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Hepatosis in broiler chickens: The role and efficacy of therapeutic and prophylactic agents containing hepatoprotectors

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Abstract. The preservation of poultry stock can be improved by incorporating therapeutic and preventive agents, including hepatoprotectors, into the diet. This study aimed to evaluate the effect of an experimental drug containing hepatoprotectors on the health of broiler chickens. The research sought to identify the potential of the preparation to enhance liver function and overall poultry stock survival. The study was conducted from 2023 to 2024 at Odesa State Agrarian University. Investigations were carried out

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to assess the effects of the experimental preparation in the following doses: 1.0 g/kg body weight (therapeutic dose), 2.0 g/kg body weight (double therapeutic dose), and 5.0 g/kg body weight (fivefold therapeutic dose) over 30 days. The experiment was conducted on 500 Cobb 500 broiler chickens aged 1 to 40 days. Additionally, biochemical blood parameters were measured and analysed using a Polish biochemical selective automatic analyser, the Hitachi 902. Studies have established that the optimal dose of the experimental drug for hepatosis in broiler chickens is 1.0 g/kg body weight. After administration of the drug, the serum bilirubin content decreased by 27.3%, lactate dehydrogenase activity decreased by 17.1%, aspartate aminotransferase activity decreased by 16.4%, alanine aminotransferase activity decreased by 19.3%, and vitamin A content increased by 25.6%, while the phagocytic activity of pseudoeosinophils increased by 23.1%. The results of the studies have proven that the experimental drug normalises liver function, positively affects the biochemical composition of blood, promotes growth, provides protection and natural resistance of the broiler organism, and even improves the quality of poultry products. Based on the above, it is necessary to improve methods for early diagnosis of liver function disorders in poultry and apply effective methods for correcting metabolic processes

Keywords: liver; hepatoprotectors; erythrocytes; haemoglobin; leukocytes

INTRODUCTION

Poultry farming is a sector of agriculture characterised by high liquidity within the market environment and rapid, dynamic development. The profitability of feed is significantly higher than in other branches of animal husbandry, therefore the cost of poultry meat is the lowest, which makes poultry production affordable for consumers (Bogach *et al.,* 2021). A decisive factor for the rearing of young stock is the onset of productivity – 130-150 days (depending on the cross of chickens). At this point, the metabolic load on the poultry reaches its maximum. Approximately 2-3 weeks before the start of egg production, significant changes occur in the structure and function of the oogenic organs and the metabolism of young hens (Paliy *et al.,* 2021; Dotsenko *et al.,* 2021). With the onset of sexual maturity, under the influence of the endocrine system, the intensity of metabolism changes, especially mineral metabolism, to form powerful reserves of calcium, which are actively used for the formation of egg cells. The liver plays a key role in this process, as it synthesises the active form of vitamin D (Ponomarenko *et al.,* 2021).

Recent studies have highlighted a high prevalence of liver diseases in both meat and egg-laying poultry. The liver is frequently involved in overall pathological processes associated with non-infectious, infectious, and parasitic diseases. According to A. Agbonon and M. Gbeassor (2019) and A. Baradaran *et al.* (2019), non-infectious diseases in poultry often include liver pathologies such as hepatitis or liver dystrophy, and these conditions have been diagnosed in 5.0-50.8% of cases. These pathological processes are often more pronounced in egg-laying poultry, which can be attributed to the specific metabolic characteristics of chickens and their housing conditions. Authors T. Bemela Mawulom *et al.* (2021), and X. Chen *et al.* (2023) noted that poultry diseases such as avian hepatitis and hepatic steatosis are prevalent on farms with mixed ownership. Clinically, this manifests as general weakness, reduced mobility, obesity, anaemia of the ears and comb, decreased egg production, increased levels of urea, creatinine, and bilirubin in the blood, and a decrease in the number of red blood cells. In addition to hepatocellular changes, kidney and heart dystrophy, individual haemorrhages in the liver are also observed in diseased birds.

Hepatitis or hepatic steatosis is caused by a disruption in the metabolism of substances, characterised by the degeneration and necrosis of liver cells and the impairment of all liver functions. As noted by P. D'Souza *et al.* (2019), this reflects on the overall condition of the bird and its productive characteristics, which can lead to mortality. A crucial prerequisite for effective prevention of liver diseases is a complete and balanced diet. When keeping poultry, feeding should correspond to the physiological state, be complete in terms of overall nutrition, protein composition, mineral content, and vitamins, and meet the specific needs of the species and age of the bird. Since contamination of feed with mycotoxins often causes liver dystrophy and hepatitis, feeding animals with high-quality feed is an important aspect of prevention. Therefore, it is necessary to eliminate adverse factors that can affect the quality of compound feed, such as energy imbalance in the feed, the presence of toxic metabolites, amino acids, vitamins, etc.

