

# AN EFFECT OF ANTI-STRESS FEED ADDITIVES ON BROILER PRODUCTIVITY AND MEAT QUALITY

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## Abstract

The paper presents the study on an impact of feed additives Peak anti-stress and SPAO (SPAO-complex) with different lithium content on meat productivity and meat quality of broiler chickens. The feed additives exert a pronounced metabolic effect, have adaptogen properties and allow forming a mechanism that facilitates compensation of the expenditure of the body, which significantly increases upon stress development. It was established that the average daily gain of the broiler chickens increased by 1.8% and 4.3% on the background of using SPAO-complex and Peak anti-stress, respectively, compared to the broiler chickens that did not receive the feed additives in the daily diet. It was shown that addition of feed additives with lithium into a diet led to an improvement of the indices of broiler meat productivity and meat quality: a level of yield of the carcasses of the 1st category increased up to 56.2–79.1%, high organoleptic indices of meat were ensured, the protein content in white and red chicken meat increased and functional-technological properties of minced meat improved. The use of feed additives ensured profitability of industrial poultry production; the highest indices of profitability were established upon introduction of the feed additive Peak anti-stress into a diet — up to 8.67 rubles per each ruble of expenses. The obtained results of the study should be taken into consideration in the technological processes when raising broiler chickens.

## Introduction

According to the Food Security Doctrine of the Russian Federation adopted by the Executive Order of the President of the Russian Federation of January 21, 2020, the agro-industrial complex of the country faces a task of creation, reconstruction and development of modern productions regarding the output of feed additives for animals to increase meat raw material production including poultry. When forming poultry meat quality, an important role is given to prevention of stressful situations in the conditions of industrial poultry production by using feed additives that mitigate an effect of stress factors.

Several authors [1] notice an important role of antioxidants in the composition of a diet. These antioxidants include the natural bioflavonoid dihydroquercetin and arabinogalactan — a water-soluble polysaccharide of plant origin. Their addition to the combined feed for broilers affects the lipid metabolism, which is characterized by a decrease in the fat content in pectoral muscles, and also facilitates a decrease in peroxide compounds in broiler meat due to the low content of abdominal fat in a carcass, and in a dose of 3.6 g/ton increases broiler liveweight by 3.97%, improves feed conversion.

The use of the feed additive HydroLactiv and antioxidant Epophen in combined feed and their conjunct influence have a positive effect on productivity and meat quality of Cobb broiler chickens. The authors [2] note that the average daily liveweight gain increases by 11.0%, the efficiency of digestion and utilization of dietary nutrients is stimulated, which increases feed conversion into meat products — feed consumption per 1 kg of the liveweight gain decreases by 9.9%. According to the data of controlled slaughter, balanced feed-

ing improves broiler meat quality. For example, pre-slaughter weight of broiler chickens increases by 10.7%, the weight of an eviscerated carcass by 368.4 g or 15.89%, slaughter yield of broilers by 0.85%. The chemical composition of broiler meat changes by 8.49% in terms of the dry matter content and the protein content in broiler meat changes by 0.91%.

The anti-stress additive Acti'z Vitamins B in an effervescent form for egg-laying hens contains nicotinamide, pantothenic acid, vitamins B1, B2, B6, folic acid, D- biotin and vitamin B12. It is added during the period of intensive egg-laying and the peak of productivity of hens from the parent population and according to some authors [3] facilitates an improvement in the metabolic processes, poultry productivity and quality of produced young birds.

It was established that the antioxidant of the new generation Bisphenol-5 had a positive effect on the hematological and biochemical parameters of blood and growth of birds. For example, upon addition of the antioxidant into complete feed at a dose of 0.0002%, 0,0004%, 0.0008% and 0.0015% of the daily ration, an increase in hemoglobin by 2.6–21.6%, red blood cells by 5.1–47.6%, protein by 15.7%, glucose by 7.8%, calcium and inorganic phosphorus by 6.1% and 6.5%, respectively, was observed in the chickens of the experimental groups. The activity of enzymes taking part in digestion of feed components increased by 14.7 and 8.3%, which indicates a positive effect of the additive on the protein, carbohydrate and mineral metabolism, as well as the enzymatic activity [4].

