New integrated system for raising poultry as a factor of increasing its productivity and metabolic status

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Abstract. The article presents the results of studying the influence of a developed scheme for raising poultry, including the use of 2.0% feed additive and 10.0% feed mixture (corn extract, perlite, corn grist) + 1% selephlan on metabolic processes, growth, development, safety and functional state of the liver of broiler chickens. It has been determined that the joint use of feed additives based on grain processing products and selephlan as a part of complete feeds for broiler chickens contributes to an increase in gross and average daily live weight gain by 6.9 and 7.5%, improvement feed conversion by 1.1%. The use of selephlan made it possible to neutralize the high load on the liver caused by the highly nutritious type of feeding of poultry, maintaining its healthy structure and functional activity, helping to reduce hepatoindicative enzymes by 39.2% (ALT) and by 13.4% (AST), and also activate protein and carbohydrate metabolism throughout the entire productive rearing period, which had a beneficial effect on the growth characteristics of meat poultry and the quality of the resulting livestock products.

1 Introduction

The main aim of developing and improving the work of the agro-industrial complex is currently to ensure the country's food security. According to many experts, the most important industry that can solve this problem in Russia is poultry farming [1-4]. Domestic and world experience confirms that industrial poultry farming is capable of quickly increasing the production of food products that the country desperately needs and ensuring an optimal balance in the population's diet. The high efficiency of poultry production in comparison with other industries is due to the precocity of poultry, lower specific consumption of feed, energy, and human labor, which proves the feasibility of developing this priority area of agricultural production. Today, poultry farming, being the leading branch of livestock farming, occupies a significant share in the total volume of meat production. At the same time, 89% of the current structure of poultry meat production is broiler meat [5].

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The introduction of the new highly productive crosses with a more intense metabolism into industrial poultry farming has led to an increased risk of diseases associated with metabolic disorders. Modern technology for the production of poultry meat is based on the use of complete feed, regulation of the maintenance regime, mechanization and automation of production processes, as well as effective methods of veterinary and sanitary preventive measures [6-7].

One of the modern trends in the development of industrial production is waste-free and low-waste technology for processing crop products. The emergence of this direction is due to the need to prevent the harmful effects of industrial waste on the environment. Waste-free production involves the development of technological processes that ensure the highest possible comprehensive processing of raw materials. This allows, on the one hand, the most efficient use of natural resources, completely processing generated waste into marketable products, and, on the other hand, reducing the amount of waste and thereby reducing its negative impact on environmental systems. The creation of waste-free production is a very complex and lengthy process, the intermediate stage of which is low-waste production. The introduction of new waste-free technologies involves increasing the degree and completeness of processing of agricultural raw materials with a more complete extraction of useful components from them, as well as involving production waste in the national economic circulation [8-9].

The technology of microbiological bioconversion of waste is intended for processing raw materials not used in traditional feed production into carbohydrate-protein feed additives and feed with the participation of a diverse consortium of microorganisms that influence the quality characteristics of the finished feed, enriching it with the complex of organic acids. The peculiarity of the final obtained product using the alternative microbiological bioconversion technology is mainly that, in essence, the raw materials for the production of feed additives are processed in an environment similar to the microflora of the initial section of the esophagus, i.e. the first stage of digestion - “preparing food for digestion” begins outside the esophagus. Therefore, the process of digestion of such feed directly in the esophagus of animals, poultry and fish is characterized by a high level of biological processes and feed digestibility, as well as reduced enzyme and energy costs of the body at the entire stage of digestion. As a result, it is possible to obtain a pre- and probiotic feed additive, the carrier of which can be various sorbents (bentonites, perlites, sapropels and other natural minerals) [10]. At the same time, the integrated use of components of plant and mineral raw materials can help to increase the productivity and quality of the resulting products.

However, to ensure the genetically inherent high productivity of modern poultry in feeding, it is necessary to use not only complete feed and feed additives, balanced for all nutritional elements, but also drugs that promote more efficient digestion and use of feed, influencing metabolic processes and functional activity of the liver as the main metabolic organ of poultry. Such enrichment of balanced feed for young poultry has a positive effect on growth, development, safety, feed costs and economic indicators [11].