In foreign practice, complex preparations based on vitamins B4, B12, E, methionine, and selenium are often used. These substances complement each other and enhance the protective functions of the liver. The pathogenesis of liver diseases is primarily based on damage to cellular elements, especially hepatocytes, leading to dysfunction, dystrophic changes, inflammation, cell lysis, necrosis, and fibrosis (Feng *et al.,* 2019; Erukainure *et al.,* 2020). Therefore, hepatoprotectors are used to restore liver cell metabolism. The search for highly effective hepatoprotectors for liver protection in poultry is a pressing issue. According to C. Gregg *et al.* (2022), hepatoprotectors can be classified into the following groups: plant-based hepatoprotectors, phospholipid preparations, organ preparations, amino acid

derivatives, selenium-containing preparations, ursodeoxycholic acid preparations, synthetic drugs, and preparations from other groups.

Therefore, addressing the problem of normalising metabolic processes in poultry and restoring the morpho-functional state of the liver through the use of hepatoprotectors is one way to increase the efficiency of poultry farming and the production of high-quality products. This objective has informed the aim of the current study.

MATERIALS AND METHODS

A study conducted between 2023 and 2024 at the Odesa State Agrarian University aimed to investigate the effects of the drug Hep-A-Stres on the performance of broiler chickens and meat quality. The hepatoprotector was used to normalise metabolism, enhance overall resistance and productivity, prevent and treat hepatic steatosis, during stressful periods, and accelerate growth during the finishing period. Hep-A-Stres is a clear, oily liquid ranging from colourless to yellowish, with the possibility of slight sediment. The composition of 1 ml of the drug contains: carnitine hydrochloride – 25 mg; D, L-methionine – 10 mg; sorbitol – 200 mg; choline chloride – 18.75 mg; magnesium sulphate heptahydrate – 10 mg; benzyl alcohol – 15 mg; distilled water – up to 1 ml.

- Carnitine hydrochloride increases muscle mass and improves heart function by stimulating metabolic processes and enhancing the body's endurance. It reduces the risk of hepatic steatosis and improves the uptake of vitamins and minerals into cells, exhibiting antioxidant properties.
- Methionine and choline chloride contribute to the synthesis of liver enzymes, which is crucial for detoxification, and help lower blood cholesterol levels due to their lipotropic effects.
- Sorbitol and magnesium sulphate regulate intestinal transit and enhance bile flow.

The study was conducted on 220 chicken embryos and 120 Cobb 500 broiler chicks. The experiment involved injecting 0.1 ml of the drug into the yolk sac of the embryo at dilutions of 1:10, 1:100, and 1:1000. Each dose was tested on 25 embryos. At the time of the experiment, the chicken embryos were divided into 3 groups of 30, while the control group contained 20 intact embryos that were injected with an isotonic sodium chloride solution. On the 19th day of incubation, embryonic development was assessed. This included measuring body weight, cranio-caudal length, and the development of the pectoral and pelvic limbs. To examine the effect of the preparation on the offspring after hatching, 30 eggs were retained in each group and incubated until the chicks hatched. The resulting 120 chicks were reared to 40 days of age. The technical parameters of rearing were following the recommended practices for this crossbreed. Weekly measurements of the live weight of the broiler chickens were taken. Live weight is an indicator of bird development and reflects the impact of feeding and rearing conditions.

The clinical and physiological condition of the broiler chickens was assessed daily through visual inspection of the flock and observation of behaviour, appetite, and overall health. Physiological status was evaluated at the beginning and end of the experiment using morphological and biochemical blood parameters. Blood samples were collected from the brachial wing vein or after decapitation of the bird for biochemical analysis. Haematological parameters were determined, including red blood cell count, white blood cell count, haemoglobin concentration, erythrocyte sedimentation rate (ESR), and the percentage of band neutrophils, eosinophils, and monocytes (Kanda *et al.,* 2020). Additionally, biochemical blood parameters were measured and analysed using a Polish Hitachi 902 biochemical selective automated analyser. Blood samples were prepared according to the manufacturer's instructions (2010/63/EU).

To investigate drug resistance in broiler chickens, 30 ten-day-old chicks were divided into four groups. The first group served as a control. The second, third, and fourth groups were experimental. Hep-A-Stres was added to the diet of chickens in the experimental groups at doses according to Table 1. This means that each group received a specific dose of the drug per kilogram of body weight for 30 days, corresponding to the indicated doses: 1.0, 2.0, and 5.0 g/kg body weight, respectively. The data from this study allowed for a comparison of the efficacy and safety of different doses of the drug on chickens compared to the control group.