The study [5] describes a positive role of L-carnitine and preparations on its basis on the lipid metabolism in broiler chickens. L-carnitine is important in transportation of fatty acids into mitochondria ensuring their oxidation. According

to the data of the authors, the preparation Strolitin, which active ingredient is L-carnitine and accessory substances are magnesium sulfate, sorbitol and distilled water, has the anabolic, antihypoxic and antithyroid action, stimulates the regenerative activity of tissues, normalizes the metabolic processes, prevents osteoporosis and activates fat metabolism. When receiving the preparation from the age of 1–5 days and from 21–25 day, broiler chickens show a 6.95% and 6.09% increase in liveweight by the end of raising, a 6.3% and 5.35% decrease in feed consumption per gain, respectively; in addition, a positive effect on liveability of the population was observed.

Prokhorova Yu.V. et al. (2016) reported that feed additives with microelements, in particular, the preparation Selemagum-O (a water soluble complex of selenium and vitamin E) had a positive effect on the body of broiler chickens; when using the preparation from the first days of life of broiler chickens at a dose of 1 ml/100 l water, the indices of gain and liveability improved on average by 3.5% [6].

Zinc has been actively used. It is a component of more than 200 metalloenzymes, affects the cell growth and division, skin condition, plumage, osteogenesis, wound healing, reproductive function, immune system, cellular respiration, brain development, formation of behavioral reflexes and so on. Skopichev V. G. et al. [7] noted that zinc deficiency caused stunting, retardation of the development, reduction in egg production, disorder of eggshell formation.

Among the agents that affect the nervous system and are used for stress prevention in animal husbandry are lithium salts. According to the data [8] «...lithium preparations are psychotropic pharmaceutical products from the group of mood stabilizers. Lithium is an alkali metal; therefore, it is used in medicine and veterinary medicine in a form of salts — carbonate, oxybutirate, nicotinate, succinate, chloride, sulfate and citrate, and their use is conditioned by the specific mechanism of action, which is based on an effect of the lithium ion on different divisions of the nervous system...»

Fisinin V. I. et al. [9] note that «... the use of lithium carbonate at a dose of 15 mg/kg body weight of broilers facilitated an increase in liveability and average daily increase in the population. Lithium carbonate at a dose of 15 mg/kg body weight of broilers is expedient to use in broiler production enterprises as it facilitates acceleration of growth, an increase in liveweight gain, liveability of the population...»

Bachinskaya V. M. [10] recommends to «...use lithium citrate in hens of the parent flock and broiler chickens two days before testing stress sensitivity, on the day of testing and during two days after the turpentine test. Administration of lithium citrate does not influence formation of the local adaptive syndrome at the point of injection of the irritating substance...»

Effectiveness of lithium salt addition into a diet as a means of stress prevention is confirmed in [11,12]. The use of feed additives with the probiotic [13,14] and antioxidant [5] properties facilitates formation of meat productivity and production of high-quality meat.

To reduce the unfavorable effect of heat stress or stress caused by vaccination, as well as antibiotics or anticoccidial agents, it is recommended to use the feed additive Betamint, which consists of biologically active substances: vitamin C, betaine, menthol. Betamint exerts a rapid and durable effect in the control of heat stress; the preparation is given with water at a dose of 1 l/ton over three days before and after the stress factor [15].

