38	100.42 ± 37.64*	276.50 ± 85.16	131.33 ± 38.60*
QMAFAnM, ×10^5 CFU/cm^3	2.3 ± 0.03	2.1 ± 0.03	2.2 ± 0.02	2.9 ± 0.02
TBC, CFU/cm^3	> 150	> 100	> 150	> 100
Presence of inhibitors	lack	lack	lack	lack

Notes: * — $p < 0.05$; ** — $p < 0.01$; ** — $p < 0.001$ relative to the output data.

Thus, in our opinion, the quality of milk after the action of 'Forticept Udder Wash' and 'Forticept Udder Forte' improved by increasing the content of fat and digestible protein, along with reducing the content of protein, dry matter and SCC, possibly by reducing QMAFAnM and inflammatory products.

An important factor influencing the economic indicators of the dairy industry is the amount of milk yield. Many scientists have proven a close correlation between SCC and milk yield (Pinedo et al., 2009). Even a small increase of SCC can be considered the most sensitive indicator of reduced productivity of cows. Thus, control milking showed somewhat different dynamics of volumes of milk obtained from cows in groups.

It was found that from the experimental group before the start of the experiment 1,200 l of milk was milked, and on the 30th day after the start of the use of hygienic products 'Forticept' milk production increased by 1.3% and amounted to 1,215 l.

At the same time, in the control group milk yields decreased by 3.7% during this period from 1,396 to 1,345 l (Fig. 4).

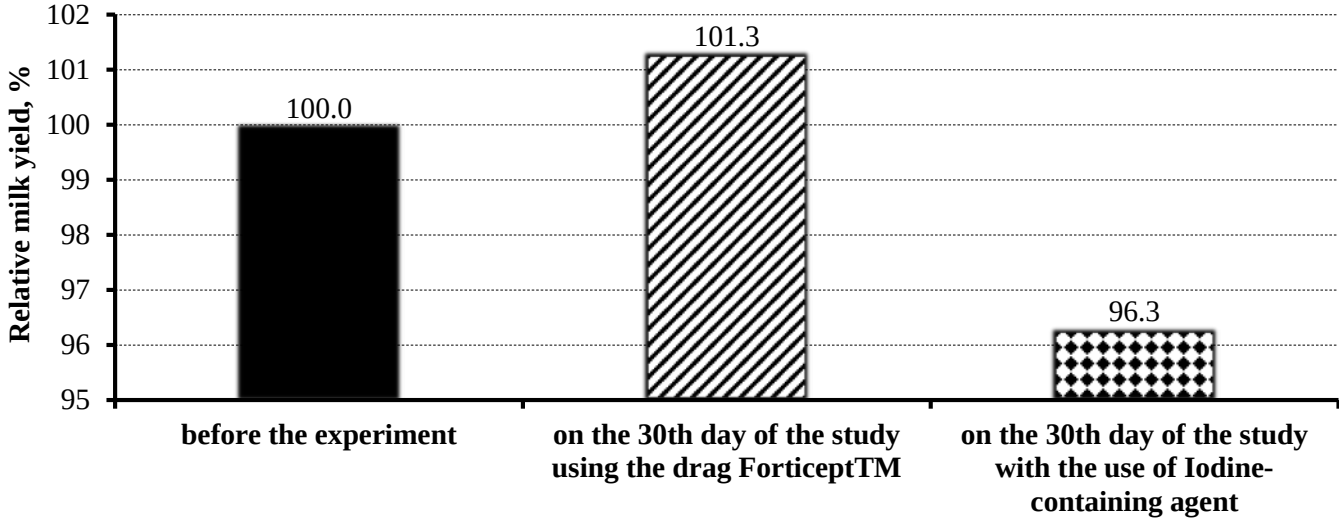

Figure 4. Relative milk yield after the application of udder hygiene products (M ± m, n = 48)

Conclusions. 1. The application of udder hygiene products 'Forticept Udder Wash' and 'Forticept Udder Forte' on the 30th day after treatment reduced the number of cows with subclinical mastitis by 59.0% and cases of hyperkeratosis by 20.6%.

2. There was an improvement in milk quality after the action of 'Forticept Udder Wash' and 'Forticept Udder Forte', including an increase in fat content by 16.4%, digestible protein by 10.4% ($p < 0.05$) and a decrease in protein by 26.5% ($p < 0.05$), dry matter by 16.5% ($p < 0.01$) and 3.3 times decrease of SCC, possibly due to a decrease of QMAFAnM by 9.5% and TBC to > 100 CFU/cm^3, the corresponding products of inflammation.

3. The use of drugs of the 'Forticept' complex allows to obtain stable milk yields with a tendency to increase: the gross milk yield in the experimental group for the 30 days increased by 1.3% (with a decrease in the control group by 3.7%).

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THE EFFECTS OF VITAMINS E AND C ON INDIVIDUAL LIPIDES IN THE LIVER AND SKELETAL MUSCLES OF CHICKEN BROILERS

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Summary. The purpose of the work was to find out the changes in the lipid composition of the liver and skeletal muscles of broiler chickens at different stages of growth under the influence of supplements of vitamins E and C in their diet. The studies were conducted on four groups of broiler chickens. The control group was fed a standard compound feed. The first experimental group in addition to the specified compound feed received tocopherol acetate in the amount of 0.1 g/kg, the second — ascorbic acid, 0.25 g/kg. The third experimental group of chickens received tocopherol acetate and ascorbic acid at mentioned doses. The lipids from these tissues were extracted by the Folch method, and the ratio of individual lipid classes was determined by thin layer chromatography on silica gel. The results of the studies indicate the stimulating effect of vitamins E and C on the accumulation of total lipids in the skeletal muscles and liver of broiler chickens. In addition, we can conclude that feeding the broiler chickens of supplements containing vitamins E and C during the period of intensive growth promotes the increase of lipid synthesis in their liver and deposition of synthesized lipids in skeletal muscle. However, these processes are accompanied by a redistribution of the ratio of individual lipid classes in the investigated organs and tissues of chickens

Keywords: lipids, broilers, vitamin supplements, tocopherol, ascorbic acid

Introduction. One of the most significant problems in poultry industry is the decline in the viability especially in early age. This is due to the intensification of production and critical periods of postnatal poultry development, especially in broiler chickens. At the same time, successful poultry farming is only possible if birds receive all the nutrients and biologically active substances. In the absence of one component, the metabolism processes are disrupted, which results in a reduction in the protective mechanisms in poultry, its productivity and product quality (Leeson and Summers, 2001, 2005; Klasing and Leshchinsky, 2000; Klasing, 2007).

It is known that protein and also lipid synthesis in poultry growth are due, on the one hand, to the involvement of structural lipids (phospholipids, cholesterol) in the plastic processes that are associated with the morphological and functional development of organs and tissues of the bird in the early stages of ontogenesis, and from the other hand — the importance of energy value of the reserve lipids (triacylglycerols) in meeting the needs of the bird for metabolic energy. In this regard, it is important to study the total content of lipids and their individual classes in different organs and tissues of broiler chickens at different stages of their growth. In addition, the study of quantitative changes in lipid content in organs and tissues of poultry at different stages of individual development, mechanisms and factors of their regulation is a theoretical basis for controlling the biochemical composition and nutritional value of meat.

At the same time, in order to fulfill the bird's genetic potential and stimulate its growth and development, the optimal provision of their need for vitamins, and especially vitamins E and C, has a significant effect (Kuttappan et al., 2012; Fisinin and Surai, 2013; Vlizlo et al., 2015). These vitamins are known to exert a regulatory influence on the resistance, growth, and safety of the bird.

Among the many important values of vitamins E and C for the body of animals and poultry, the most important is their role in ensuring the functioning of the antioxidant system. It is well known that tocopherol is incorporated into the cell membrane and protects polyunsaturated fatty acids of phospholipids from the action of reactive oxygen. Instead, ascorbic acid directly neutralizes the superoxide radical to hydrogen peroxide, and it helps to maintain a certain level of tocopherol, which also has a positive effect on the functioning of the antioxidant protection system.

In this view, **the purpose of the work** was to find out the changes in the lipid composition of the liver and skeletal muscles of broiler chickens at different stages of growth under the influence of vitamins E and C in the diet. Such systematic studies on broiler chickens, as evidenced by the analysis of the literature, have not yet been conducted in wide range.

Materials and methods. The studies were conducted in one of the farms in the Lviv Region on four groups of 100 broiler chickens in each group, ranging from 1 to 41 days of age. Keeping chickens was indoor with free access to feed and water.

The control group of chickens was fed a standard compound feed balanced on the basic nutrients according

to the norms recommended for cross ROSS-308. The first experimental group of poultry in addition to the specified compound feed received tocopherol acetate in the amount of 0.1 g/kg of compound feed, the second — ascorbic acid, 0.25 g/kg compound feed. The third experimental group of chickens — tocopherol acetate and ascorbic acid at mentioned doses.

Samples of liver and thigh muscles were taken for biochemical studies. The lipids from these tissues were extracted with a chloroform-methanol (2:1) mixture by the Folch method, and their number was determined by weight method, and the ratio of individual lipid classes by thin-layer chromatography on silica gel (Folch, Lees and Sloane Stanley, 1957; Kates, 2010).

The resulting digital data were statistically processed using Microsoft Excel. The degree of reliability of comparative data was estimated by Student's *t*-test (t). The difference at ($p < 0.05–0.001$) was considered as reliable.

Results and discussion. It is known that the skeletal muscles of poultry and other species of animals are characterized by less intense lipid metabolism than the liver, but due to the large mass of skeletal muscle, the total lipid content of these is about 50% of the amount of body lipids. The nutritional and biological value of poultry meat is closely related to the content of lipids and their fatty acid composition.

Table 1 presents data on lipid content and their individual classes in the skeletal muscles of broiler chickens of 27 days of age. From the table, we can see that feeding chickens with supplements of vitamins E and C caused an increase in the content of total lipids in the skeletal muscles.

In particular, in chickens of the first, second and third experimental groups the total lipid content in skeletal muscles was 41.5% ($p < 0.05$), 43.5% ($p < 0.05$) and 62.8% ($p < 0.01$) respectively higher than that of the control group.

This increase in total lipid content in the tissue of the thigh muscle of the experimental groups can be explained by the increase in the intensification of lipid synthesis in the body of the chickens under general intensification of metabolism during their intensive growth under the influence of nutrition supplements. In this case, feeding to chickens the tocopherol acetate and ascorbic acid supplement was more likely to accumulate total lipids in the skeletal muscles of the bird.

Table 1 — Content of total lipids and their individual classes in the tissue of thigh muscle of broiler chickens (M ± m, n = 5)

Lipids, %	Groups			
	Control	Experiment 1 (vitamin E)	Experiment 2 (vitamin C)	Experiment 3 (vitamins C i E)
Total lipids, g/kg	2.07 ± 0.07	2.93 ± 0.09*	2.97 ± 0.03*	3.37 ± 0.18**
Phospholipids	12.60 ± 1.95	18.67 ± 0.42*	12.87 ± 0.54	13.37 ± 0.41
Diacylglycerols	13.60 ± 0.40	19.27 ± 0.79**	13.50 ± 0.66	12.40 ± 0.50
Cholesterol	20.43 ± 0.20	12.10 ± 1.00**	18.10 ± 0.36**	22.00 ± 0.60
NEFA	15.53 ± 0.55	14.73 ± 0.23	10.03 ± 0.39	15.83 ± 0.20
Triacylglycerols	21.87 ± 0.74	18.70 ± 0.75*	24.17 ± 0.52	20.43 ± 0.58
Cholesterol ethers	17.67 ± 0.23	16.43 ± 0.61	16.13 ± 0.45*	16.13 ± 0.64

Notes: * — $p < 0.05$; ** — $p < 0.01$; ** — $p < 0.001$ to control group.

In the study of individual classes of lipids (Table 1), the increase in the relative content of phospholipids and diacylglycerols in skeletal muscles of chickens receiving vitamin E supplements attracts attention.

Thus, the relative content of phospholipids and diacylglycerols, which are known to be intermediates in the synthesis of phospholipids and triacylglycerols, in the chick muscle of the first experimental group was respectively 1.5 ($p < 0.05$) and 1.4 times ($p < 0.01$) higher, and the content of free cholesterol and triacylglycerols is 1.6 ($p < 0.01$) and 1.2 ($p < 0.05$) times lower than the content of these lipid classes in the control group.

The increase in the relative content of phospholipids in the skeletal muscles of chickens in this group can be explained by the fact that vitamin E protects the fatty acids of membrane phospholipids from peroxidation.

At the same time, vitamin E significantly affects the activity of phospholipases A, the key enzymes of glycerophospholipid metabolism (Kwag et al., 2001; Oliveira et al., 2016).

Other results of the studies include the reduction of free ($p < 0.01$) and etherificated ($p < 0.05$) cholesterol in the skeletal muscles of chickens in the second experimental group receiving vitamin C (Table 1). On the other hand, feeding the chickens of the third experimental group with vitamin E and C supplements did not significantly affect the ratio of individual lipid classes in the skeletal muscle of the bird. At the same time, there was a tendency for the growth of free cholesterol content in muscle, which can be explained by the effect of vitamin C on cholesterol metabolism in animals and birds (Turley, West and Horton, 1976).

Thus, the results of the studies indicate the stimulating effect of vitamins E and C on the accumulation of total lipids in the skeletal muscles of broiler chickens. This effect was more pronounced in the muscles of chickens received vitamin E and C supplements. However, changes in the ratio of individual lipid classes were shown in the thighs of the chickens of the first experimental group, namely: an increase in the relative content of phospholipids and diacylglycerols and reduction of free cholesterol and triacylglycerols. Vitamin C has been shown to reduce cholesterol in the thigh muscles.