***Table 1**. Experimental design for broiler chickens*

Group	Drug	Dose, g/kg body weight
1 – control	-	-
2 – experimental	Hep-A-Stres	1.0
3 – experimental	Hep-A-Stres	2.0
4 – experimental	Hep-A-Stres	5.0

***Source:** compiled by the authors*

Physicochemical methods for determining meat freshness were conducted by national standards DSTU 3136:2017 (2019), DSTU 3143-95 (2009), and DSTU 3143:2013 (2014). The amino acid composition of the meat was determined using an automated multi-functional infrared spectrometer manufactured by "Infrapid-61" (Hungary). Meat samples were prepared according to the manufacturer's instructions. Statistical analysis was performed using the Statistica 6.0 software package. The significance of mean differences was evaluated using Student's t-test. All experimental studies were conducted by modern methodological approaches and complied with the relevant requirements and standards, specifically meeting the requirements of DSTU ISO/IEC 17025:2005 (2006). Animal husbandry and all manipulations were carried out following the provisions of the Order on the Procedure for Carrying out Experiments and Experiments on Animals by Scientific Institutions (Law of Ukraine No. 249, 2012), and the European Convention for the Protection of Vertebrate Animals used for Experimental and Other Scientific Purposes (1986).

RESULTS

Based on the external examination, no differences were observed between the foetuses of the control and experimental groups. The length of the forelimbs and hindlimbs, as well as the body weight, did not show any statistically significant differences compared to the control. Therefore, based on this study, it can be concluded that the experimental drug, at the indicated doses, does not exhibit embryotoxic or teratogenic effects on chicken embryos (Table 2).

***Table 2**. Dimensions and weight of chicken embryos, n = 20 (M ± m)*

Group	Pectoral length, mm	Pelvic length, mm	Body size, mm	Body weight, g
Control	31.9 ± 1.76	65.7 ± 2.58	77.1 ± 3.33	22.9 ± 3.24
After administration of isotonic solution	31.8 ± 1.79	65.1 ± 3.58	76.8 ± 3.22	22.8 ± 4.16
Experimental				
1:10	31.4 ± 1.25	65.7 ± 2.21	75.1 ± 3.44	23.8 ± 3.19
1:100	31.7 ± 1.63	66.6 ± 3.25	76.0 ± 3.28	23.3 ± 4.11
1:1000	31.4 ± 2.79	65.7 ± 3.26	75.8 ± 4.34	23.5 ± 3.14

***Source:** compiled by the authors*

During the examination of the larynx, nasal cavity, eyeballs, brain, internal organs, and skeletal system of embryos on a series of parallel cross-sections of the body, neck, and head, no anatomical deviations were found in the topography and morphology of the internal organs, in the rate of ossification of the skeletal bones, and their spatial orientation. The conducted studies showed that the highest percentage of chick hatching was observed in the second and third experimental groups. Thus, the drug under investigation not only lacks embryotoxic effects but also stimulates the sequential development of embryos. They do not have a teratogenic effect, and therefore, they can be included in the diets of breeding poultry. In the next stage of the study, the tolerability of the experimental drug in broiler chickens was determined. The results of the experiments showed that the use of the drug contributed to an improvement in the activity of the birds. The average daily weight gain of the birds was 5.5-7.9% higher than the control values for all applied doses of the experimental drug (Table 3). This indicates that the drug contributes to improving the health and development of broiler chickens, which may indicate its tolerability and effectiveness in poultry farming conditions.

***Table 3**. Results of the tolerability test of the experimental drug in broiler chickens*

Indicator	Groups			
	1 – control	2 – experimental	3 – experimental	4 – experimental
Number at the start of the study, heads	30	30	30	30
Mortality	1	-	-	-
Survival rate, %	96.6	100	100	100
Feed consumption per kg of weight gain, kg	1.81	1.76	1.77	1.78
Average daily gain, g	46.4	50.1	49.8	48.9

***Source:** compiled by the authors*

Regarding feed consumption per unit of production, the indicators were within the zootechnical standards for this cross of poultry. However, in the experimental groups, feed conversion was higher compared to the control after the application of all doses (by 1.6-2.8%) compared to the control group. The effect of the experimental drug on the morphological and biochemical blood parameters is presented in Tables 4 and 5.