According to the data [16,17], «...the use of the anti-stress preparations Vitaminoacid and Magic Antistress Mix on the background of industrial stress factors ensures superiority over the control in terms of liveweight on average by 5.15 and 2.17% in replacement pullets, by 0.73 and 0.73% in laying hens, by 4.46 and 1.06 in replacement cockerels, and by 1.33 and 3.04% in roosters; the uniformity of the population increased by 1.08 and 5.49% in pullets, by 6.95 and 9.30% in cockerels and by 2.90 and 8.13% in laying hens, respectively; the uniformity of roosters in the second experimental group increased by 7.41%. Vitaminoacid and Magic Antistress Mix facilitated an increase in liveability of the population of replacement pullets by 0.45 and 0.52%, cockerels by 0.94 and 1.38%, a reduction of feed expenditure by young birds by 0.33 and 1.33%, liveability of laying hens by 0.1 and 0.41%, roosters by 0.57 and 1.14%, respectively. They had a positive effect on the growth and metabolic processes in the body of young poultry.

Engashev S. V. et al. [18] proposed a method for reduction of heat stress in broilers by adding the antioxidant with the 3-oxypyridine structure into a diet, which allowed increasing liveability of the poultry population in the conditions of heat stress by 1.04% and increasing the average daily gain by 7.7%.

A group of authors under the leadership of R. Kh. Gadzanov [19] developed a means for stress prevention in poultry production using pharmacological preparations from the group of tranquilizers phenazepam and the Eleutherococci extract, which showed high liveability of poultry population (95–90%) and additional gains. However, the United Nations Commission on Narcotic Drugs placed phenazepam into a list of substances subjected to special control; the use of the proposed scheme determines a necessity of individual administration of preparations, which makes their use in industrial poultry production more difficult.

The use of agents from different pharmacological groups influencing formation of the stress reaction and its strength for stress prevention in poultry production determines the course of adaptive processes in the body of birds. The promising directions are the use of complex preparations and preparations based on lithium salts, which have multifaceted mechanisms of the pharmacological action and low toxicity as stress protectors; and antioxidant preparations that positively influence the morphological and biochemical blood composition, growth and productivity of poultry.

However, data on an effect of feed additives with lithium on poultry meat quality are absent in scientific literature.

In this connection, the aim of the research was to study an effect of the feed additives Peak anti-stress and SPAO

(SPA0-complex) — a stress protector and antioxidant for animals, which were developed by us, on broiler meat productivity and meat quality.

### Materials and methods

The experiments were carried out in the Department of Food Engineering of the Ural State University of Economics and the Department of Morphology, Physiology and Pharmacology of the South Ural State Agrarian University.

The production experiments, testing and implementation were carried out on the chickens of the final hybrid of Arbor Acres cross in the conditions of AO «PRODO Tyumensky Broiler» in the Tyumen Oblast.

The chickens for the experiment were obtained from the breeding farm of the second order from the hens of the parent flock at the age of 245 days, the duration of egg storage was 5 days, the level of hatching was 88.9%. The chickens were kept in the poultry house with the usable space of 1288 square meters; density upon placing was 18.6 birds/m<sup>2</sup>. The chicken body weight upon placing was 38.67 g; the floor temperature upon placing was 32.6–32.8 °C. The study was carried out in the conditions of the experimental facility with floor housing of broiler chickens in separate sections that spatially belonged to the same shop.

Three groups of broiler chickens with 6000 birds in each were selected for the experiment. The broiler chickens in the control group did not receive any pharmacological preparations and feed additives in addition to the main diet.

SPA0-complex was used in the second experimental group at a dose of 925 mg/kg liveweight; the scheme included five times of administration before slaughter. SPA0-complex was administered through the system of medicators Dosa-tron D25 RE0.2–2.0%. The content of lithium citrate was 10 mass%. In the third experimental group, the recipe composition for production of complete feed included the feed additive Peak anti-stress, which contained lithium carbonate (16.5–16.7 mass%) at a dose of 1693 g of the feed additive per 1 ton of feed or 440–552 mg per 1kg of chicken body weight. The proposed scheme included five times of feed additive administration daily during five days before slaughter.