It is important to emphasize that the liver is central to the exchange of lipids and fatty acids in poultry and other animals. In addition, it is the main place of deposit of vitamins. The lipids that are absorbed in the small intestine enter the lymph into the blood of the portal vein and thence into the liver. Fatty acids, structural and reserve lipids are intensively synthesized in the liver and fatty acids are oxidized. Besides, the liver produces lipoproteins, which are the main source of lipids and fatty acids for peripheral tissues (Jiang, Robson, and Yao, 2013).

Table 2 shows that changes in total lipid content in broiler chickens are similar to changes in skeletal muscle. However, in the liver, these changes were more pronounced than in the skeletal muscles. Thus, the total lipid content in the liver of chickens of the first, second and third experimental groups was respectively 1.4 ($p < 0.05$), 2.4 ($p < 0.001$) and 2.2 times ($p < 0.001$) higher than in the control birds. In our opinion, the reasons for this increase are similar to those observed with the increase in lipid content in skeletal muscles. Because the liver plays a key role in lipid metabolism, the compounds synthesized in this organ are more deposited in other tissues of the body.

Studies have shown that, unlike skeletal muscle, the phospholipid content in the liver of chickens of the first experimental group was 6.9% ($p < 0.001$) lower than that of the control group (Table 2). Such a decrease in the content of structural lipids in the liver is a rather unfavorable symptom for the body. Moreover, it was accompanied by an increase in the relative content of triacylglycerols, which may indicate certain signs of an increase in the deposition of reserve lipids in the liver, which may subsequently lead to its fatty dystrophy. Similar changes, only less pronounced (1.9%, $p < 0.01$), were found phospholipid content in the liver of chickens treated with vitamin C. At the same time, in the liver of chickens in the third experimental group treated with vitamin E and C, opposite changes were detected.

Table 2 — Content of total lipids and their individual classes in the liver of broiler chickens (M ± m, n = 5)

Lipids, %	Groups			
	Control	Experiment 1 (vitamin E)	Experiment 2 (vitamin C)	Experiment 3 (vitamins C i E)
Total lipids, g/kg	1.60 ± 0.12	2.20 ± 0.15*	3.80 ± 0.18***	3.50 ± 0.12***
Phospholipids	26.10 ± 0.30	19.17 ± 0.23***	24.17 ± 0.24**	31.20 ± 1.79*
Diacylglycerols	9.10 ± 0.35	12.60 ± 0.51**	17.77 ± 0.75***	25.83 ± 0.78***
Cholesterol	9.23 ± 0.23	12.63 ± 0.43**	14.17 ± 0.23***	11.04 ± 1.00
NEFA	18.10 ± 0.49	14.27 ± 0.31**	14.30 ± 0.35**	9.34 ± 0.67***
Triacylglycerols	12.83 ± 0.38	23.10 ± 0.74***	12.47 ± 0.64	8.77 ± 0.48**
Cholesterol ethers	24.60 ± 0.12	18.13 ± 0.31***	17.06 ± 0.72***	14.77 ± 0.52***

Notes: * — $p < 0.05$; ** — $p < 0.01$; ** — $p < 0.001$ to control group.

Thus, the phospholipid content in the liver of chickens in this group was 5.1% ($p < 0.05$) higher than in the control group. The causal treatment of such differences is rather problematic and requires further detailed studies.

From the data of Table 2 we see that in the liver of chickens of the first, second and third experimental groups the relative content of diacylglycerols was respectively 1.4 ($p < 0.05$), 1.9 ($p < 0.001$) and 2.8 ($p < 0.001$) times higher and the content of non-etherified fatty acids 1.3 ($p < 0.01$), 1.3 ($p < 0.01$) and 1.9 ($p < 0.001$) times less than the content of these classes of lipids in the liver of chicks in the control group. These data indicate the growth of synthetic processes in the liver of broiler chickens by the action of vitamin E and C supplements with the simultaneous use of free fatty acids in these processes.

Other results show that a significant decrease ($p < 0.01$) of the relative content of triacylglycerols in the liver tissue of chickens in the third experimental group treated with tocopheryl acetate with ascorbic acid. As shown above, this process was accompanied by an increase in the relative content of the structural component of hepatocyte membranes – phospholipids. However, in the case of a decrease in phospholipid content, as observed in the chickens of the second experimental group, a higher content of triacylglycerols ($p < 0.001$) was simultaneously observed. These data, on the one hand, indicate a certain relationship between the synthesis and breakdown of structural and reserve lipids in hepatocytes of chickens and, on the other hand – the redistribution of the relative content of their classes by the action of the vitamins. From other data, it should be noted

that feeding chickens with vitamins E and C led to a decrease in the relative content of cholesterol ethers ($p < 0.001$).

Conclusions. Summarizing the results of the studies, we can conclude that feeding the broiler chickens of supplements containing vitamins E and C during the period of intensive growth promotes the increase of lipid synthesis in their liver and deposition of synthesized lipids in skeletal muscle. However, these processes are accompanied by a redistribution of the ratio of individual lipid classes in the investigated organs and tissues of chickens.

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CASE REPORT ON THE HUMAN INFECTION WITH TULAREMIA IN MYKOLAIV REGION, 2018

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Summary. The work aims to provide a study and report the case with a 47-year-old white man from urban-type settlement Oleksandrivka (Voznesensk District, Mykolaiv Region) diagnosed with pharyngitis, amygdalitis, polylymphoadenopathy, and buboadenitis caused by *Francisella tularensis*. The tularemia diagnosis in the patient was confirmed with agglutination test and western blot of patient's blood serum in dilutions 1:100 and 1:200 respectively. The additional surveillance study (rodents, ticks, and water samples) in the surrounding area of the patient's house showed positive results for *F. tularensis* in ticks in dilution 1:160++++

Keywords: *Francisella tularensis*, tularemia, zoonosis, ticks, Ukraine

Introduction. Tularemia is a zoonotic disease caused by a Gram-negative bacterium *Francisella tularensis*. The disease is widespread in the Northern Hemisphere and it is transmitted by contact with naturally infected animals (rodents or lagomorphs), inhalation, arthropod bites (ticks or deer flies), or ingestion of contaminated meat or water. Particularly active source of the *F. tularensis* is the common vole (*Microtus arvalis*). Cats are carriers of infection among pets. In total, over 100 species of animals can be infected with *F. tularensis*. Tularemia can be transmitted by 13 species of ticks belonging to 4 genera: *Amblyomma*, *Dermacentor*, *Haemaphysalis*, and *Ixodes*, from which the most epizootically significant for Ukraine are ticks of the genus *Dermacentor*. The transmission of tularemia from person to person has not been described. There is a high risk of human infection among hunters, farmers and country inhabitants as the infective dose is extremely low (less than 10 bacteria) (Petersen and Schriefer, 2005; Hopla, 1974; Sjöstedt, 2007; McLendon, Apicella and Allen, 2006; WHO, 2007; Oyston, Sjöstedt and Titball, 2004).

For the cultivation of *F. tularensis*, special nutrient media should be used such as FT, Chapin, and McCoy media containing cysteine. After 48 h of incubation at 37°C *F. tularensis* forms small and roundish colonies. The causative agent of tularemia is a bacterium that is slowly growing in culture and is extremely difficult to secrete from field samples (the rate of isolating from animal corpses is not higher 30%). Therefore, the most commonly used methods for identifying *F. tularensis* are the detection of the pathogen genome (PCR) and antigens or antibodies to it (MA, ELISA). The results of these methods must be confirmed by western blot to avoid cross-reactions and false-positive results with other related bacteria (*Brucella* spp., *Yersinia* spp., etc.) (WHO, 2007; Bevanger, Maeland and Naess, 1988; Byström et al., 2005; Petersen et al., 2004; Schmitt et al., 2005).

The first official cases of tularemia in Ukraine were reported in the 1940s. They were related to the professional infection of fur and sugar workers. In 1948–1949, tularemia deaths were reported in all regions of the country. In 1960, the incidence of tularemia declined sharply as a result of the natural foci identification and the implementation of special measures, namely: vaccination of people living in natural foci and reduction of rat populations. In the late 1980s and the 1990s, the epidemic activity of tularemia foci with an outbreak among people (approx. 200 cases of infection) was again registered in the steppe regions of Ukraine — Odesa and Mykolaiv, as well as constant foci activity was registered on Byriuchyi Island (Hightower et al., 2014; Rusev et al., 2005).

According to the official data of the Public Health Center of the Ministry of Health of Ukraine and Regional Laboratory Centers, at present, outbreaks of tularemia among people usually occur in the form of several isolated cases a year, with the onset of the disease in mild and medium forms, often with the buboes formation. The last case of human infection with tularemia in Ukraine was registered in March 2019 in the Okhtyrka District (Sumy Region). The vaccination against tularemia is not currently carried out in Ukraine.

The case. A 47-year-old white man from urban-type settlement Oleksandrivka (Voznesensk District, Mykolaiv Region) appealed to a traumatologist on 02.04.2018 because of a domestic swine bite that was held in his own small private swine household.

After the first aid of the traumatologist, on 06.04.2018 the patient visited an otorhinolaryngologist, who diagnosed pharyngitis.

On 12.04.2018 the patient was admitted to the Neurological department of the Voznesensk Central Regional Hospital. The diagnosis was changed to degenerative-dystrophic lesions of the spine, polylymphoadenopathy, amygdalitis.

Three weeks later, on 27.04.2018, the patient appealed to the infectious disease doctor who changed the diagnosis to herpesvirus infection, polyadenopathy.

After the appearance of a bubo seven days later the diagnosis was changed to bubonadenitis, and it was started with blood tests for *F. tularensis*.

Materials and methods. Blood serum of the patient was taken in the Voznesensk Central Regional Hospital and sent to the Mykolaiv Regional Laboratory Center of the Ministry of Health of Ukraine. It was examined for *F. tularensis* antibodies using commercial agglutination test kit according to the manufacturer protocol ('Microgen', Russian Federation).

One aliquot of the sample was inactivated in water bath at 60°C for an hour and sent to the National Scientific Center 'Institute of Experimental and Clinical Veterinary Medicine' (Kharkiv), where it was studied for *F. tularensis* antibodies with western blot: invitrogen gel loading buffer ('Thermo Scientific', USA) was added into 150 µl of *F. tularensis* LPS (concentration 2.5 µg/µl). The mixture was boiled for 5 min, cooled down on ice for 1–2 min, and applied into polyacrylamide gel. Run vertical electrophoresis in western blot electrophoresis buffer at 180–200 V until LPS are separated. Assemble blotting sandwich with nitrocellulose membrane and provide blotting in pre-cooled transfer buffer with refrigerant for 1 h 15 min at 100 V. The membrane was blocked in PBST with 5% skimmed milk for 1 h at 18–25°C or overnight at 4°C. Then, the membrane was incubated with sample diluted 1:200 in PBST with 2% rabbit serum ('BioWest', USA) for 1 h on a rocking plate. The membrane was washed 3 times with PBST. Then, the membrane was incubated with Mouse-anti-Human IgG Secondary HRP-coupled antibodies ('Invitrogen', USA) diluted 1:2,000 for 45 min at rocking plate. The membrane was washed 3 times with PBST. Then, membrane was incubated for 10 min in the dark with TMB SeramunBlau precipitate solution ('Seramun Diagnostica', Germany). The reaction was stopped by washing 1–2× with H_20 and the membrane was left to dry.

The additional surveillance study (rodents, ticks, and water samples) in the surrounding area of the patient's house carried out using commercial agglutination test kit according to the manufacturer protocol ('Microgen', Russian Federation).

Results. The agglutination test approved the diagnosis 'tularemia' in the patient in sample dilution 1:100. The western blot approved the diagnosis in sample dilution 1:200 (Fig.).

In addition, positive results for *F. tularensis* in ticks in dilution 1:160++++ were obtained.

Discussion. Voznesensk District of Mykolaiv Region is an endemic territory of tularemia occurrence. *F. tularensis* was isolated there from small mammals in the 1990s (Hightower et al., 2005).

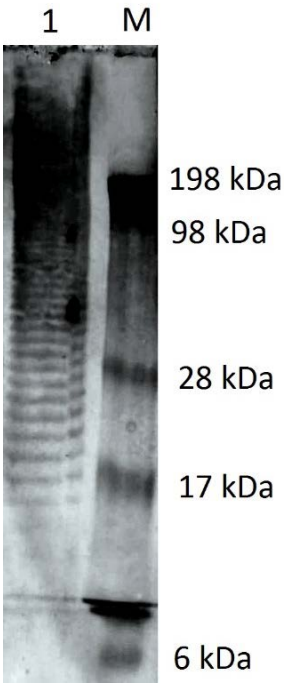

Figure. The western blot result of the patient serum: 1 — blood serum, M — protein weight marker Invitrogen SeeBlue Plus 2 ('Thermo Scientific', USA). The result considered as positive, when the LPS pattern is present in range of 15–98 kDA (Schmitt et al., 2005)

Despite the rare findings of *F. tularensis* in this district, it is known, that the outbreaks of tularemia may occur annually within 5 years, and may also be absent for more than a decade. Usually, after a long lapse, the first case of a new outbreak appears, the disease may be forgotten and not easily diagnosed (WHO, 2007). This thesis is clearly demonstrated in the case report: the diagnosis staging for the patient took the whole month and was done correctly only after the bubo appearance, when the illness became severe. For this reason, it is important to provide routine monitoring of regions for tularemia foci and make the results widely available, especially among physicians, to make diagnosis staging faster.