***Table 4**. Morphological parameters of the blood of broiler chickens, n = 10 (M ± m)*

Indicator	Groups			
	1 – control	2 – experimental	3 – experimental	4 – experimental
Baseline data				
Erythrocytes, million/μl	2.87 ± 0.20	2.81 ± 0.15	2.90 ± 0.17	2.85 ± 0.14
Leukocytes, thousand/μl	28.9 ± 1.39	28.3 ± 1.25	28.2 ± 1.21	28.4 ± 1.14
Haemoglobin, g/l	94.4 ± 4.12	94.1 ± 4.23	94.9 ± 4.26	94.6 ± 4.22
Leukogram, %				
Basophils	2.7 ± 0.32	2.5 ± 0.28	2.1 ± 0.39	2.4 ± 0.41
Eosinophils	6.3 ± 0.41	6.4 ± 0.57	6.2 ± 0.61	6.0 ± 0.59
Pseudoeosinophils	26.1 ± 1.85	26.5 ± 1.29	26.7 ± 1.33	25.4 ± 1.33
Lymphocytes	58.3 ± 0.92	58.4 ± 1.19	58.1 ± 1.15	60.1 ± 1.29
Monocytes	6.6 ± 0.69	6.2 ± 0.55	6.9 ± 0.53	6.1 ± 0.79
After administration of the drug				
Erythrocytes, million/μl	2.98 ± 0.20	3.05 ± 0.14	3.06 ± 0.21	3.05 ± 0.22
Leukocytes, thousand/μl	29.9 ± 1.52	29.7 ± 1.51	29.8 ± 1.52	30.2 ± 1.63
Haemoglobin, g/l	94.9 ± 4.31	95.0 ± 4.28	96.4 ± 4.47	96.3 ± 4.42
Leukogram, %				
Basophils	2.8 ± 0.45	2.1 ± 0.41	2.0 ± 0.41	2.1 ± 0.46
Eosinophils	6.1 ± 1.14	6.8 ± 1.11	6.3 ± 1.10	6.1 ± 1.11
Pseudoeosinophils	27.0 ± 1.5	28.1 ± 1.2	29.6 ± 1.1	29.8 ± 1.3
Lymphocytes	56.3 ± 1.2	56.5 ± 1.5	56.9 ± 1.2	57.1 ± 1.4
Monocytes	7.8 ± 0.7	6.5 ± 0.6	6.4 ± 0.5	6.2 ± 0.4

***Source:** compiled by the authors*

***Table 5**. Biochemical parameters of the blood of broiler chickens, n = 10 (M ± m)*

Indicator	Groups			
	1 – control	2 – experimental	3 – experimental	4 – experimental
Baseline data				
Total protein, g/L	2.32 ± 0.16	2.30 ± 0.11	2.29 ± 0.10	2.30 ± 0.12
Inorganic phosphorus, mmol/L	7.63 ± 0.22	7.61 ± 0.25	7.70 ± 0.20	7.60 ± 0.11
Total calcium, mmol/L	10.46 ± 0.24	10.44 ± 0.21	10.38 ± 0.20	10.28 ± 0.33
Vitamin A, μg/ml	0.32 ± 0.026	0.31 ± 0.021	0.33 ± 0.026	0.32 ± 0.024
Carotene, μg/g	308.2 ± 12.7	307.7 ± 12.9	306.4 ± 11.28	310.7 ± 11.9
AST, nmol/(h/L)	0.52 ± 0.054	0.51 ± 0.053	0.52 ± 0.059	0.51 ± 0.58
ALT, nmol/(h/L)	0.23 ± 0.020	0.24 ± 0.019	0.21 ± 0.017	0.23 ± 0.023
After administration of the drug				
Total protein, g/L	2.37 ± 0.18	2.39 ± 0.15	2.39 ± 0.17	2.38 ± 0.14
Inorganic phosphorus, mmol/L	8.01 ± 0.34	8.11 ± 0.39	8.09 ± 0.31	8.10 ± 0.33
Total calcium, mmol/L	12.23 ± 0.31	12.81 ± 0.30	12.91 ± 0.32	12.89 ± 0.31
Vitamin A, μg/ml	0.34 ± 0.030	0.33 ± 0.032	0.34 ± 0.038	0.34 ± 0.039
Carotene, μg/g	309.3 ± 6.74	340.2 ± 6.11*	347.9 ± 6.13*	350.3 ± 6.27*
AST, nmol/(h/L)	0.54 ± 0.061	0.53 ± 0.060	0.55 ± 0.059	0.52 ± 0.066
ALT, nmol/(h/L)	0.25 ± 0.019	0.24 ± 0.030	0.25 ± 0.022	0.24 ± 0.026

***Note:** * – P < 0.05*
***Source:** compiled by the authors*

Haematological analysis revealed a trend towards increased red blood cell count and haemoglobin levels in chickens from the 3rd and 4th experimental groups. However, no statistically significant changes in the morphological blood parameters of the experimental chickens were observed throughout the study period. Analysing the leukogram, it can be concluded that after drug administration, it did not change significantly, with only a trend towards an increase in pseudoeosinophils observed. The obtained results may indicate that the drug has a minimal impact on the haematological parameters of chickens, but this warrants further investigation to elucidate the exact mechanisms of its effect on the avian organism.