The necessity to use the SPA0 pharmacological complex during five days before slaughter of birds was substantiated by the scientific research carried out earlier by Miftakhytdinov A. V. et al. [20], who used different duration and doses of SPA0-complex administration to the hens of the parent flock during planned technological stresses. The period of five days facilitates the maximum effect and at the same time does not lead to reduction of the psychomotor reactions and appetite in birds and is linked with the pharmacokinetic characteristics of lithium salts.

The feed additive SPA0-complex was given to birds with water, as administration of pharmacological agents through the system of medicators (auto-dosing systems for pharmaceutical products) is the most convenient and, frequently, effective form of using pharmacological agents in the industrial poultry production. Medicators ensure a

high degree of dose uniformity. SPA0-complex is a water soluble pharmacological agent and is used with water. Peak anti-stress is a feed additive with lower cost compared to SPA0-complex, contains water insoluble lithium carbonate and, therefore, was used in the composition of complete feed.

The broiler chickens of the control and experimental groups were fed according to the approved diets. The zootechnical analysis of complete feed showed the correspondence to the main regulated requirements. Feed moisture was on average 10.5% (with the norm of not more than 14.0% according to GOST 18221–99 «Mixed full-ration feeds for poultry. Specifications»), a level of metabolizable energy was 1.44 MJ (with the norm of not less than 1.34) the quantity of crude protein was within a normal range (19.0%). Complete feed had the optimal ratio of calcium and phosphorus of 1.9:1 and was also balanced by the main essential and non-essential amino acids, and had the optimal profile regarding lysine (100%): methionine + cystine — 77%, threonine — 69%, tryptophan 10%. Thus, the nutritional level of the diets for broiler chickens corresponded to the recommended requirements for raising Arbor Acres broilers.

The water supply was the same in the control and experimental groups. The zoohygienic conditions of keeping of the control and experimental groups were regulated with adherence to the technological regulations according to the requirements for the cross. The scheme of prophylaxis of viral and bacterial diseases corresponded to the approved veterinary regulations and instructions.

The chickens were slaughtered on the 38th day after hatching using the equipment of the «STORK» company (the line speed was 9000 birds/hour).

After slaughter, fifty birds from the first and second groups were examined for the following indices: the number of carcasses of the 1st category, number of carcasses sent to industrial processing, analysis of defects.

The indices of broiler meat productivity and meat quality were determined by conventional methods. Statistical analysis of the experimental data was carried out using the software package STATISTICA 12.

### Results and discussion

To compare an effect of the feed additives on the growth and development of broiler chickens, the average daily gain, efficiency coefficient and broiler liveability were assessed. The obtained data suggest stimulation of the metabolic processes in the body of the birds due to reduction of pre-slaughter stress (Table 1).

By assessing the indices of the bird growth, the data were obtained that indicated an advantage of using feed additives.

During the experiment, the average daily gain was on average higher by 4.3% in the third experimental group compared to the control; this index increased by 1.8% compared to the second experimental group. This is explained by better intake of feed, which consumption increased to 22.5% on the six week of the experiment with feed conversion of 4.4%. Generally, the efficiency coefficient in the experimental

Table 1. Efficiency of using feed additives (n=50)

	Groups		
	1 group (control)	2 group (experimental)	3 group (experimental)
Average daily gain, g	57.30 ± 0.35	58.30 ± 0.41	59.77 ± 0.38
		P <sub>1</sub> ≤ 0.0323	P <sub>2</sub> ≤ 0.0374
		P <sub>3</sub> ≤ 0.0224	
Liveability, %	94.42 ± 0.42	95.01 ± 0.51	96.57 ± 0.34
		P <sub>1</sub> ≤ 0.1304	P <sub>2</sub> ≤ 0.0302
		P <sub>3</sub> ≤ 0.0388	
Feed conversion, feed/units	1.61	1.58	1.56
Efficiency coefficient	341.67	357.90	377.26

Note: P<sub>1</sub> — significance compared to the samples from the 1<sup>st</sup> group; P<sub>2</sub> — significance compared to the samples from the 2<sup>nd</sup> group; P<sub>3</sub> — significance when comparing the 1<sup>st</sup> group and the 2<sup>nd</sup> group

group was higher than in the control by 35.6 units, which was quite significant compared to the prototype (16.2 units). Broiler liveability in the third experimental group increased to 96.6%, which was 2.2% higher than in the control; in the second group, broiler liveability was 0.6% higher than in the control.