Conclusions. The tularemia diagnosis in the 47-year-old patient with pharyngitis, amygdalitis, polylymphoadenopathy, and buboadenitis from urban-type settlement Oleksandrivka (Voznesensk District, Mykolaiv Region) was confirmed with agglutination test and western blot of blood serum in dilutions 1:100 and 1:200 respectively.

The additional surveillance study (rodents, ticks, and water samples) in the surrounding area of the patient's house showed positive agglutination test results for *F. tularensis* in ticks in dilution 1:160++++.

Acknowledgments. The research was funded by the German Federal Foreign Office (project No. 16.9072.6-007.04 'Ukrainian-German Biosecurity Initiative on Zoonosis Risk Management at the EU External Borders').

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FEATURES OF THE PARASITIC SYSTEM FORMATION IN HERBIVOROUS FISH IN THE AQUACULTURE OF THE NORTH-EASTERN AND EASTERN REGIONS OF UKRAINE

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Summary. The research aimed to determine the peculiarities of the formation of the parasitic system in herbivorous fish in the aquaculture of the North-Eastern and Eastern regions of Ukraine. In fish farms of the North-Eastern and Eastern regions of Ukraine, 26 species of parasites were found in herbivorous fish: 19 species in the silver carp (11 — protozoa, 1 — monogeneans, 4 — trematodes, 3 — parasitic crustaceans); 18 species in the grass carp (6 — protozoa, 1 — monogeneans, 4 — trematodes, 4 — cestodes, 3 — parasitic crustaceans); and 20 species in the bighead carp (10 — protozoa, 1 — monogeneans, 4 — trematodes, 2 — cestodes, 3 — parasitic crustaceans). 11 species (42.3%) of registered parasites were invasive; 18 species (69.2%) of the detected herbivorous fish's parasites develop directly and 8 (30.8%) — with the participation of definitive and intermediate hosts; the fish is an additional (second intermediate) host in the life cycle of 6 species (23.1%) of parasites. Outbreaks of diseases caused by parasitic protozoa from the genera *Myxobolus, Cryptobia, Chilodonella,* and *Ichthyophthirius* have been reported in both fingerlings and two-year-olds. The protozoa from the genera *Ichthyobodo, Trichodina,* and *Trichodinella* were registered en masse only in fingerlings. Pathogens from the genus *Dactylogyrus* were more often registered among three-year-old silver and bighead carps. Metacercariae of *Ichthyocotylurus variegatus* were found en masse in fingerlings of the grass carp. *Posthodiplostomum cuticola* larvae in unfavorable farms were found with a high level of prevalence in fish of different age groups. Thong plerocercoids were more commonly recorded in two-year-old silver and bighead carps and fingerlings of the grass carp. The highest level of cestode infection with *Bothriocephalus acheilognathi* was recorded in fingerlings of the grass carp. Parasitic crustaceans *Sinergasilus lieni* with a high level of prevalence were registered in two-year-old and three-year-old fish. Crustaceans *Lernaea cyprinacea* massively affected two-year-old and three-year-old fish. Pathogens from the genera *Trichodina, Cryptobia,* and *Chilodonella*, and *Dactylogyrus hypophthalmichthys, Posthodiplostomum cuticola,* and *Sinergasilus lieni* were of the greatest epizootic significance for the silver carp; for the bighead carp — from the genus *Myxobolus,* (especially *M. pavlovskii*), *Chilodonella piscicola, Ichthyophthirius multifiliis, Dactylogyrus aristichthys, Posthodiplostomum cuticola, Diplostomum spathaceum, Digramma interrupta,* and *Sinergasilus lieni*; for the grass carp — *Bothriocephalus acheilognathi, Ichthyocotylurus variegatus, Ligula intestinalis, Sinergasilus major, Lernaea cyprinacea, Ichthyobodo necator,* and *Ichthyophthirius multifiliis*

Keywords: parasitic system, protozoa, helmints, parasitic crustaceans, herbivorous fish, aquaculture

Introduction. The main objects of aquaculture in Ukraine are herbivorous fish: the silver carp — *Hypophthalmichthys molitrix* (Valenciennes, 1844), the bighead carp — *Hypophthalmichthys nobilis* (Richardson, 1845), and the grass carp — *Ctenopharyngodon idella* (Valenciennes, 1844). This is a group of fish from the Far Eastern complex, which was acclimatized in the reservoirs of Ukraine in the second half of the 20th century. In addition to their industrial significance, these fish species are the improvers of water bodies, and their range of food (except for the bighead carp) is not competitive with other native species.

Herbivorous fish larvae are obtained only by the factory method — by incubating the eggs in special devices. This is due to the lower water temperature in the reservoirs of Ukraine than in the basins of the Amur, the Ussuri, and the Songhua River — the natural habitats of these species of fish.

Seeds from the broodstock begin to ripen at a temperature of 21–22°C. The broodstock is injected with pituitary hormones for the simultaneous maturation of eggs and milk. Eggs selected from females are fertilized with male milk in special containers and transferred to incubators. After hatching, the larvae are transferred into fry (growth) ponds. In autumn, fingerlings are transferred into the winter ponds, and after winter — in the spring, fingerlings are transferred into feeding ponds (Vovk, 1976).

Fish stocking material was first imported to Ukraine from the Far East in 1954 (Vovk, 1976). Prior to its introduction parasitic fauna of herbivorous fish counted 23 pathogen species (Davydov et al., 2011). A number of these parasites have spread significantly and disease outbreaks have begun to cause significant economic damage to fish farms.

In addition, herbivorous fish have been found to be highly susceptible to some species of local parasites, pathogens of such diseases as diplostomosis, digramosis, postodiplostomosis, ligulosis, etc. (Davydov et al., 2005, 2011; Musselius, 1969). A similar picture was registered during the acclimatization of herbivorous fish in other countries (Beretar', 2009; Lysenko, 2003, 2004).

The monograph 'Ecology of Fish Parasites in Water-Bodies of Ukraine' (Davydov et al., 2011) contains more than 200 scientific papers devoted to the study of species diversity of herbivorous fish's parasites in aquatic ecosystems of Ukraine. Along with this, data on the current epizootic status of water bodies in the aquaculture of the North-Eastern and Eastern regions of Ukraine are missing.

The aim of the research was to determine the peculiarities of the formation of the parasitic system in herbivorous fish in the aquaculture of the North-Eastern and Eastern regions of Ukraine. In this regard, the following tasks were set: to study the species composition of parasites, to determine the level of infection of fish, to study the age dynamics of infection, to identify epizootically significant species of parasites that can cause disease outbreaks and fish death.

Materials and methods. Fifteen specimens of each fish species and age groups were studied in a specialized laboratory of the National Scientific Center 'Institute of Experimental and Clinical Veterinary Medicine' (Kharkiv, Ukraine). Ichthyological material was taken in different seasons of the year from spawning, growing, feeding, and wintering ponds in specialized fish farms, as well as agricultural ponds of Kharkiv, Sumy, Poltava, and Donetsk regions.

Ichthyological analysis was performed by the method of incomplete helminthological autopsy according to Bykhovskaya-Pavlovskaya (1985) and Markevich (1951). Species affiliation of parasites was determined by the 'Keys to Parasites of Freshwater Fish of the Fauna of the USSR' (Bauer, 1984, 1985, 1987).

Prevalence of infection (PI, %) was determined by the formula:

$$PI = \frac{x}{y} \times 100\%$$

where: x — the number of fish in which parasites were found; y — the total number of studied fish.

Statistical processing of the obtained results was carried out following the recommendations on biometrics using the parametric Student's *t*-test (Van Emden, 2019).

Results and discussion. According to the results of the research (Table 1), 19 species of parasites were found in the silver carp: 11 species (59.7%) of protozoa, 1 (5.3%) — monogeneans, 4 (21.0%) — trematodes, 3 (15.8%) — parasitic crustaceans; 20 species of parasites were registered in the bighead carp: 10 species (50.0%) of protozoa, 1 (5.0%) — monogeneans, 4 (20.0%) — trematodes, 2 (10.0%) — cestodes, 3 (15.0%) — parasitic crustaceans; and 18 species of parasites were recorded in the grass carp: 6 species (33.3%) of protozoa, 1 (5.6%) — monogeneans, 4 (22.0%) — trematodes, 4 (22.0%) — cestodes, 3 (16.7%) — parasitic crustaceans.

In total, 26 species of parasites were found in herbivorous fish, of which 11 species (42.3%) are invasive.

It should be noted that 18 species (69.2%) of the detected herbivorous fish's parasites develop directly and 8 (30.8%) — with the participation of definitive and intermediate hosts. The fish is an additional (second intermediate) host in the life cycle of 6 species (23.1%) of parasites.

Representatives of the genus *Dactylogyrus* are specific parasites to their hosts: in the case of the silver carp only *D. hypophthalmichthys* was registered, in the grass carp — *D. ctenopharyngodonis*, and in the bighead carp — *D. aristichthys*. Representatives of parasitic crustaceans from the genus *Sinergasilus* showed species specificity too: *S. lieni* was registered in the silver carp and the bighead carp, and *S. major* in the grass carp.

It is important to note that in the silver carp coupled with the bighead carp, 15 species (68.2%) of the detected pathogens are parasites on the surface of the body, skin and gills; one species is a parasite of the intestinal mucosa, one species — a parasite of the eyes, one species — the subcutaneous tissue, three species — the abdominal cavity.

In the grass carp, 11 species (61.1%) were found to be parasites on the surface of the body, skin and gills; one species were parasites of the eyes, three species — the abdominal cavity, and two species — the intestine. *M. ellipsoides* was localized in all organs and tissues of the three species.

According to the results of studying the age dynamics of infection of herbivorous fish with pathogens of protozooses, the data shown in Fig. 1 were obtained.

Thus, the data in Fig. 1 show that outbreaks of diseases caused by parasitic protozoa were recorded mainly in this fingerlings and two-year-old fish. It should be noted that the highest level of PI by microsporidia was recorded in fingerlings and two-year-old fish. At the same time, PI *M. pavlovskii* in fingerlings reached 89%, in two-year-olds — 78%, the level of infection of three-year-olds and four-year-olds was much lower — 14% and 11%, respectively.

The prevalence of *M. drjagini* and *M. ellipsoides* in two-year-olds was 14% and 20%, three-year-olds — 9% and 12%, fingerlings — 3% and 8%, respectively. A similar pattern was registered in the *E. sinensis* infection: PI in two-year-olds was 12%, three-year-olds — 8%, fingerlings — 3%. Another picture was observed when infecting fish with pathogens of ciliaphorosis — *T. acuta, T. nigra, T. epizootica*: the highest level of infestation was recorded in fingerlings — 81%, 58%, 19%, and the infection in two-year-olds was much lower — 22%, 14 %, 4%, respectively.

Table 1 — Species composition of herbivorous fish's parasites and places of their localization in the conditions of aquaculture of the North-Eastern and Eastern regions of Ukraine

No.	Parasite species	Localization	Fish species		
			Silver carp	Bighead carp	Grass carp
1	* *Cryptobia branchialis* (Nie in Chen, 1956)	gills	+	+	–
2	*Ichthyobodo necator* (= *Costia necatrix*) (Henneguy, 1883)	gills, skin	+	+	+
3	* *Eimeria sinensis* Chen, 1956	intestine	+	+	–
4	* *Myxobolus pavlovskii* (Achmerov, 1954)	gills	+	+	–
5	* *Myxobolus drjagini* (Achmerov, 1954)	subcutaneous tissue	+	+	–
6	*Myxobolus ellipsoides* Thélohan, 1892	all organs and tissues	+	–	+
7	*Chilodonella piscicola* (Zacharias, 1894) Jankowski, 1980	gills, body surface	+	+	+
8	*Ichthyophthirius multifiliis* Fouquet, 1876	gills, body surface	+	+	+
9	*Trichodina acuta* Lom, 1961	gills, body surface	+	+	+
10	*Trichodina nigra* Lom, 1961	gills, body surface	+	+	–
11	*Trichodinella epizootica* (Raabe, 1950) Sramek-Husek, 1953	gills, body surface	+	+	+
12	* *Dactylogyrus hypophthalmichthys* Achmerov, 1952	gills	+	–	–
13	* *Dactylogyrus aristichthys* Long et Yu, 1958	gills	–	+	–
14	* *Dactylogyrus ctenopharyngodonis* Achmerov, 1952	gills	–	–	+
15	*Diplostomum spathaceum* (Rudolphi, 1819) mtc	eyes	+	+	+
16	*Posthodiplostomum cuticola* (Nordmann, 1832) mtc	skin	+	+	+
17	*Ichthyocotylurus variegatus* (= *Tetracotyle variegate*) (Creplin, 1825) Odening, 1969 mtc	abdomen	+	+	+
18	*Apophallus donicus* (Skrjabin et Lindtrop, 1919) mtc	body surface, fins, gills	+	+	+
19	* *Khawia sinensis* Hsü, 1935	intestine	–	–	+
20	* *Bothriocephalus acheilognathi* Yamaguti, 1934	intestine	–	–	+
21	*Ligula intestinalis* (Linnaeus, 1758) l	abdomen	–	+	+
22	*Digramma interrupta* (Rudolphi, 1810) l	abdomen	–	+	+
23	* *Sinergasilus lieni* Yin, 1949	gills	+	+	–
24	* *Sinergasilus major* (Markevich, 1940)	gills	–	–	+
25	*Lernaea cyprinacea* Linnaeus, 1758	skin	+	+	+
26	*Argulus foliaceus* (Linnaeus, 1758)	skin	+	+	+

Remarks: * — invasive species, mtc — metacercariae, l — larvae.