The data presented in Table 5 shows that the administration of the drug caused an increase in serum

carotene levels in the 2nd, 3rd, and 4th experimental groups by 9.9%, 12.5%, and 13.1%, respectively, compared to the control values (in all cases P < 0.05). Regarding other biochemical blood parameters, they did not show significant changes and remained within the physiological norm. Thus, the conducted studies showed that Hep-A-Stres, at the tested doses, did not cause significant deviations in the bird's metabolic processes. During the macroscopic examination of the internal organs, no pathological changes were observed.

Based on the conducted research, it can be concluded that the drug, at the tested doses, was non-toxic to poultry. Its prolonged application (for 30 days) at doses of 1.0, 2.0, and 5.0 g/kg body weight (the therapeutic dose and two- and fivefold doses of the therapeutic dose) had no negative impact on the function of vital organs and systems in chickens, physiological and biochemical blood parameters, and did not cause changes in the structure of their organs. The next stage of the research will determine the effect of the drug on certain factors of the body's natural resistance (Table 6).

***Table 6**. Indicators of natural resistance in broiler chickens, n = 10 (M ± m)*

Indicator	Groups			
	1 – control	2 – experimental	3 – experimental	4 – experimental
		Hep-A-Stres		
		0.5 g/kg	1.0 g/kg	2.0 g/kg
Baseline data				
Bactericidal activity of blood serum, %.	35.33 ± 2.67	36.21 ± 2.43	34.88 ± 2.71	35.65 ± 3.22
Lysozyme activity of blood serum, %.	16.12 ± 1.22	15.94 ± 1.34	16.12 ± 1.43	16.77 ± 1.42
Phagocytic activity, %.	40.21 ± 1.76	40.23 ± 2.15	39.11 ± 2.43	40.23 ± 3.24
After administration of the drug				
Bactericidal activity of blood serum, %.	37.22 ± 2.35	38.75 ± 2.43	40.14 ± 2.53	40.43 ± 2.36
Lysozyme activity of blood serum, %.	17.12 ± 1.13	18.21 ± 1.43	19.12 ± 1.45	18.97 ± 2.15
Phagocytic activity, %.	40.23 ± 2.34	41.65 ± 3.12	49.51 ± 2.27*	49.19 ± 2.40*

***Note:** * – P < 0.05*
***Source:** compiled by the authors*

The table shows that the administration of the maximum dose of the drug to chickens in the 3rd and 4th experimental groups significantly increased the phagocytic activity of pseudoeosinophils compared to the control (23.1% and 22.3%, respectively). Although there was a trend towards increased bactericidal activity of serum in chickens of all experimental groups (from 4.1% to 8.6%), these changes were not statistically significant compared to the control. The increase in phagocytic activity of pseudoeosinophils can be explained by the high bioavailability and effectiveness of the drug's components and their synergistic action. Thus, the conducted studies showed that the drug, at the highest doses (1.0 and 2.0 g/kg body weight), increases the natural resistance of the organism and increases the average daily gain and survival rate of broiler chickens. However, the dose of 1.0 g/kg is considered optimal, as a higher dose (2.0 g/kg) does not cause a significant increase in weight or improvement in immune status in birds, and a lower dose (0.5 g/kg) is considered less effective. The next stage of the study was a physicochemical assessment of the broiler meat, as shown in Table 7.

***Table 7**. Physicochemical parameters of broiler chicken meat, n = 10 (M ± m)*

Indicator	Groups			
	1 – control	2 – experimental	3 – experimental	4 – experimental
Drugs		Hep-A-Stres		
		0.5 g/kg	1.0 g/kg	2.0 g/kg
pH	6.42 ± 0.07	6.04 ± 0.05	5.94 ± 0.06	6.2 ± 0.03
Reaction to peroxidase with benzidine	Doubtful	Positive	Positive	Positive
Acid number of fat, mg KOH	0.92 ± 0.08	0.94 ± 0.07	0.96 ± 0.07	0.92 ± 0.05
Determination of acidity-oxidation coefficient	0.36 ± 0.07	0.54 ± 0.08	0.54 ± 0.07	0.56 ± 0.09
Reaction with formalin	Doubtful	Negative	Negative	Negative