The final period of chicken fattening is characterized by the highest waste of population. It is during this time that stresses linked with the high intensity of the metabolic processes (productivity reaches 80–100g/day/chicken during this period) and high density of birds (due to their large weight in this period) facilitate a decrease in immune system effectiveness and lead to high mortality linked with activation of viruses and bacteria. The use of anti-stress and antioxidant agents during final fattening and vaccination of the parent flock of hens [20,21] facilitate maintenance of normal functioning of the immune system and prevention of the development of social and heat stress, which finally influences overall broiler liveability. Feed conversion is calculated in arbitrary units; in absolute terms, conversion increased only by 0.03 g in the second group and by 0.05 g in the third group, which is quite possible when using anti-stress agents and was vividly demonstrated in the performed investigations.

Table 2 presents meat productivity of broiler chickens. Meat yield was higher by 0.6% in the second experimental group and by 1.3% in the third experimental group compared to the control. In the second experimental group, the level of yield of carcasses of the first category increased up to 56.2% and technical waste reduced by 0.4%. The high

yield of the bird carcasses of the first category (up to 79.1%) indicates an advantage of the method of using. The chicken carcasses of the third group differed from the first control group and the second experimental group by the number of defects. Technological defects associated with primary poultry processing (scalding, plucking, evisceration and chilling) were not taken into account, as the preparation and the feed additive did not influence their presence or absence. The number of black-and-blue marks, bruises and hematomas reduced by 23.5%, sprains and closed fractures by 20.0%, open fractures by 33.3% in the third experimental group compared to the control. In the second experimental group, the number of black-and-blue marks, bruises and hematomas reduced by 29.4%, sprains and closed fractures by 60.0%, open fractures by 33.3%. The obtained data indicate a decrease in the pre-slaughter injuries when using the feed additives and an advantage of Peak anti-stress.

According to the results of the organoleptic assessment of broiler chickens after slaughter, the control and experimental samples corresponded to the requirements of GOST 31962–2013 «Chicken meat (carcasses of chickens, broiler-chickens and their parts). Specifications» for the category «fresh meat»:

- the surface of the carcasses had the whitish-yellow color with the pinkish tint;
- subcutaneous and internal fatty tissue had the pale yellow color;
- the serous membrane of the thoracoabdominal cavity was moist, shiny, without slime and molds;

Table 2. Meat productivity of broiler chickens (n=50)

	Group		
	1 group (control)	2 group (experimental)	3 group (experimental)
Slaughter yield of eviscerated carcass, % (to liveweight)	72.8	73.4	74.1
Including the first grade, %	42.7	56.2	79.1
the second grade, %	57.3	43.8	20.9
Technical waste, %	15.6	15.5	15.2
Quantity of injuries received during poultry slaughter:			
Including black-and-blue marks, bruises and ematomas, units	34	26	24
sprains and closed fractures, units	5	4	2
open fractures, units	3	2	2

— muscles were slightly moist on the cut surface, did not leave a moist spot on the filter paper, were firm and elastic, the pit formed when pressing by the finger quickly straightened;

— odor was specific, typical for fresh poultry meat.

Table 3 presents the data on the comparative analysis of the tasting results of cooked meat and broth from birds of the control and experimental groups using the 9-point scale.