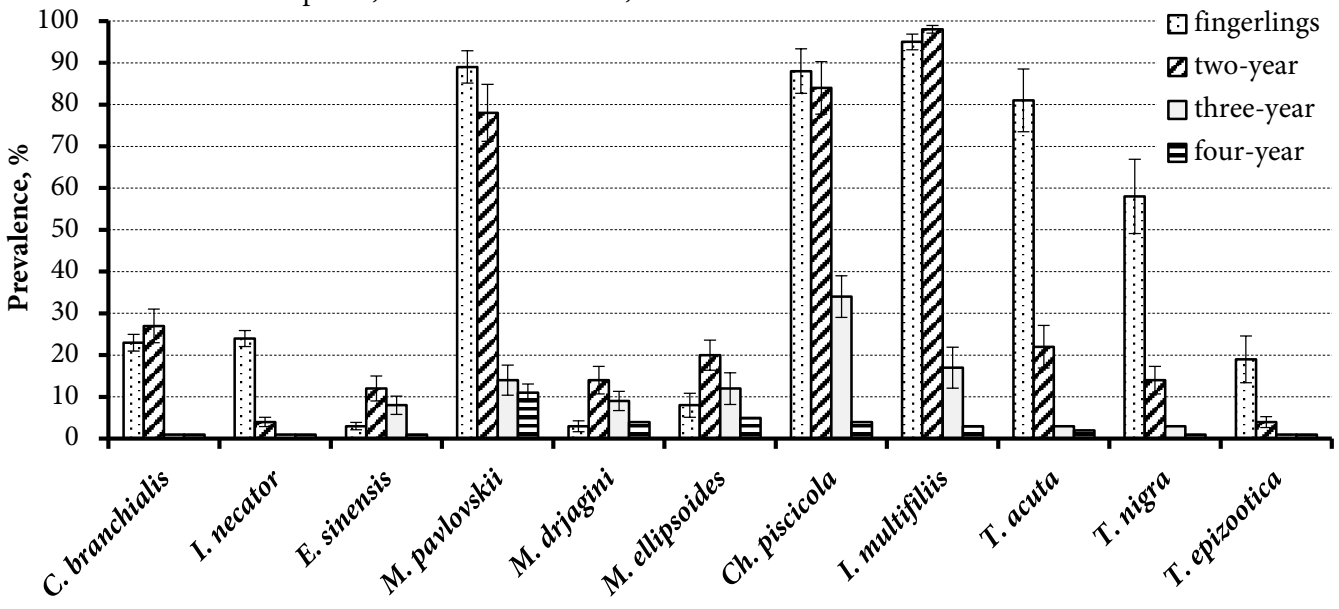

Figure 1. Age dynamics of infection of herbivorous fish with pathogens of protozooses during outbreaks of diseases in fish farms of the North-Eastern and Eastern regions of Ukraine

Outbreaks of protozoozes caused by other parasitic ciliates — *Ch. piscicola* and *I. multifiliis* were accompanied by high levels of infection in both fingerlings — 88%, 95% and two-year-olds — 84%, 98%, respectively. As for the pathogens of mastigophorosis, a high level of prevalence of *I. necator* was registered in fingerlings — 24%, and the pathogen *C. branchialis* was detected with a fairly high level of infection in fish both fingerlings (23%) and two-year-olds (27%). Infection of four-year-olds with the protozoa was significantly reduced and turned into a form of parasite carriage.

When studying the seasonal dynamics of infection of fish with protozoa, it was found that the peak level of infection of the silver carp with parasites from the genera *Trichodina* and *Trichodinella* was registered in August, the protozoa of the genus *Cryptobia* — in August–September. Outbreaks of ichthyoftiriosis infection (*I. multifiliis*) were most often recorded in the conditions of significant fish density that occurred in early summer when fry were in spawning ponds (when growing young) or in autumn among fish of different ages after transferring into winter ponds (under the conditions of autumn temperature rise). The highest level of infection of fish with chylodonels (*Ch. piscicola*) was recorded in winter ponds from October to April.

Outbreaks of disease depended on water temperature, the optimal value for the development of these parasites ranged from 5°C to 18°C. Infection of young silver carp with myxosporidia (*M. pavlovskii, M. ellipsoides, M. drjagini*) was registered from the first days of their placing in growing ponds and an increase in intensity was observed throughout the warm period of the year. The highest level of infection of both fingerlings and two-year-old silver carp was registered at the beginning of the winter period. The death of the bighead carp from myxobolic parasitemia was sometimes observed.

Thus, according to the results of the conducted researches it was established that the pathogens from the genera *Trichodina* and *Cryptobia*, to a lesser extent — *Chilodonella*, had the greatest epizootic significance for the silver carp. Representatives of the genus *Myxobolus*, especially *M. pavlovskii*, which caused outbreaks among fingerlings and two-year-olds, proved to be epizootically important species for the bighead carp. *Ch. piscicola* and *I. multifiliis* were also of epizootic significance. In the grass carp, protozoa were found mainly in the form of parasite carriage with a slight level of prevalence, but outbreaks caused by *I. necator* and *I. multifiliis* have been reported.

The level of infection of the silver carp coupled with the bighead carp with pathogens of helminthiasis and crustaceosis in outbreaks of the diseases in fish farms in the North-Eastern and Eastern regions of Ukraine is shown in Fig. 2. Pathogens from the genus *Dactylogyrus* were more frequently registered among three-year-olds with a maximum level of *D. hypophthalmichthys* infection in the silver carp — 74% and *D. aristichthys* in the bighead carp — 54%.

Metacercariae of *Diplostomum spathaceum* were more often registered in two-year-old fish — 34%, less often in fingerlings (22%) and three-year-olds (15%). *P. cuticola* larvae in unfavorable farms were found with a high level of prevalence in fish of different age groups: PI of two-year-olds — 81%, three-year-olds — 54%, fingerlings — 38%.

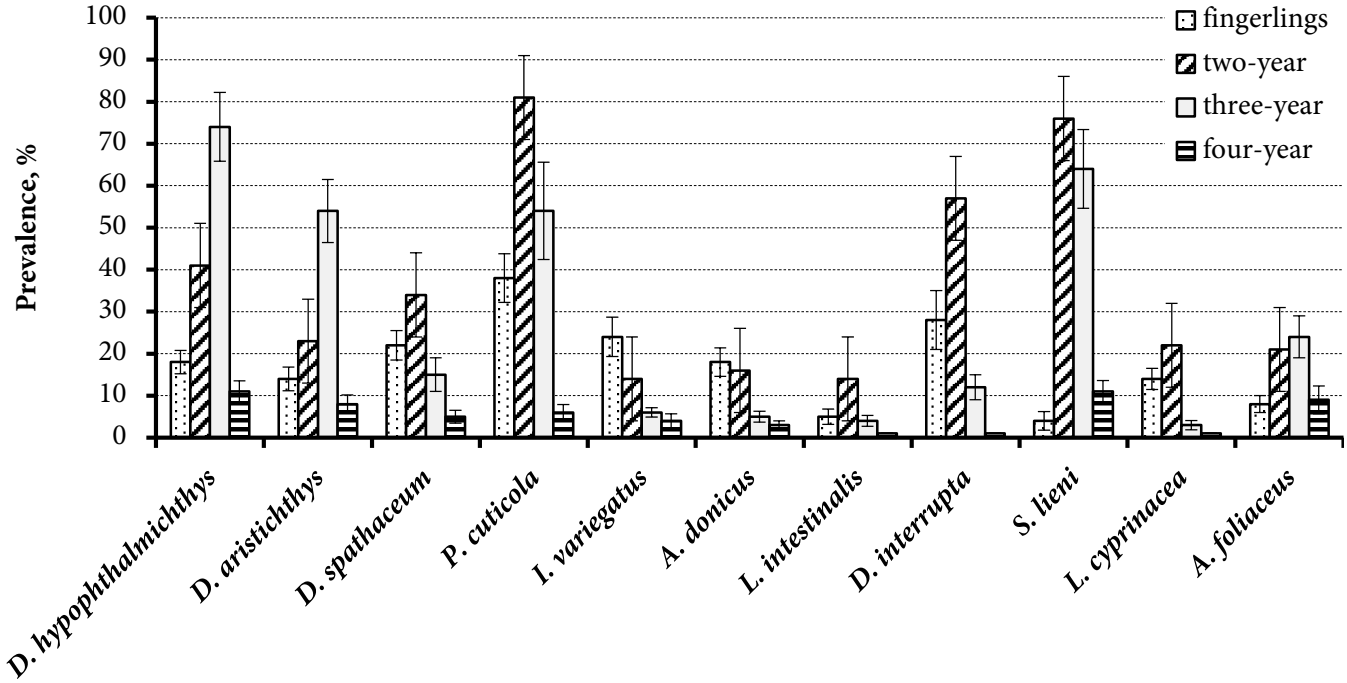

Figure 2. Age dynamics of infection of the silver carp and the bighead carp with helminthic and crustacean pathogens in disease outbreaks in fish farms in the North-Eastern and Eastern regions of Ukraine

Similar dynamics of infection was observed when infected with metacercariae of *I. variegatus* and *A. donicus* — 24% and 18% in fingerlings, 14% and 16% in two-year-olds, and it significantly reduced in older fish. Thong plerocercoids in outbreaks of ligulidosis were also more common registered among two-year-olds: PI with *L. intestinalis* — 14%, PI with *D. interrupta* — 57%.

Parasitic crustaceans *S. lieni* with a high level of prevalence were registered in two-year-old and three-year-old fish — 76% and 64%, respectively. *L. cyprinacea* was more often found among two-year-olds (PI — 22%) and fingerlings (PI — 14%). *A. foliaceus* were registered among fish of different age groups: PI in fingerlings — 8%, two-year-olds — 21%, three-year-olds — 24%, four-year-olds — 9%.

The age dynamics of infection of the grass carp with pathogens of helminthiasis and crustaceasis is shown in Fig. 3.

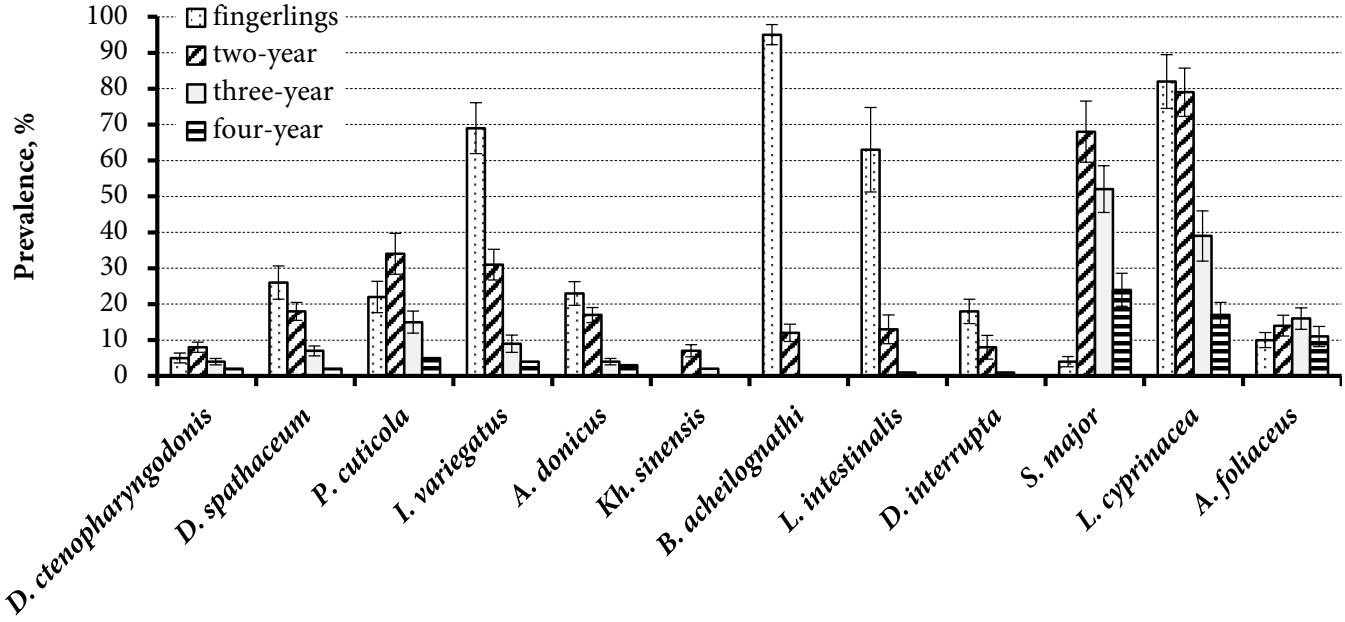

Figure 3. Age dynamics of infection of the grass carp with helminthic and crustacean pathogens in disease outbreaks in fish farms in the North-Eastern and Eastern regions of Ukraine

Parasitic fauna and the level of infection of the grass carp differed slightly from other herbivorous fish species. Thus, monogeneans *D. ctenopharyngodonis* were registered with a low level of infection in fish of all age groups (PI in fingerlings — 5%, two-year-olds — 8%, three-year-olds — 4%). Metacercariae of *I. variegatus* were found en masse in fingerlings of the grass carp with PI 69%, the lowest level of prevalence was registered in two-year-olds and three-year-olds — 31% and 9%, respectively.

A similar pattern of dynamics of infection was observed when infected with metacercariae of trematodes *D. spathaceum* and *A. donicus* — 26% and 23% in fingerlings, and 18% and 17% in two-year-olds, respectively.