***Source:** compiled by the authors*

The table shows that the pH of the meat from the experimental broiler chickens indicates a mature and good quality state, while the pH values of the meat from the control group broiler chickens suggest a diseased state. The freshness and quality of the meat are also confirmed by indicators such as the acid-oxidation ratio and the acid number of the fat. When the drug was added, the acid-oxidation ratio of the meat from broiler chickens in all experimental groups was within the range of 0.54-0.56, while this value in the control group was 0.36. The benzidine reaction was positive in the meat of the experimental groups and negative in the formalin reaction, while in the meat of the control group broiler chickens, this indicator was doubtful.

Therefore, all the investigated parameters indicate that the meat of broiler chickens from the experimental groups, where the experimental drug was applied, corresponds to a mature and good quality state, while the meat of broiler chickens from the control group is classified as meat from diseased poultry according to all the investigated parameters. The determination of the content of essential amino acids, such as tryptophan and hydroxyproline, is an important method for assessing the nutritional value of meat (Table 8)

Table 8. *Biological value of broiler chicken meat, n = 10 (M ± m)*

Indicator	Groups			
	1 – control	2 – experimental	3 – experimental	4 – experimental
		Hep-A-Stres		
		0.5 g/kg	1.0 g/kg	2.0 g/kg
Hydroxyproline, %	0.23 ± 0.03	0.22 ± 0.05	0.21 ± 0.04	0.21 ± 0.05
± compared to control, %	-	-4.3	-8.6	-8.6
Tryptophan, %	1.20 ± 0.05	1.24 ± 0.09	1.28 ± 0.04	1.29 ± 0.06
± compared to control, %	-	+3.3	+6.7	+7.5
PQI	5.2 ± 0.31	5.6 ± 0.28	6.1 ± 0.29	6.1 ± 0.32
± compared to control, %	-	+7.7	+17.3	+17.7

Source: *compiled by the authors*

Tryptophan, which is found in large quantities in intracellular proteins, is a positive indicator of meat quality, whereas hydroxyproline, which is primarily found in connective tissue, is a negative indicator of quality. The ratio of these amino acids reflects the biological value of meat, known as the protein quality index (PQI). In the experimental groups of broiler chickens, the content of tryptophan in the breast muscles was 3.3-7.5% higher than in the control group, while the content of hydroxyproline was correspondingly lower by 4.3-8.6%. This resulted in a protein quality index of the meat in the experimental groups being 17.3-17.7% higher than in the control groups.

DISCUSSION

In industrial poultry farming, the high stress on the bird's organism leads to persistent disruptions in the functional activity of liver cells, even with minor deviations in metabolic processes. Symptoms of liver diseases often do not manifest immediately but only after a certain period, separated from the onset of the pathological process. According to scientists J. Heeren and L. Scheja (2021), antioxidants, such as flavonoids, play a key role in restoring liver function and increasing the overall resistance of the poultry's organism. Flavonoids, along with other antioxidants that enter the body through feed, are important components of the cell's antioxidant system. They can act as traps for free radicals and chelate metal ions involved in peroxidation. Polyphenolic compounds, to which flavonoids belong, can interact with various lipid radicals and stabilise them, forming phenol radicals that do not participate in oxidative processes.

In the studies conducted by O. Juanola *et al.* (2021) and S. Kismiati *et al.* (2023), it was found that alpha-tocopherol, which possesses a phenolic structure, interacts with lipid peroxide free radicals during lipid peroxidation reactions by donating a hydrogen atom. This process reduces the lipid peroxide to a hydroperoxide, thereby halting the progression of lipid peroxidation. The free radical generated from alpha-tocopherol as a result of this reaction stabilises and does not participate in further chain reactions. It can directly interact with lipid peroxide radicals, reducing them and converting them into a stable oxidised form known as tocopherol quinone. Such a reaction contributes to the cessation of lipid oxidation and helps maintain the stability of fats in products. According to S. Marimuthu *et al.* (2022), the role of antioxidants in regulating cellular immunity is an established fact. The intracellular redox balance acts as a regulatory factor in T-cell activation processes, macrophage secretion of lymphokines, and cellular apoptosis. Thus, the functional synergy of antioxidants indeed enables the achievement of maximum protective effects and high stability of the preparation at lower concentrations of antioxidants.