As follows from the data in Table 3, all samples of meat and meat broth from broiler chickens of the experimental and control groups had high indices with higher scores in the experimental samples. In terms of appearance, meat of the experimental broiler groups did not differ from the control and received the same average score — 8.11 points. Appearance and color on the cut surface were characterized as follows: «very beautiful», «beautiful», «good». When assessing taste of meat and meat broth from broiler chickens of the experimental and control groups, the following characteristics were used: «very tasty», «tasty», «quite tasty». The differences in the scores between the second and third experimental groups by appearance and color on the cut surface and taste were 0.11 and 0.10 points; they were 0.22 and 0.10 points by appearance of meat broth compared to the control samples. The differences in the meat sensory indices (odor, juiciness and consistency) were more pronounced. According to the results of tasting of meat broth, the experimental groups had higher average scores by 0.21 and 0.13 points, respectively. The characteristics «good», «beautiful», «very beautiful» were given to this indicator. Odor of meat and meat broth from broiler chickens was described with the attributes «quite aromatic», «aromatic» and «very aromatic». The number of points in meat assessment were higher in the second and third experimental groups by 0.22 and 0.18 points, in assessment of meat broth by 0.12 and 0.04 points, respectively. The experts characterized meat juiciness as «very juicy», «juicy» and «quite juicy» with the prevalence of the first two characteristics in the experimental groups,

which influenced the average score being higher by 0.50 and 0.41 points. Consistency of broiler meat in the experimental groups was higher by 0.22 and 0.18 points and was mainly characterized as «very tender» and «tender».

In general, the scoring of meat and meat broth from broiler chickens of the experimental groups showed the superiority of their sensory indices over the results of the control group by 0.17–0.20 points and 0.13–0.21 points, respectively, which corresponded to the level of very high quality.

Therefore, changes in the sensory indices of cooked meat and meat broth from broiler chickens of the experimental groups indicated an increase in the consumer properties of meat products.

Assessment of the chemical composition of poultry meat demonstrated pronounced changes in the protein and fat content. For example, the protein content was higher by 12.4 and 15.2% in white meat, by 1.2 and 4.1% in red meat and by 18.8 and 5.8% in minced meat from birds of the second and third groups, respectively, compared to the control. With that, in the group, in which the feed additive Peak anti-stress was used, the protein content in fillet, legs and minced meat was 2.5, 2.9 and 2.0% higher, respectively, compared to the group of birds, which received SPAO-complex. It should be noted that the use of feed additives allowed bringing the protein content in white meat to the regulatory levels, which conditioned the strict correspondence of produced meat to the 1st category of quality and the higher biological and nutritional value (Table 4).

Somewhat different picture was observed for the fat content in meat. This parameter in white meat from birds of the experimental groups was 37.7% and 27.9% higher than in the control, respectively. However, the fat level in breasts of birds from the third experimental group was 7.1% lower compared to the second group. The fat content in red meat from the third experimental group was lower by 15.2% compared to the control and by 0.3% compared to the samples of meat from the second group. Similar results were obtained

Table 3. Results of tasting of cooked broiler meat and meat broth

	1 group (control)	2 group (experimental)	3 group (experimental)
<b>Cooked meat</b>			
Appearance	8.11 ± 0.93	8.11 ± 0.78	8.11 ± 0.67
Appearance and color on the cut surface	8.11 ± 0.78	8.22 ± 0.83	8.21 ± 0.75
Odor	8.11 ± 0.08	8.33 ± 0.07*	8.29 ± 0.12*
Taste	7.89 ± 0.78	8.07 ± 0.87	8.03 ± 0.47
Consistency (tenderness)	7.89 ± 0.07	8.11 ± 0.09*	8.07 ± 0.32
Juiciness	8.06 ± 0.08	8.56 ± 0.03*	8.47 ± 0.19*
Overall mean score	8.02 ± 0.31	8.22 ± 0.27	8.19 ± 0.36
<b>Meat broth</b>			
Appearance	8.22 ± 0.67	8.44 ± 0.73	8.32 ± 0.67
Aroma	8.21 ± 0.83	8.33 ± 0.71	8.25 ± 0.83
Taste	8.22 ± 0.67	8.44 ± 0.73	8.36 ± 0.67
Overall mean score	8.20 ± 0.47	8.41 ± 0.36	8.33 ± 0.47