Metacercariae of *P. cuticola* were more often registered in two-year-olds (PI — 34%), less often in fingerlings (PI — 22%) and three-year-olds (PI — 15%). Pleguercoids ligulide were registered mainly in fingerlings (PI with *L. intestinalis* — 63%, *D. interrupta* — 18%) and two-year-olds (PI with *L. intestinalis* — 13%, *D. interrupta* — 8%).

Infection with *B. acheilognathi* in fingerlings reached 95%, while prevalence of two-year-olds did not exceed 12%, and in older fish helminths were not detected. It should be noted that *Kh. sinensis* with PI of 7% and 2%, respectively, were found in two-year-old and three-year-old grass carp.

Compared with other herbivorous fish species, the grass carp was more often affected by crustaceans *L. cyprinacea*. The PI in fingerlings and two-year-olds reached 82 5 and 79%, and the level of infection of three-year-olds and four-year-olds was 39% and 17%, respectively. A high level of infection with crustaceans *S. major* was registered. Thus, the PI in fingerlings was insignificant (4%), but in older fish it reached 68% in two-year-olds, 52% in three-year-olds, 24% in four-year-olds. The level of *A. foliaceus* infection in fish of different age groups almost did not differ and ranged from 10% in fingerlings to 16% in three-year-olds.

According to the analysis of seasonal dynamics of infection of fish with helminthiasis and crustacean pathogens, it was found that monogeneans in fingerlings of the silver carp began to be registered in July, the maximum level of infection of fish regardless of age was observed in late July–August, with decreasing the water temperature prevalence decreased.

Pathogens of postodiplostomosis were registered in fish throughout the year, but the highest level of infection was observed in the autumn. During the winter,

prevalence decreased slightly, but began to increase again during the summer. When infected with metacercariae of *D. spathaceum, I. variegatus,* and *A. donicus*, the peak level of infection was also observed in autumn, but during the winter period prevalence did not decrease significantly. Infection with plerocercoids ligulide (*L. intestinalis, D. interrupta*) occurred throughout the summer and in late autumn prevalence was the highest. Due to the death of fish weakened by pathogens during the winter, the level of prevalence decreased significantly in the spring.

A similar pattern was observed in the infection of the grass carp with pathogens of botryocephallosis, but the peak of the infection was observed in late summer–early autumn. The highest level of infection with parasitic crustaceans from the genera *Sinergasilus* and *Lernaea* was recorded throughout the summer period with the maximum level of prevalence in September. Crustaceans *A. foliaceus* were recorded on fish throughout the year.

Therefore, based on the results of research, it was found that monogeneans *D. hypophthalmichthys*, metacercariae of *P. cuticola*, *S. lieni* have a veterinary-sanitary (epizootic) significance in aquaculture for the silver carp, for the bighead carp — *D. aristichthys, P. cuticola, D. spathaceum, D. interrupta, S. lieni*, for the grass carp — *B. acheilognathi, I. variegatus, L. intestinalis, S. major, L. cyprinacea.*

According to Davydov et al. (2012) modern fauna of herbivorous fish's parasites in reservoirs of Ukraine is represented by 83 species. At the same time, about 20 species of invasive species of parasites have survived, including 11 species of protozoa (*C. branchialis, Eimeria mylopharyngodoni, Myxidium ctenopharyngodonis, Sphaerospora amurensis, Sphaerospora cyprini, Myxobolus dispar, Myxobolus latus, M. drjagini, M. ellipsoides, Balantidium ctenopharyngodoni, Thrichodina nobilis*), four species of monogeneans (*D. ctenopharyngodonis, Dactylogyrus lamellatus, D. hypophthalmichthys, Gyrodactylus ctenopharyngodontis*), three species of cestodes (*Biacetabulum appendiculatus, Kh. sinensis, B. acheilognathi*), two species of trematodes (*Amurotrema dombrovskajae, Sanguinicola skrjabini*), one species of crustaceans (*S. lieni*). Other parasites are native species that have been transmitted to herbivorous fish from native ichthyofauna.

According to our data, 26 species of parasites were found in herbivorous fish, of which 11 species are invasive.

It should be noted that the fauna of herbivorous fish's parasites differs in different regions of Ukraine. According to Katiukha and Vozniuk (2016), only pathogens of diplostomosis and sinergasillosis in the silver carp and only pathogens of lerneosis in the grass carp were found in the aquaculture of Rivne Region.

The obtained results on the age and seasonal dynamics of infection allow the introduction of a set of treatment and prevention measures in the control of pathogens (Dunn and Hatcher, 2015). Thus, to control monogeneans and parasitic crustaceans, it is recommended to take preventive measures at the beginning of the growing season in June among fish of all ages.

Double treatment of fish with larval cestodes and trematodes is recommended — in July and September among fingerlings and two-year-olds. In intestinal cestodes, the most effective treatment period is August–September. Preventive treatment of fish of all ages with parasitic protozoa should be carried out after transferring fish into winter ponds.

Conclusions. 1. In fish farms of the North-Eastern and Eastern regions of Ukraine, 26 species of parasites were found in herbivorous fish: 19 species in the silver carp (11 — protozoa, 1 — monogeneans, 4 — trematodes, 3 — parasitic crustaceans); 18 species in the grass carp (6 — protozoa, 1 — monogeneans, 4 — trematodes, 4 — cestodes, 3 — parasitic crustaceans); and 20 species in the bighead carp (10 — protozoa, 1 — monogeneans, 4 — trematodes, 2 — cestodes, 3 — parasitic crustaceans). 11 species (42.3%) of registered parasites were invasive; 18 species (69.2%) of the detected herbivorous fish's parasites develop directly and 8 (30.8%) — with the participation of definitive and intermediate hosts; the fish is an additional (second intermediate) host in the life cycle of 6 species (23.1%) of parasites.

2. Outbreaks of diseases caused by parasitic protozoa from the genera *Myxobolus, Cryptobia, Chilodonella,* and *Ichthyophthirius* have been reported in both fingerlings and two-year-olds. The protozoa from the genera *Ichthyobodo, Trichodina,* and *Trichodinella* were registered en masse only in fingerlings. Pathogens from the genus *Dactylogyrus* were more often registered among three-year-old silver and bighead carps. Metacercariae of *Ichthyocotylurus variegatus* were found en masse in fingerlings of the grass carp. *Posthodiplostomum cuticola* larvae in unfavorable farms were found with a high level of prevalence in fish of different age groups. Thong plerocercoids were more commonly recorded in two-year-old silver and bighead carps and fingerlings of the grass carp. The highest level of cestode infection with *Bothriocephalus acheilognathi* was recorded in fingerlings of the grass carp. Parasitic crustaceans *Sinergasilus lieni* with a high level of prevalence were registered in two-year-old and three-year-old fish. Crustaceans *Lernaea cyprinacea* massively affected two-year-old and three-year-old fish.

3. Pathogens from the genera *Trichodina, Cryptobia,* and *Chilodonella*, and *Dactylogyrus hypophthalmichthys, Posthodiplostomum cuticola,* and *Sinergasilus lieni* were of the greatest epizootic significance for the silver carp; for the bighead carp — from the genus *Myxobolus,* (especially *M. pavlovskii*), *Chilodonella piscicola, Ichthyophthirius multifiliis, Dactylogyrus aristichthys, Posthodiplostomum cuticola, Diplostomum spathaceum, Digramma interrupta,* and *Sinergasilus lieni*; for the grass carp — *Bothriocephalus*

acheilognathi, Ichthyocotylurus variegatus, Ligula intestinalis, Sinergasilus major, Lernaea cyprinacea, Ichthyobodo necator, and *Ichthyophthirius multifiliis.*

Prospects for further research. The obtained results will help to increase the effectiveness of control of the epizootic situation, will allow more rapid and effective implementation of anti-epizootic measures, will justify the development of more effective treatment and prevention measures, which will improve the quality and safety of fishery products.

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Part 2. Biosafety

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THE QUALITY AND SAFETY OF EGGS OBTAINED FROM LAYING HENS AFTER THEIR EXPERIMENTAL POISONING WITH SODIUM BROMIDE

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Summary. The purpose of this study was to determine the quality and safety of eggs obtained from laying hens after their experimental poisoning with sodium bromide. According to the principle of analogues, three experimental and one control group of laying hens (n = 15) were formed. The background bromine content of the compound feed was 2.0 mg/kg. An aqueous solution of sodium bromide was added daily to the feed of the chickens of the experimental groups for 28 days, followed by the observation of the birds for 14 days without its addition. Chickens of the 1st experimental group received bromine with feed at a dose of 10.0 mg/kg, 2nd — 50.0 mg/kg, 3rd — 250.0 mg/kg of feed. During the experiment, eggs were collected daily, their quality was determined according to the requirements of DSTU 5028:2008 'Hen's Eggs for Human Consumption. Specifications' and the rules for the veterinary and sanitary examination of poultry eggs. In addition, the bromine content was determined separately in egg white, yolk, and shell. Bromine content was determined by X-ray fluorescence analysis. Statistical processing of research results was conducted. Under the conditions of the chronic experiment, clinical manifestations of poisoning in chickens were not observed. No significant deviation from the control group was observed in productivity, egg mass, white to yolk mass ratios, and pH values of yolk and white. However, an uneven distribution of the eggs by category was established. Starting from the 2nd day of the experiment, bromine was excreted in laying hens with egg whites. The maximum value was observed on the 18th–28th days of the experiment: in the 1st experimental group a reliable excess 2.5 times of bromine content relative to the control was observed; in 2nd — 7.2 times, and in 3rd — 26.9 times. Thus, eggs from chickens of all groups conformed to DSTU 5028:2008 and the rules for the veterinary and sanitary examination of poultry eggs. However, the bromine content in the eggs of all experimental groups reliably exceeded the reference value for 28 days when sodium bromide was received with feed. Even 14 days after the experiment, the content of the element reliably exceeded the control value in the eggs of chickens from the 2nd and 3rd experimental groups, which may indicate the ability of bromine to cumulate

Keywords: egg quality and safety, bromine, laying hens, sodium bromide

Introduction. Today, there is a risk of getting excess bromine into food, since large quantities of consumer products are produced using brominated flame retardants (flame retardants). In connection with the detection of these compounds in samples of various environmental objects (Alaee et al., 2003; Luda, Balabanovich and Camino, 2002), on the recommendation of the European Commission (EC, 2014), the Member States of the European Union should monitor their presence in foodstuffs.

The highest concentration ranges of flame retardants were found in fish, fish products, and fish feeds (Fernandes et al., 2016; Poma et al., 2016).

In addition, the treatment of plants with bromine-containing pesticides can lead to increasing bromine content in food. Thus, according to Greve (1983) after methyl bromide treatment bromine content was observed: 3–7 mg/kg in strawberries, vegetables, and cereals, and over 200 mg/kg in leafy vegetables and herbs (lettuce, turnips, purslane, celery).

According to our previous studies (Kutsan, Orobchenko and Golubev, 2015), the bromine content in the compound feedstuff for poultry from Ivano-Frankivsk, Kharkiv, Poltava, Luhansk, and Donetsk regions was 0.66–14.36 mg/kg. Bromine content in water from wells in Kharkiv, Mykolaiv, Poltava, Luhansk, and Cherkasy regions was at the level of 0.011–11.08 mg/l. In Ukraine, bromine content in the feed is not normalized by any normative document. The maximum permissible level of inorganic bromides is given in the monograph by Aleksandrov (2000) and is 35.0 mg/kg of feed. In drinking water, according to Directive 98/83/EC (CEU, 1998) — 0.01 mg/l, and according to Hygienic Standard 2.1.5.1315-03 — 0.2 mg/l.

It should also be noted that the literature (Gurin, 2002; Radchikov et al., 2010) provides information on the use of bromine compounds as feed additives to improve animal meat production and reduce feed costs. Thus, when added to the diet of calves of potassium bromide at a dose of 280 mg of bromine per 100 kg of live weight, there was a

tendency to decrease the active acidity of the meat and some increase in the amount of moisture retention, as well as the intensity of coloring of the meat.

Increasing the level of the element in the diets of pigs to 14.7–17.2 mg/kg of dry matter contributed to the increase in the average daily growth of animals by 9.3–16.2%, slaughter yield — by 1.9–3.2%, bromine content in muscle — by 5.9%.

Bromine affects the central nervous system (inhibitory processes) and the endocrine system, namely, it has a regulatory effect on the function of the thyroid gland, delays the flow of thyroxine into the blood, resulting in the domination of assimilation processes in the body (Petunenkov, 2000).

In addition to its effect on the thyroid gland, bromine also caused a decrease in the number of luteal bodies in the ovaries of female rats and a decrease in spermatogenesis in males (Van Leeuwen, Den Tonkelaar and Van Logten, 1983). There are no data in the literature on the use of bromine compounds in poultry, in particular laying hens and its effect on the quality and safety of eggs.

Therefore, the **purpose of this study** is to determine the quality and safety of eggs obtained from laying hens after their experimental poisoning with sodium bromide.

Materials and methods. A chronic toxicological experiment was conducted in vivarium of National Scientific Center 'Institute of Experimental and Clinical Veterinary Medicine' (Kharkiv, Ukraine) to study the possible effect of bromine (sodium bromide) on laying hens and their products.

The experiment was carried out on 365-day-old Hisex White cross laying hens weighing 1.2–1.6 kg. According to the principle of analogues, three experimental and one control groups of animals (n = 15) were formed.

The compound feedstuff for laying hens KK 1–18 was used.

The background content of bromine in the compound feed for chickens was 2.0 mg/kg. The feed for the experimental groups was mixed daily with an aqueous solution of sodium bromide for 28 days, for the next 14 days bird monitoring was continued without adding sodium bromide solution to the feed.