Research is being conducted into the interactions of various antioxidants within the body, allowing for the creation of optimal antioxidant compositions. A significant aspect of the experimental drug's application

in these studies was the emphasis on a comprehensive assessment of the clinical and biochemical status of broiler chickens. This is a crucial step in ensuring their optimal health and productivity, justifying optimal doses of the experimental drug for broiler hepatosis to ensure effective treatment and prevention of diseases in poultry, as well as investigating the physicochemical composition and biological value of broiler chicken meat. Similar results were obtained by O. Oke *et al.* (2020), as they confirmed the effectiveness of using hepatoprotectors for broiler chickens in terms of reducing the feeding period. This is of great importance for industrial poultry farming, where growth rate and productivity are key factors helping to ensure the efficiency and cost-effectiveness of poultry meat production. The research results showed that the experimental drug does not cause local irritation, has no embryotoxic or teratogenic properties, and has a low allergic potential, making it safe and convenient to use for poultry throughout the entire growing period.

When selecting a hepatoprotector, preference was given to this experimental drug, which has been frequently used in Ukraine in recent years. Research by K-Y. Tian *et al.* (2020) confirm the positive impact of using Carnivet L and Introvit A on the general condition and productivity of broiler chickens. A significant increase in the content of total protein in blood serum by 16.9% indicates an improvement in protein metabolism and the overall physiological state of the bird. Of particular interest is the effect of these drugs on the meat quality of broilers. An increase in the acid-oxidation coefficient of meat to 0.54-0.56 indicates the maturity and good quality of the meat, which is an important quality indicator. For comparison, in the control group, this indicator was significantly lower (0.36), indicating less mature and possibly lower-quality meat. Another important aspect is the increased content of tryptophan and decreased content of hydroxyproline in the breast muscles of experimental groups of broiler chickens. Tryptophan, as an essential amino acid, plays an important role in protein synthesis and can positively affect the growth and development of poultry. A decrease in the level of hydroxyproline, which is a marker of collagen, may indicate an improvement in meat texture, as a decrease in the amount of collagen makes the meat softer and juicier. These results confirm the effectiveness of using Carnivet L and Introvit A in improving meat quality and the physiological state of broiler chickens, which can be beneficial for increasing the profitability of production and meeting consumer demands for the quality of food products.

The results of the current research align with the data presented by R. Trofimiak and L. Slivinska (2021). Administration of the drug Carcesel into the diet of broiler chickens significantly increased their performance indicators. In particular, the experimental group showed an increase in pre-slaughter live weight by 2.76-5.02% and carcass weight by 2.93-5.89% compared to the control group. This indicates the effectiveness of the drug in stimulating bird growth and increasing their final productivity. In addition, an increase in muscle tissue mass by 3.32-6.75%, breast muscle mass by 3.53-7.83%, and edible carcass parts by 3.33-6.47% was noted. These indicators demonstrate an improvement not only in overall weight but also in the quality characteristics of the meat, which is an important factor for commercial poultry farming.

According to the research of S. Wang *et al.* (2023), the increased productivity of the broilers in the experimental group can be attributed to the higher protein quality index (PQI), which was 3.92-7.84% greater compared to the control. Additionally, the meat preparation technique score was also 3.92-7.84% higher than the control's 1.81-3.61%. During the experiment, a positive impact on the nutritional value of meat was observed, with the protein content of muscle tissue increasing by 7.5%, fat content by 8.3%, and energy value by 4.8%. Overall, the authors' results emphasise the importance of optimising the feeding of broiler chickens to achieve better performance and meat quality, which can be beneficial both economically and from a nutritional standpoint.

The results of the current organoleptic study confirm the findings of V. Yaremchuk *et al.* (2020) and V. Yaremchuk and L. Slivinska (2020). According to their data, feeding broiler chickens various immunostimulants had a significant impact on the digestibility of key nutrients. Specifically, the digestibility of organic matter increased by 3.92%, protein by 7.80%, fat by 5.35%, fibre by 6.7%, and NFE (nitrogen-free extract) by 1.7%. This contributed to better nutrient absorption and, consequently, more efficient feed utilisation. Their data showed that feeding broiler chickens with various immunostimulants indeed significantly affected the digestibility of important nutrients. In particular, the digestibility of organic matter increased by 3.92%, protein by 7.80%, fat by 5.35%, fibre by 6.7%, and NFE (nitrogen-free extract) by 1.7%. This improved nutrient absorption and allowed for more efficient feed utilisation. The experimental broiler chickens showed higher average daily weight gains (3.11-10.79%) and live weight at slaughter (3.7-10.29%) compared to the control group. The improvement in feed conversion, i.e., the ability to more efficiently convert feed into weight gain, allowed for better utilisation of the biological potential of poultry meat productivity. This not only increased pre-slaughter weight and carcass weight but also increased the slaughter yield of dressed carcasses by 2.52-2.68%. The yield of edible carcass parts also reached 85.0-86.1%, which is an important indicator for assessing the productivity and quality of whole meat.