Note: \* — is significant at  $p \leq 0.05$  relative to the control group

Table 4. Chemical composition of broiler meat

	group		
	1 group (control)	2 group (experimental)	3 group (experimental)
<b>White meat (fillet)</b>			
Mass fraction of protein, %	20.52 ± 0.81	23.06 ± 0.47	23.64 ± 0.66
		P <sub>1</sub> ≤ 0.0412      P <sub>2</sub> ≤ 0.0454	
		P <sub>3</sub> ≤ 0.3745	
Mass fraction of fat, %	1.54 ± 0.21	2.12 ± 0.29	1.97 ± 0.13
		P <sub>1</sub> ≤ 0.0478      P <sub>2</sub> ≤ 0.0423	
		P <sub>3</sub> ≤ 0.321	
<b>Red meat (leg)</b>			
Mass fraction of protein, %	17.50 ± 0.07	17.72 ± 0.13	18.23 ± 0.18
		P <sub>1</sub> ≤ 0.0381      P <sub>2</sub> ≤ 0.0352	
		P <sub>3</sub> ≤ 0.0322	
Mass fraction of fat, %	8.53 ± 0.73	7.25 ± 0.56	7.23 ± 0.69
		P <sub>1</sub> ≤ 0.3457      P <sub>2</sub> ≤ 0.4753	
		P <sub>3</sub> ≤ 0.5278	
<b>Minced meat</b>			
Mass fraction of protein, %	18.81 ± 0.75	19.91 ± 0.76	20.31 ± 0.97
		P <sub>1</sub> ≤ 0.2352      P <sub>2</sub> ≤ 0.3561	
		P <sub>3</sub> ≤ 0.3347	
Mass fraction of fat, %	9.71 ± 0.66	8.83 ± 0.54	8.51 ± 0.75
		P <sub>1</sub> ≤ 0.2453      P <sub>2</sub> ≤ 0.2143	
		P <sub>3</sub> ≤ 0.2344	

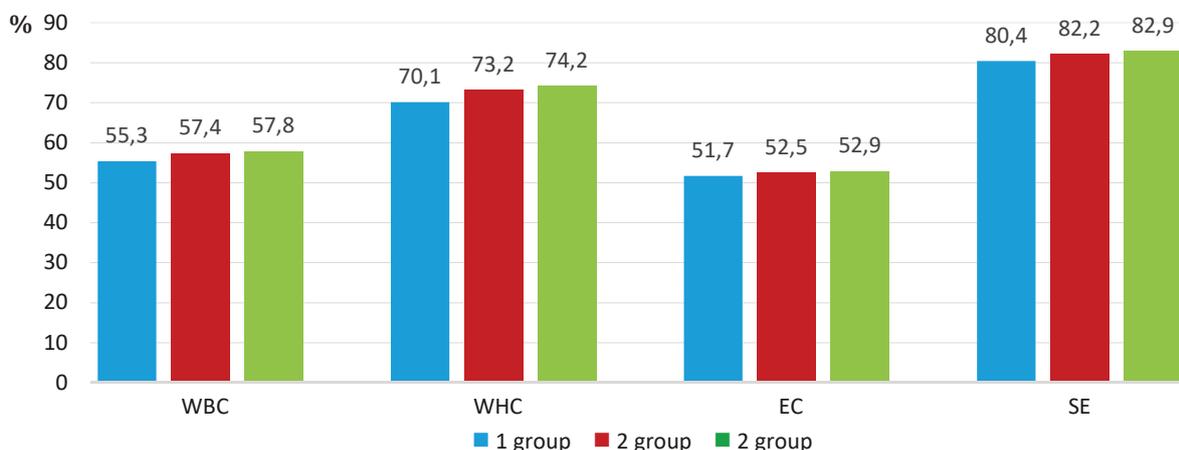
Note: P<sub>1</sub> — significance compared to the samples from the 1<sup>st</sup> group; P<sub>2</sub> — significance compared to the samples from the 2<sup>nd</sup> group; P<sub>3</sub> — significance when comparing the 1<sup>st</sup> group and the 2<sup>nd</sup> group