Chickens of the 1st experimental group were treated with bromine at a dose of 10.0 mg/kg, 2nd — 50.0 mg/kg, 3rd — 250.0 mg/kg of feed. Chickens of all groups had free access to water.

During the experiment, eggs were collected from the experimental poultry daily to determine their quality according to physicochemical parameters, following the requirements of DSTU 5028:2008 (DSSU, 2009) and rules for the veterinary and sanitary examination of poultry eggs.

In the dynamics of the experiment the bromine content in eggs from the experimental birds was also examined (separately examined the content of the element in white, yolk, and shell). Bromine content was determined in pooled egg samples for every two days of the experiment using X-ray fluorescence analysis on a Spectroscan max spectrometer as recommended (Kutsan, Orobchenko and Kocherhin, 2014).

Statistical analysis of the research results was performed using the Microsoft Excel 2003 application package (for Windows 7). The reliability of the obtained results was evaluated by the Student's *t*-test (Van Emden, 2019).

Results and discussion. During the experiment, clinical observations of the bird were performed. Thus, the hens of all groups were mobile, received well food and water, had a cross-like appearance: comb and earrings were brilliant, bright red, beak yellowish, plumage white, smooth and shiny, well adhered to the surface of the body.

No significant deviation from the control group was observed in productivity.

Thus, for the whole study period, 314 eggs were obtained from the control group chickens, from the 1st experimental group — 316, 2nd — 313, 3rd — 311 (Table 1).

The average weight of eggs obtained during the day from the experimental groups was also not significantly different from that in the control group.

Table 1 — Dynamics of the daily number of eggs obtained from laying hens after their experimental poisoning with sodium bromide

Egg collection period, day of the experiment	Control group	Experimental groups		
		I	II	III
1–2	22	22	22	22
3–4	23	22	24	22
5–6	24	24	22	24
7–8	21	20	21	22
9–10	22	25	24	22
11–12	25	22	23	21
13–14	22	23	22	25
15–16	15	16	15	15
17–18	17	18	18	18
19–20	18	17	17	17
21–22	17	15	18	15
23–24	15	19	17	16
25–26	18	17	15	18
27–28	15	15	15	15
29–30	7	7	7	7
31–32	6	6	6	5
33–34	5	5	5	7
35–36	5	6	5	5
37–38	7	7	6	5
39–40	5	5	6	5
41–42	5	5	5	5
Total	314	316	313	311

According to the requirements of DSTU 5028:2008 (DSSU, 2009), eggs are divided into categories according to weight: selected — 73.0 g or more, higher — 63.0–72.9 g, the 1st — 53.0–62.9 g, the 2nd — 45.0–52.9 g, and small — 35.0–44.9 g.

No eggs in the 'small' category were observed in any group during the whole study period.

In the control group, 5.4% of the eggs were of the 2nd category, 58.5% — 1st, 35.8% — higher, and 0.3% — selected.

The percentage of 2nd category eggs compared to control was slightly smaller in the 1st and 2nd experimental groups, when in the 3rd group it increased and was 6.0%. The percentage of 1st category eggs increased markedly in all experimental groups, and the higher category, on the contrary, decreased compared to control.

The largest difference was observed in the 3rd experimental group, which was 72.8% and 20.1%, respectively.

The percentage of the selected category eggs was also slightly higher in all experimental groups compared to control, the highest — in the 2nd experimental group (1.2%) (Fig. 1).

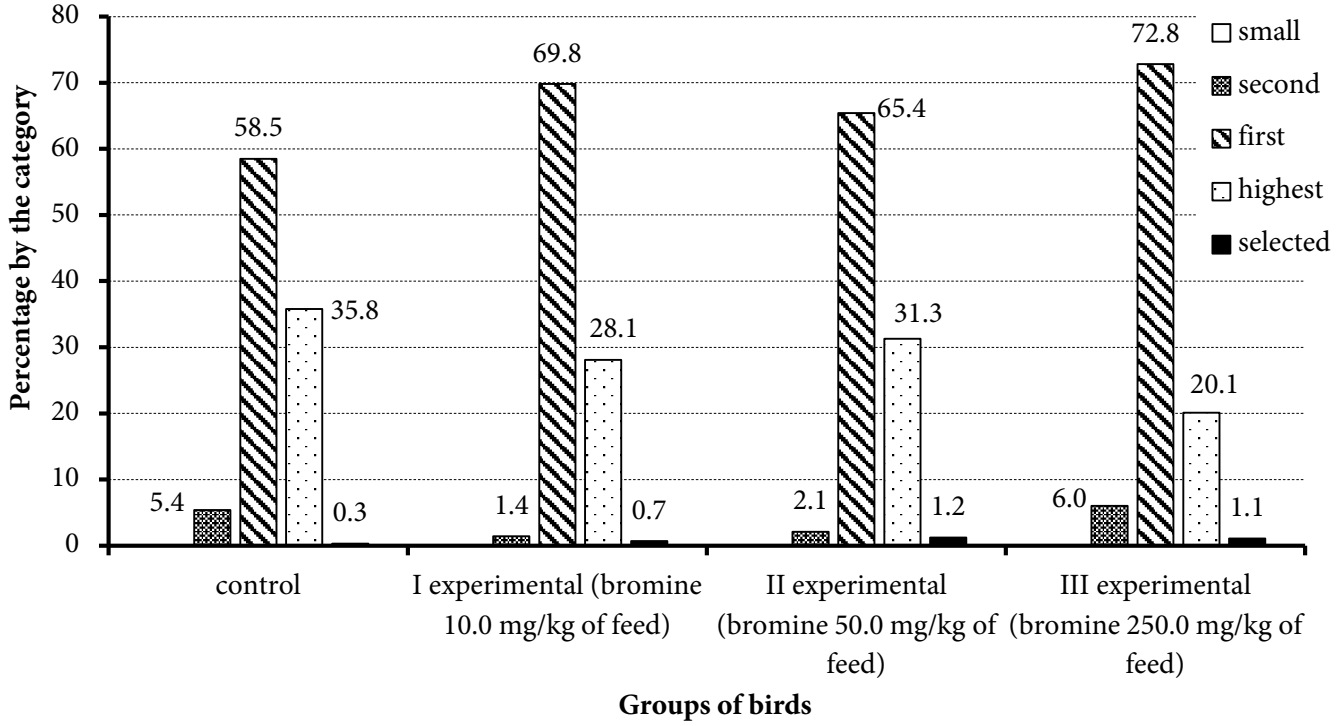

Figure 1. Distribution of eggs by category according to DSTU 5028:2008 (DSSU, 2009) during the chronic experiment

According to the results of the veterinary and sanitary examination of eggs from laying hens of the control and experimental groups, it was established that their quality met the requirements of the current DSTU 5028:2008 (DSSU, 2009). During the whole period of the experiment: the shell was whole, strong, without damage, smooth; the yolk is bright yellow, uniformly colored, elastic by consistency, retained shape; white is pure, transparent, viscous, without signs of deterioration; the smell is characteristic for fresh eggs.

The weight of the white, yolk, and shell, as well as the ratio of egg white to the yolk, under the conditions of oral administration of sodium bromide in the dynamics of the chronic toxicological experiment, were not significantly different from those in the control group (Table 2). The white weight ranged 30.88–35.15 g, the yolk — 16.70–18.90 g, the shell — 7.52–8.60 g, the ratio of the white to the yolk — 1.69–2.08.

The egg yolk and the egg white pH values in the experimental groups were also not significantly different from ones in the control group (Table 3).

Investigating the bromine content in eggs for the whole study period, it was found that in the yolk and shell of the control and all experimental groups, the bromine content was below the limit of 0.014 mg/kg for bromine. In the egg white in the control group during the experiment, the bromine content ranged from 8.01 to 10.89 mg/kg. In the 1st experimental group, on the 2nd day of the experiment, we observed a reliable excess of bromine in egg white, 1.4 times relative to control. The maximum value (23.03 ± 0.26 mg/kg) was observed on the 18th–28th days of the experiment, and on the 12th day after the experiment, its content in the experimental group was not significantly different from that in the control group (Fig. 2).

Table 2 — Dynamics of the white, yolk, and shell mass and the ratio of egg white to the yolk in eggs obtained from laying hens after their experimental poisoning with sodium bromide

Period, days	Groups		Indices			
			White mass, g	Yolk mass, g	Ratio of the white to the yolk	Shell mass, g
1–14	Control		33.40 ± 0.75	17.92 ± 0.51	1.88 ± 0.08	8.05 ± 0.20
	Experimental	I	34.42 ± 0.36	17.37 ± 0.39	1.99 ± 0.05	7.96 ± 0.24
		II	34.52 ± 0.87	17.61 ± 0.26	1.97 ± 0.07	8.24 ± 0.31
		III	32.59 ± 0.46	17.48 ± 0.23	1.87 ± 0.04	8.28 ± 0.07
15–28	Control		32.91 ± 0.62	17.89 ± 0.55	1.85 ± 0.07	8.04 ± 0.20
	Experimental	I	34.41 ± 0.54	17.18 ± 0.16	2.00 ± 0.03	8.06 ± 0.15
		II	33.20 ± 0.43	17.61 ± 0.26	1.88 ± 0.04	8.28 ± 0.16
		III	34.18 ± 0.59	17.30 ± 0.34	1.98 ± 0.06	7.93 ± 0.25
29–42	Control		33.27 ± 0.73	17.78 ± 0.42	1.87 ± 0.08	8.41 ± 0.23
	Experimental	I	32.78 ± 0.94	17.51 ± 0.45	1.88 ± 0.09	8.36 ± 0.21
		II	34.13 ± 0.77	18.11 ± 0.42	1.89 ± 0.07	8.43 ± 0.20
		III	32.99 ± 0.48	17.47 ± 0.40	1.90 ± 0.06	8.34 ± 0.19

Table 3 — Dynamics of the white and yolk pH in eggs obtained from laying hens after their experimental poisoning with sodium bromide

Period, days	Control group	Experimental groups		
		I	II	III
Egg white pH				
1–6	8.53 ± 0.09	8.70 ± 0.08	8.26 ± 0.30	8.57 ± 0.11
7–12	8.55 ± 0.05	8.58 ± 0.08	8.69 ± 0.05	8.58 ± 0.16
13–18	8.30 ± 0.12	8.09 ± 0.08	8.29 ± 0.02	8.45 ± 0.09
19–24	8.47 ± 0.04	8.58 ± 0.08	8.54 ± 0.02	8.57 ± 0.07
25–30	8.58 ± 0.03	8.56 ± 0.09	8.64 ± 0.05	8.66 ± 0.02
31–36	8.53 ± 0.07	8.56 ± 0.01	8.43 ± 0.13	8.38 ± 0.07
37–42	8.50 ± 0.01	8.46 ± 0.06	8.42 ± 0.06	8.47 ± 0.06
Egg yolk pH				
1–6	7.39 ± 0.05	7.18 ± 0.17	7.18 ± 0.11	7.27 ± 0.15
7–12	7.41 ± 0.16	7.39 ± 0.02	7.36 ± 0.08	7.21 ± 0.10
13–18	7.13 ± 0.03	7.03 ± 0.08	7.17 ± 0.07	7.11 ± 0.22
19–24	7.10 ± 0.09	7.12 ± 0.15	7.14 ± 0.18	7.05 ± 0.11
25–30	6.85 ± 0.15	7.03 ± 0.16	6.96 ± 0.04	6.94 ± 0.06
31–36	7.10 ± 0.15	6.96 ± 0.10	6.81 ± 0.10	7.09 ± 0.06
37–42	6.97 ± 0.07	6.66 ± 0.24	6.83 ± 0.08	6.76 ± 0.08

In the 2nd experimental group, the reliable excess of bromine content was observed at all study periods, and the maximum level was observed on the 18th–28th days of the experiment (65.38 ± 0.71 mg/kg), in the last study period bromine content 1.9 times exceeded the control. In the 3rd experimental group, the bromine content in egg white reached 243.52 ± 4.39 mg/kg on the 18th–28th days of the experiment, which was 26.9 times higher than the control. On the 2nd day after the experiment, its content 8.8 times exceeded the control, and on the 14th day — 3.5 times.

Analyzing the data of bromine content in eggs, we can say that with chronic sodium bromide entering the body, a significant amount of bromine is excreted from the organism with egg white, starting from the 2nd day of its supply with feed. It should also be noted that bromine tends to cumulate since the release of bromine with eggs was observed even 14 days after stopping the experiment. This is also evidenced by our previous studies (Kutsan, Orobchenko and Koreneva, 2019) concerning the toxicokinetics of bromine in the body of laboratory animals.

The uneven distribution of the percentage of eggs by category may be due to endocrine disorders caused by bromine (Petunenkov, 2000; Van Leeuwen, Den Tonkelaar and Van Logten, 1983), so this question requires a more detailed study.