The results obtained show that the meat from broiler chickens after the administration of the drug "Hep-A-Stres" meets the highest quality standards and has a

high biological value. This highlights the effectiveness of this drug not only in restoring liver function but also in increasing the overall productivity and natural resistance of poultry. Given the positive results obtained, it is recommended to include the drug "Hep-A-Stres" in the diet of broiler chickens to improve the health, productivity, and meat quality of chickens. This is important for producers who want to obtain high-quality products.

CONCLUSIONS

The results obtained from the study confirm the safety of the drug "Hep-A-Stres" when used at various stages of chicken development. The absence of a negative impact on the development of chicken embryos, including appearance, limb length, and body weight, indicates that the drug has no embryotoxic or teratogenic effects. The positive effect of the drug on tolerability, especially the activity and average daily weight gain of broiler chickens, also confirms its effectiveness. The increase in average daily weight gain in the experimental group compared to the control by 5.5-7.9% was significant, indicating that the drug contributed to improved growth and overall condition of the birds. The findings of this study allow for the conclusion regarding the safety and effectiveness of the "Hep-A-Stres" preparation for use in the feed of broiler chicks.

The results obtained demonstrated that this drug has a positive impact on the organisms of growing broiler chickens. The addition of the drug to feed during broiler chicken feeding is non-toxic. Long-term application in doses 3-5 times higher than the therapeutic dose does not have a negative impact on the physiological state, morphological and biochemical composition of the blood, and does not cause changes in the structure of hepatocytes. Veterinary and sanitary examination of the meat of broiler chickens showed that the quality of the meat in the control and experimental groups corresponded to the indicators of fresh healthy chicken meat. However, physical and chemical differences were noted. Based on the research results, it is recommended to include this drug in the feed of broiler chickens. This contributes to the restoration of liver function and increases the productivity and natural resistance of poultry. To achieve the best results, poultry producers should adhere to the established dosages of the drug and recommendations for use, which are based on further research and expert recommendations. The potential for further research lies in the thorough study of the drug's effects on field metabolic and organic systems of agricultural and exotic poultry.

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CONFLICT OF INTEREST

None.

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Гепатоз у курчат-бройлерів: роль та ефективність застосування лікувально-профілактичних засобів із гепатопротекторами

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Анотація. Збереженість поголів'я можна поліпшити, вводячи в раціон лікувально-профілактичні препарати, в тому числі гепатопротектори. Мета дослідження полягала в оцінці впливу дослідного препарату, що містить гепатопротектори, на здоров'я курчат-бройлерів. Дослідження спрямоване на виявлення потенціалу препарату для покращення функції печінки та загального збереження поголів'я сільськогосподарської птиці. Дослідження було проведено у період з 2023 р. по 2024 р. в Одеського державному аграрному університеті. Були проведені дослідження для вивчення ефектів експериментального препарату в таких дозах: 1,0 г/кг маси тіла (терапевтична доза), 2,0 г/кг маси тіла (подвійна терапевтична доза) і 5,0 г/кг маси тіла (5 терапевтичних дозах) протягом 30 днів. Дослід проводили на 500 курчатах-бройлерах кросу Кобб 500 віком від 1 до 40 днів. Крім того, вимірювали та досліджували біохімічні показники крові за допомогою польського біохімічного селекційного автоматичного аналізатора Hitachi 902. Дослідженнями встановлено, що оптимальною дозою дослідного препарату при гепатозах курчат-бройлерів є 1,0 г/кг маси тіла. Після прийому препарату вміст білірубіну в сироватці крові знизився на 27,3 %, активність лактатдегідрогенази знизилася на 17,1 %, активність аспартатамінотрансферази знизилася на 16,4 %, активність аланінамінотрансферази знизилася на 19,3 %, вміст збільшився. Вітамін А збільшився на 25,6 %, а фагоцитарна активність псевдоеозинофілів зросла на 23,1 %. В результаті досліджень доведено, що дослідний препарат нормалізує роботу печінки, позитивно впливає на біохімічний склад крові, сприяє росту, забезпечує захист і природну опірність організму бройлерів і навіть покращує якість продукції птахівництва покращувати. І з вище вказаного необхідно вдосконалювати методи ранньої діагностики порушень функцій печінки у птиці і застосовувати ефективні методи корекції метаболічних процесів

Ключові слова: печінка; гепатопротектори; еритроцити; гемоглобін; лейкоцити