regarding the fat content in minced meat; however, in this case, the difference between the third and second experimental groups was 3.6%. According to the reference data, the recommended protein content in red meat is not less than 18.0%. In our study, only the use of the feed additive Peak anti-stress allowed achieving this regulatory level.

Generally, the obtained results are indicative of the higher protein content in poultry meat of the experimental groups and reduction of red meat fattiness. With that, the most pronounced changes were noticed in the group of birds that received the feed additive Peak anti-stress.

Functional-technological properties of minced meat (water binding capacity (WBC), water holding capacity (WHC), emulsifying capacity (EC) and stability of emulsion (SE)) made from meat of the control and experimental groups were studied (Figure 1).

It follows from Figure 1 that the minced meat samples from the experimental groups were distinguished by higher functional-technological properties. For example, WBC was higher by 3.8% and 4.5%, WHC by 4.4% and 5.9%, EC by 2.0% and 2.3%, SE by 2.2% and 3.1%, respectively, in the samples of the second and third experimental groups compared to the control.



**Figure 1.** Functional-technological properties of minced meat (water binding capacity (WBC), water holding capacity (WHC), emulsifying capacity (EC) and stability of emulsion (SE)) made from meat of the control and experimental groups

Taking into consideration the production indices, results of slaughter and costs for broiler chicken production, economic efficiency and profitability of feed additive using were assessed.

According to the conventional methodology used in veterinary medicine (1997) and recommendations of Zhuravlev N. A. [22], economic efficiency of veterinary measures per a ruble of costs expresses the relation of an economic effect (a positive economic result) to total costs on these veterinary measures (including a cost of a preparation and labor costs of its using). In our experiment, with regard to the obtained additional profit due to an increase in meat productivity and meat quality in the second experimental group, where SPAO-complex was used, economic efficiency per one ruble of costs was 0.19 rubles, in the third experimental group it was 8.67 rubles, which clearly indicates an advantage of using the feed additive Peak anti-stress in economic terms.

In the process of activation of glucogenolysis and glycolysis, the release of catecholamines, glucagon and corticosterone into the blood occurs. The catabolic effect of corticosterone is manifested in breakdown of amino acids to provide for energy expenditure of the body and mobilization of fatty acids; it is this fact that is linked with a decrease in meat productivity and poultry meat quality.

Therefore, the use of feed additives allows activation of the adaptation processes in the body of birds and stabilize

metabolism due to the combined stress protective and antioxidant action, which is evident from an increase in the average daily gain of broiler chickens on the background of using SPAO-complex and Peak anti-stress by 1.8–4.3%, meat yield by 0.6–1.3%, yield of the carcasses of the 1st category of up to 56.2–79.1%, as well as from an improvement in the organoleptic properties of meat, an increase in the protein content in white and red meat and an increase in functional-technological properties of minced meat. The use of the feed additives is economically profitable.

### Conclusion

To increase stress resistance of birds in the conditions of industrial production, one of the main factors is the use of a balanced diet enriched with a vitamin and mineral complex, probiotic additives and additives with the antioxidant properties. Studies proved the efficiency of feed additives with microelements, including lithium salts as a stress protector regarding meat productivity of poultry. The results of the study on the effect of the feed additives Peak anti-stress and SPAO-complex with different lithium content on broiler meat productivity and meat quality show an increase in the average daily gain by 1.8% and 4.3%, respectively, and an increase in the biological value of poultry meat. It is necessary to take into account the obtained results in the technological processes upon broiler production.

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