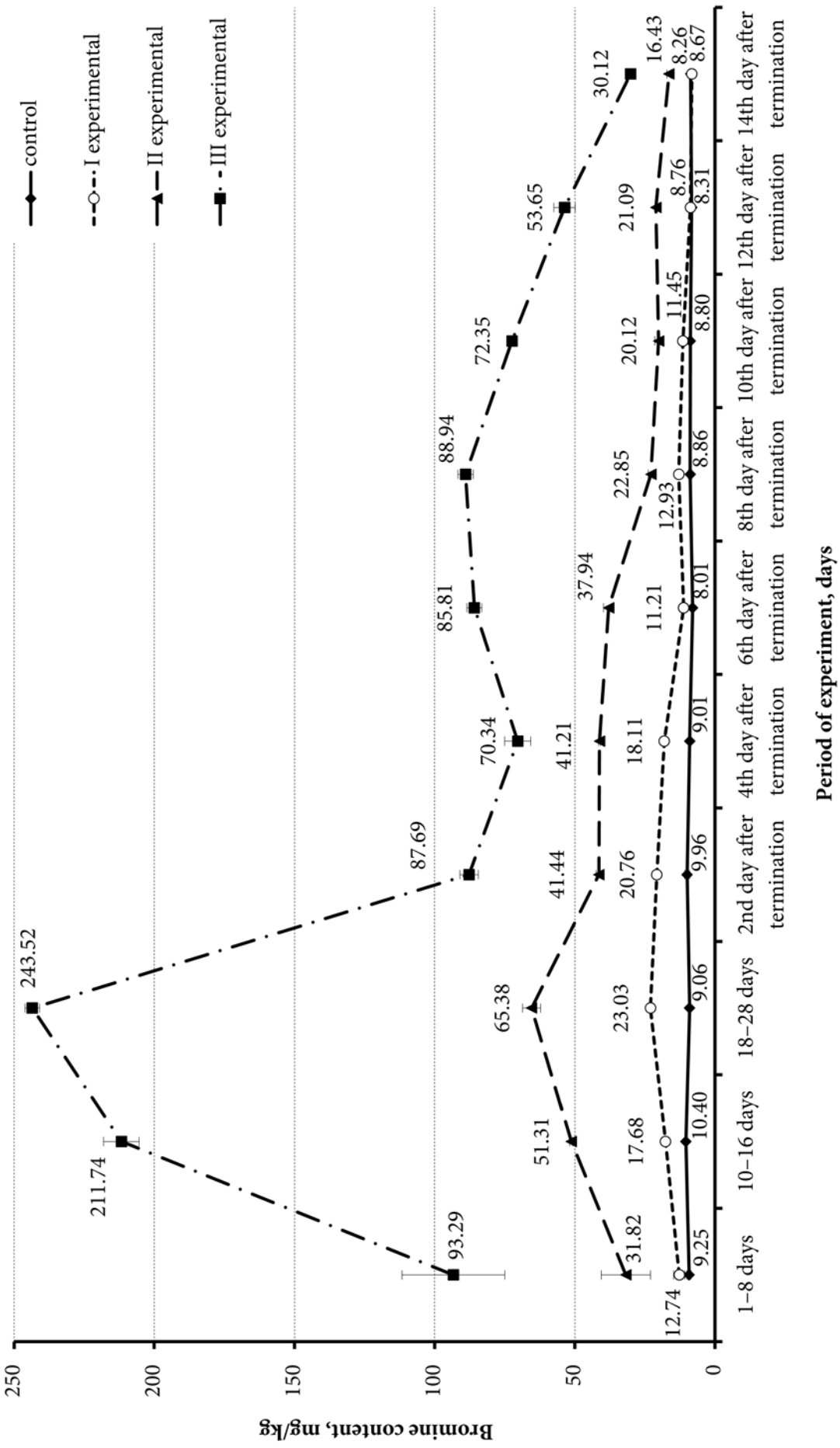

Figure 2. Dynamics of Bromine content in the white of eggs from experimental laying hens under conditions of chronic intake of sodium bromide (M ± m, n = 3)

Conclusions. Inorganic bromine under the conditions of chronic introduction to laying hens at doses of 10.0 mg/kg, 50.0 mg/kg, and 250.0 mg/kg of feed did not cause clinical manifestations of poisoning, but the uneven distribution of the percentage of egg categories may be as a result of endocrine disorders.

Eggs from chickens of all groups conformed to DSTU 5028:2008 (DSSU, 2009) and the rules for the veterinary and sanitary examination of poultry eggs.

Starting from the 2nd day of administration, bromine was excreted in laying hens with egg whites. In the birds receiving the bromine at the maximum dose, the content of the element in egg whites on the 18th–28th days of the experiment 26.9 times exceeded the control indicator. The high content of bromine in the eggs of the experimental groups after stopping its administration indicates the ability of bromine to cumulate.

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ADAPTATION OF NUTRIA MEAT TO INDUSTRIAL TECHNOLOGIES OF THE MEAT INDUSTRY

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Summary. This research is to determine the features of identification of products of the slaughter of nutria while post-slaughter veterinary-sanitary control, to assess the slaughtered yield, to study the peculiarities of the chemical and biochemical composition of the products of the slaughter of nutrias. This will allow, under the conditions of import substitution, to extend the source of raw materials for the production of sausage products and assortment of meat ready-to-cook foods. This paper represents the results of the veterinary and sanitary assessment of nutria meat as a prospective raw material for the meat processing industry in Ukraine. The peculiarities of identification of slaughter products of nutria are determined by the presence of fat deposits, rounded form lipoma, and the structure of internal organs while post-slaughter veterinary and sanitary control of nutrias' carcasses. It is proved, nutrias have been shown to have a sufficiently high slaughter yield of 57.5 ± 2.3% as compared to rabbits. It has been proven that nutria has a fairly high lethal yield compared to a crawl. The difference in the slaughter rate of female and male species was negligible and was 4.5 ± 1.4%. Nutrias' Meat Index is 4.9 ± 0.7. The high content of flesh on the spinal-chest and the thigh makes it possible to recommend these parts to produce portion (pieces) semi-finished products According to physicochemical composition nutria meat is characterized by an increased content of moisture (90.27 ± 2.18%), high content of protein (20.82 ± 1.15%) and low content of fat (8.34 ± 0.71%), which makes it possible to attribute this kind of meat to dietary.

Keywords: nutria meat, veterinary-sanitary control, slaughtered yield

Introduction. One of the main fields of the meat industry is to create meat products with high qualitative, functional, and flavor characteristics, with a high level of protein in the product balanced by the amino acid composition, which will ensure competitiveness among the existing assortment. In this regard, the urgent task is to attract additional sources of meat raw materials, such as nutrias, which has high protein content and extraordinary flavor characteristics (Angelyuk, Bystrova and Gorbunova, 2014).

Nutria belongs to herbivorous animals, characterized by high growth rates, which allows obtaining not only valuable skin but also dietary meat in the short term. Although more than one hundred thousand heads of nutria are slaughtered annually in Ukraine, the issues of the veterinary and sanitary control of their meat and offal are insufficiently covered and require careful study.

Unlike other types of meat, nutria meat is somewhat darker in color. This might be explained by the fact that it contains a significant amount of muscle hemoglobin (800–1000 mg%, and rabbit meat — 150–200 mg%). In terms of organoleptic characteristics, it is not inferior to rabbit meat. Nutria meat has a pleasant sweet taste, has no specific flavors and smells (Glotova et al., 2013; Volkova and Esenbaeva, 2017; Saadoun and Cabrera, 2019). Nutria meat is thin-fibrous — the thickness of the fibers is 37–40 μm (for comparison, turkey meat — 50–51 μm), it is delicate and characterized by good juiciness. It contains relatively many (3.5–5.0%) nitrogenous non-proteinaceous extracts: creatine, carnitine, carnosine, adenylic acid, purine bases, etc.; for example, in the meat of farm animals the content of extractives is 1.0–2.5%. The fat of the nutria is fusible, resembling a pig in consistency and color. 100 g of nutria meat contains 4.716 g of fat, 23.99 g of protein, 156–213 kcal of energy (Nalyvaiko et al., 2019).

Nutria meat (bone-free in carcass, internal fat and offal) is characterized by the following chemical composition: 100 g of nutria meat contains 140 cal of energy, 18.3 g of digestible protein, 6 g of fat, 4.5 g of raw ash (Kagadiy et al., 2015; Angelyuk, Bystrova and Gorbunova, 2014).

Muscle and adipose tissue, their quantitative ratio in carcasses, qualitative composition and processing conditions have the greatest technological importance in sausage production. The ratio of muscle and connective, fat, bone and cartilage tissues in the carcass of the nutria is at the level of beef and is 69–72%:13–14%:15–17%, respectively (Kozlova, Sidorova and Cheremenina, 2017; Głogowski, Pérez and Clauss, 2018; Nalyvaiko et al., 2019).

Absence of the normative-technical documentation in Ukraine and other countries (Russia, Belarus, Georgia, and others) for the basic types of the meat products from nutria, such, as the boiled, smoked sausages, delicacies,

and also the necessity of complex estimation of quality and physical and chemical characteristics of nutria meat, predetermined necessity of researches on application of this type of meat raw material in the technology of meat products (Kozlova, Sidorova and Cheremenina, 2017; Shebela et al., 2015). Complex veterinary and sanitary measures are of great importance in organizing the technological process of processing meat raw materials (Paliy et al., 2018).

The aim of the work is to establish the features of identification of products of the slaughter of nutria while post-slaughter veterinary-sanitary control, to assess the slaughtered yield, to study the peculiarities of the chemical and biochemical composition of the products of the slaughter of nutrias.

Materials and methods. The experimental part of the work was carried out in the Department of Infectology, Quality and Safety of Agricultural Products of the Luhansk National Agrarian University and in the meat processing enterprise in the Lugansk Region (Ukraine) The objects of the study were nutrias of black breed of private farming of business owner Kuznetsov V. I. (Kharkiv). Nutrias are kept in open-air cages with a covered walking area. The area of the open-air cage makes 8 m^2, and the area with a covered walking area is 3 m^2. Ten nutrias are kept in each cage (1 male and 9 females). The area for walking is equipped with a pool with an area of 0.8 m^2. The water in the pool during the warm period of the year (April–October) is changed every day. The walls of the aviaries are built of brick, and the walking areas are fenced with an iron fence. For the construction of floors, a metal mesh covered with the crushed stone was used. The farm uses a combined (concentrate-root-herbal) type of feeding. When compiling the diet, it is taken into account that each individual of young nutria must eat 20 g of roughage per day, and an adult one — 40 g/day.

There was made slaughter of nutrias at the age of 9 months to carry out research. The weight of females was 4.7 ± 0.3 kg, males — 5.1 ± 0.7 kg, and the fatness index was 0.077 and 0.082, respectively.

The slaughter and the veterinary and sanitary control of nutria carcasses were carried out under the 'Rules of Antemortem Veterinary Inspection of Animals and Veterinary-Sanitary Examination of Meat and Meat Products' (SDVMMAPU, 2002). Weighing of carcasses and internal organs was carried out on electronic platform scales of the brand CERTUS Balance CBA-600 and CERTUS Balance CBA-6000 (Japan).

A comparative characteristic of indices of nutria meat was carried out against to rabbit meat (Volkova and Esenbaeva, 2017).

The mass fraction of hygroscopic moisture in meat was determined by the method of drying samples at a temperature of 150°C for 30 min in accordance with the requirements of GOST 9793-74 'Meat products. Methods for determination of moisture content' (Gosstandart, 1974). For testing the muffle stove of SNOL-7.2/1100 was used.

The mass fraction of fat in meat was determined in a Soxhlet apparatus in accordance with GOST 23042-86 'Meat and Meat Products. Methods of Fat Determination' (Gosstandart, 1986).

The mass fraction of fat (x, %) was calculated by the formula (1):

$$x = \frac{m_1 - m_2}{m} \times 100, \quad (1)$$

where: m — mass of the test sample, g;

m_1 — mass of extraction retort with the pieces of phosphorus, g;

m_2 — mass of extraction retort with the pieces of phosphorus and fat after drying, g.

The mass fraction of albumen in products was determined by the method of Kjeldahl in accordance with requirements of GOST 25011-81 'Meat and Meat Products. Methods of protein determination' (Gosstandart, 1981). The method is based on the mineralization of the sample according to Kjeldahl, distillation of ammonia into a solution of sulfuric acid, followed by titration of the test sample. For testing the system 'BEHR Labor-Technik' was used.

The mass fraction of a total nitrogen (x, %) was calculated by the formula (2):

$$x = \frac{0.14 \times (V_1 - V_2)}{m}, \quad (2)$$

where: m — mass of the test sample, g;

V_1 — volume exactly 0.1 mol/dm^3 — 0.05 mol/dm^3 acids (0.1 n. — 0.1 n.) was spent on titration of the test sample, cm^3;

V2 — volume exactly 0.1 mol/dm^3 — 0.05 mol/dm^3 acids (0.1 n. — 0.1 n.) was spent on titration of the control sample, cm^3.

The mass fraction of a total protein (X, %) was calculated by the formula (3):

$$X = 6.25 \times x, \quad (3)$$

where x — the average mass fraction of a total nitrogen in the test sample calculated by the formula (2), %.

An energy value is the amount of energy, that appears at biological oxidization of fats, proteins, and carbohydrates, contained in products. It is expressed in kilocalories (kcal) or kilojoules (kJ).

The energy released during oxidation 1 g of fat is 9.0 kcal, 1 g of carbohydrates — 3.75 kcal, and 1 g of proteins — 4.0 kcal. To receive the power value in the SI system units, we used the next coefficient of count: 1 kcal = 4,184 kJ (Nalyvaiko et al., 2019).

Thus, the energy value of meat (per 100 g) is calculated by the formula (4):

$$A = \big((a \times 9) + (b \times 3.75) + (c \times 4)\big) \times 4.184, \quad (4)$$

where: a — mass fraction of fat, %;

b — mass fraction of carbohydrates, %;

c — mass fraction of protein, %.

Results and discussion. At the first stage of the research, while the post-mortem veterinary-sanitary examination, we have studied the features of the structure of carcasses and internal organs of nutrias intending to establish the species belonging. Determining the meat species belonging is one of the most important tasks of veterinary and sanitary control, the purpose of which is to exclude the falsification of meat raw materials.

It has been established that the carcasses of nutria are rounded, thick, and the muscles in the shoulder and pelvic girdle are well developed. Muscle tissue is pale pink in color. Subcutaneous fat is found in the area of the withers, knee fold, elbow joint, shoulder blade, chest and root of the tail. The integumentary and internal adipose tissues are painted in yellowish-white tones. The anatomical feature of nutria should be considered the presence of a lipoma, located between the shoulder blades above the spinous processes of 5–8 thoracic vertebrae, which has a rounded shape and a lobed structure. Its average size is $(2.87 \pm 0.07) \times (4.12 \pm 0.14) \times (0.59 \pm 0.08)$ cm. It should be noted that such a lipoma is absent in rabbits and cats.

The spleen is brown-red in color, lanceolate, elongated, with rounded edges. The color of the spleen pulp is normally red-cherry. The whitish-grayish points of the trabeculae are clearly visible in the section. The parenchyma does not protrude beyond the edges of the capsule. When scraping from the surface of the incision with the back of the knife, a small amount of pulp is removed.

The heart is dark red in color, oval with a blunt apex. To the right and somewhat in front of the aorta the right heart appendage is located, and to the left — the left heart appendage, which are blindly ending protrusions of the atria (right and left, respectively). The heart is enclosed in a pericardial bag. Outside it is covered with epicardium. The weight of the heart in female nutria is on average 9.54 ± 0.28 g., and in males — 9.65 ± 0.21 g.

The lungs of the nutria consist of seven lobes: on the left lung, three lobes are well defined — apical, cardiac and diaphragmatic, on the right four lobes are well pronounced — apical, cardiac, diaphragmatic and additional. Six lobes of the right and left nutria lungs (apical, cardiac, diaphragmatic) are approximately the same size. There are deep interlobar clippings reaching the bronchi. The right and left bronchi are free of lung tissue, 1.0–1.5 cm from the bifurcation site. The weight of the lungs in females is 20.85 ± 1.19 g, and in males of the same age — 21.63 ± 1.38 grams.

The nutria liver is well developed, consists of five independent lobes and an additional one. Four lobes — the right and left medial and lateral — large, approximately equal in size, the fifth lobe is smaller in size, square in shape resembling a plate, located between the right and left medial lobes, perpendicular to their surface. The additional lobe of the liver resembles a growth up to 1.5 cm in diameter. The color of the liver is from dark brown to brown-red. The weight of the liver in female nutria is 149.3 ± 4.34 g, and in male 6-month-old nutria — 140.3 ± 0.63 g, and in 12-month-old nutria — 153.71 ± 2.88 g. The adrenal glands are rounded, 1.4 ± 0.2 cm long, located in the lumbar region near the front of each kidney. It should be noted that the rabbit and cat liver, unlike the nutria liver, has a mastoid process.

The nutria kidney shape is also specific: the right kidney is bean-shaped and the left kidney is triangular. The kidneys of a rabbit and cat are bean-shaped.

The mammary glands in females are not located on the abdomen, as in other species of animals, but high on the sides along the back. There are 8–10 nipples, 4–5 on each side, and they are located at a distance of 6–7 cm from each other.

The nutria vertebral column consists of 56–57 vertebrae, of which 7 are cervical, 13 are thoracic, 6 are lumbar, 4 are fused sacral and 26–27 are caudal. At the 8^{th} caudal vertebra, the spine ends. Nutria has 15 pairs of ribs, including 8 — real and 5 — false. The collarbone is connected to the scapula and the first rib.

Nutrias have been found to have a high slaughter rate (live weight): males — $59.8 \pm 1.6\%$, females — $55.2 \pm 2.1\%$. The difference in the slaughter rate of female and male species was negligible and was $4.5 \pm 1.4\%$.

During post-mortem examination of carcasses and internal organs of nutria, no apparent pathological anatomical changes were found, the degree of exsanguination was good, carcasses had a characteristic pink-red color.

Important indicators that determine the appropriateness of the use of raw meat in the meat industry are the meat productivity of animals and the ratio of muscle, fat and bone tissue. Meat productivity is characterized by live and lethal weight of the animal, as well as a slaughter yield.

It was established that nutria has a rather high slaughter yield (to live weight): males — $59.8 \pm 1.6\%$, females — $55.2 \pm 2.1\%$. The difference in the slaughter yield of females and males is insignificant and amounted to $4.5 \pm 1.4\%$.

By the yield of slaughter products, nutria is not inferior to rabbits (Table 1). After analyzing the data of Table 1, we can conclude that the carcass of the nutria is fleshy — the bones with the head make up $12.5 \pm 0.5\%$, while in the rabbit — $10.7 \pm 0.2\%$. The yield of fresh-killed nutria meat is 16.82% higher compared to rabbit meat. It should be noted that when slaughtering nutria, illiquid wastes account for $8.3 \pm 1.45\%$ of the carcass weight, which is 1.5% less compared to slaughtering a rabbit.

To confirm the effectiveness of the use of nutria meat in the meat industry, we cut the nutria carcass into pieces based on the anatomical features of the carcass in order to study the composition and yield of carcass muscle tissue (Fig. 1). It is known that the more muscle tissue in meat, the greater its nutritional value as a protein product.

Table 1 — Nutria slaughter yield (M ± m, n = 15)

Name of the product	Yield to carcass weight, %	
	nutria	rabbit
Fresh-killed meat including:	57.5 ± 2.30	52.4 ± 1.53
Internal fat	4.4 ± 0.15	7.2 ± 0.20
Kidneys	0.6 ± 0.25	0.6 ± 0.16
Head	8.8 ± 0.42	6.5 ± 0.19
Fur	16.6 ± 2.12	11.3 ± 2.12
Ears, paws, tail	3.1 ± 1.32	3.2 ± 1.17
Blood	1.8 ± 0.21	2.1 ± 0.13
Liver	3.5 ± 0.40	3.5 ± 0.41
Head, lungs, trachea	1.6 ± 0.10	1.3 ± 0.15
Guts (no contents)	4.9 ± 0.84	6.3 ± 0.64
Illiquid waste	8.3 ± 1.45	9.8 ± 0.12

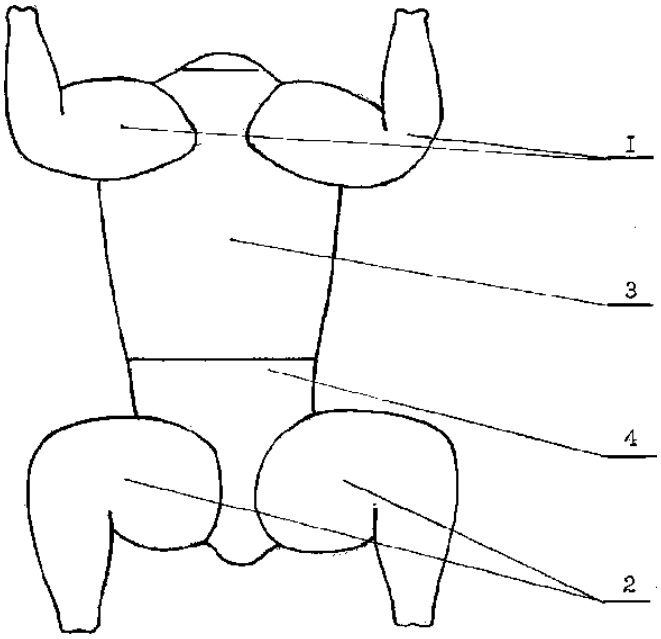

Fig. 1. Scheme of cutting carcass of nutria into culinary parts: 1 — scapular part; 2 — ham; 3 — spinal chest part; 4 — lumbar-flank part.

When boning the culinary parts, three types of tissue were distinguished: pulp, bone-cartilage, and adipose tissue (Fig. 2). Analyzing the research data on the morphological composition of the nutria carcass shown in Fig. 2, it was found that the ratio of the main tissues: muscle, fat and bone is on average 68.6:17.1:12.3. The yield of adipose tissue of carcasses of females was 1.25% higher compared to carcasses of males. Nutria flesh meat index was 4.9 ± 0.7. The largest value for this indicator was in males.

When deboning nutria carcasses rather large parts were separated: the shoulder blade 360–454 g, the ham 730–980 g, the lumbar-flank part 420–620 g, and the dorsal-chest part 590–857 g (Table 2).

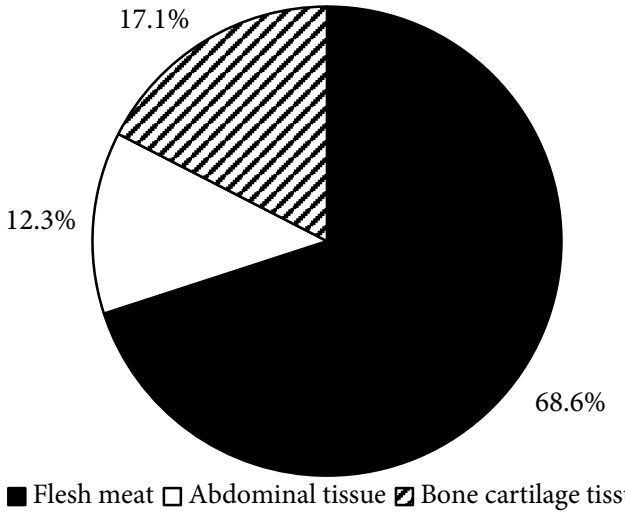

Figure 2. Morphological composition of nutria meat

Table 2 — The ratio of some parts of the nutria carcass, % of the total mass (M ± m, n = 15)

Carcass part	The yield of culinary parts when cutting nutria carcass, %	The yield of flesh meat during boning of carcass parts,%
Shoulder blade	16.3 ± 1.2	10.7 ± 2.1
Ham	36.4 ± 2.4	23.8 ± 2.3
Lumbar flank	20.2 ± 2.1	22.5 ± 1.5
Dorsal-chest	29.8 ± 1.6	13.1 ± 2.1

The largest amount of meat flesh was separated during boning of ham and lumbar flank, which is 23.8 ± 2.3% and 22.5 ± 1.5% of the carcass weight, respectively. At the same time, the largest culinary parts when cutting the carcasses of nutria were ham and dorsal-chest part — 36.4 ± 2.4 and 29.8 ± 1.6% of the total weight of the carcass, respectively.

Thus, the high content of flesh meat on the dorsal-chest part and ham allows you to use these parts not only for the production of sausages, but also for the preparation of portioned semi-finished products.

To ground the use of nutria meat in the meat industry, we studied its chemical composition in comparison with the meat of the rabbit. For this, we performed a control slaughter of nutria to study the physicochemical parameters of meat and to compare with rabbit meat. The samples of muscular tissue for further researches we took in the area of ham and shoulder-blade. The results of physical and chemical researches are presented in Table 3.

Having analyzed the data of Table 3, it was found that the nutria meat is characterized by a high moisture content (90.27 ± 2.18%), high protein content (20.82 ± 1.15%), and low fat content (8.34 ± 0.71%), which allows us to attribute this type of meat to dietary. The energy value of nutria meat is 252.92 kJ/100 g more compared to rabbit meat.

Table 3 — Physico-chemical characteristics of nutria meat (M ± m, n = 15)

Researched index	Nutria meat	Rabbit meat
pH	5.76 ± 0.02	5.95 ± 0.03
Mass concentration of moisture, %	90.27 ± 2.18	74.40 ± 0.53
Mass concentration of protein, %	20.82 ± 1.15	17.40 ± 0.29
Mass concentration of fat, %	8.34 ± 0.71	8.10 ± 0.36
Mass concentration of carbohydrates, %	0.37 ± 0.05	0
Mass concentration of ash, %	0.96 ± 0.01	1.03 ± 0.04
Mineral substance, %	1.0 ± 0.15	1.0 ± 0.12
Energy value of product, kJ/100 g	674.42 ± 2.35	421.5 ± 3.99
Protein:Fat	1:2.5	1:2.2

Thus, the chemical composition of nutria meat is not inferior to rabbit meat, and by such an indicator as the mass fraction of protein is even 3.42% higher than rabbit meat. Therefore, nutria meat can be used as an alternative meat raw material in the production of cooked sausages in accordance with DSTU 4529:2006 'Cooked Sausages of Poultry and Rabbits Meat. General Specifications' (DSSU, 2007).

According to the results of toxicological and radiological studies, there were no deviations from normalized indicators. Thus, having a high slaughter yield, meatiness index, high flesh content on the dorsal-thoracic part and ham, as well as the optimal chemical composition, nutria meat can be used in meat processing industry as an alternative raw material in the production of sausages and semi-finished meat products.

Conclusions. 1. During the realization of specific authentication of carcasses of nutrias it is necessary to pay attention to the next anatomic features: form and structure of kidneys, presence of lipoma of the rounded form, developed depot fats in area of withers.

2. It was established that nutria has a rather high slaughter yield (to live weight): males — 59.8 ± 1.6%, females — 55.2 ± 2.1%. Correlation of muscular, fatty, and bone tissue of nutria carcass is 68.6:17.1:12.3, which allows using the meat of nutria in sausage production.

3. The chemical composition of nutria meat is not inferior to rabbit meat, and, therefore, can be used as an alternative meat raw material in the production of cooked sausage products in accordance with DSTU 4529:2006 'Cooked Sausages of Poultry and Rabbits Meat. General Specifications' (DSSU, 2007).

4. However, today in Ukraine and other countries of the world there is no standard DSTU 'Nutria Meat. Technical Conditions'. This is a huge obstacle to the use of nutria on an industrial scale. This standard will introduce requirements for nutria meat, as a high-grade raw material for the manufacture of sausages.

Research prospects: Based on DSTU 4529:2006 'Cooked Sausages of Poultry and Rabbits Meat. General Specifications' (DSSU, 2007) to develop recipes of sausages using nutria meat.

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Part 2. Biosafety