Solving the problem of normalizing metabolic processes using complex drugs that influence the metabolic status of the poultry body, improve the functional activity of liver cells, have a growth-stimulating effect, and also help to increase productivity, seems to be an important reserve for increasing the efficiency of poultry farming and poultry production [12, 13].

The liver is the central organ in which most of the chemical processes associated with carbohydrate metabolism take place. It is involved in the metabolism of proteins, carbohydrates, lipids, pigments, vitamins and other substances, excretes bile, neutralizes toxins, deposits iron ions, honey, etc. Due to the numerous functions of the liver and its location relative to other organs, it is more often subject to negative influence of various facts,

which leads to the development of pathological processes and metabolic disorders in the body of animals, leading to the occurrence of hepatodystrophic processes [14, 15].

Thus, an integrated approach to the formation of a feeding strategy and veterinary welfare of the poultry industry will ensure management of the implementation of its genetic potential using resource-saving technologies that include the involvement of modern crosses of advanced grain processing waste into the practice of feed production and feeding of poultry, including the use of biotechnological methods for modifying raw materials (fermentation of waste with bacterial concentrate) in combination with hepatoprotection schemes, which will help normalize metabolic status, improve the functional activity of liver cells, increase meat productivity and safety of poultry.

The aim of the research is to develop a new system for increasing the metabolic status and productivity of poultry using pharmacological methods and resource-saving production technologies.

2 Materials and methods

Study of the influence of a new developed scheme for raising poultry, including the use of 2.0% feed additive and 10.0% feed mixture (corn extract, perlite, corn grist) + 1% selephlan on metabolic processes, growth, development, storage, and also on the functional state of the liver of broiler chickens was carried out in the vivarium of the Federal State Budgetary Scientific Institution "Krasnodar Research Center for Animal Husbandry and Veterinary Medicine" according to the All-Russian Research and Technological Institute of Poultry Farming method (Sergiev Posad, 2013). For this purpose, in accordance with the method of forming analogue groups, two groups of Arbor Acres cross broiler chickens of 42 heads each were selected. In the first six days (equalization period), the chickens received pre-start half-rationed feed. Intergroup differences between the groups (control and experimental) were the following: the control chickens during the experimental period (up to 42 days of age) were fed only complete compound feed (CF) without any additives; the chickens of the second experimental group in the period from 7 to 14 days of the experiment (start) received CF with 2.0% feed additive and 10.0% feed mixture (corn extract (CE), perlite (P), corn grist (CG)). In the period from 15 to 42 days of the experiment (growth and finishing periods), in addition to CF with the inclusion of 2.0% feed additive and 10.0% CE+P+CG, 1% selephlan was additionally fed.

Ingredient composition of the feed additive was: 50% modified brewer's grains, 50% mineral-sorbing complex consisting of 15% perlite, 15% phosphogypsum, 10% serpentinite, 10% sapropel. Brewer's grains were previously fermented with a probiotic bacteria concentrate consisting of lactic acid microorganisms *Lactococcus lactis, Lactobacillus plantarum, Lactobacillus acidophilus;* microorganisms *Propionibacterium shermanii*.

The feed mixture CE+P+CG consisted of 30.0% corn extract, 10.0% perlite and 60.0% corn grist.

Selephlan is a complex drug, the optimal ratio of components of which determines such pharmacodynamic effects as hepatoprotective adsorption, antitoxic, antioxidant.

The experiment scheme is presented in Table 1.

Table 1. Experiment scheme (n=42)

Group	**Rearing period, days**			
	1-6 (equalization period)	**7-14 (start)**	**15-28 (growth)**	**29-42 (finish)**
1 – control	Pre-starter CF	CF without additives	CF without additives	CF without additives

2 – experimental		CF with 2,0 % feed additive + 10,0 % CE+P+CG	CF with 2,0 % feed additive + 10,0 % CE+P+CG + 1,0 % selephlan	CF with 2,0 % feed additive + 10,0 % CE+P+CG + 1,0 % selephlan

The basis of the starting CF was grain feed (corn – 26-28% and wheat – 7.0-15.0% by weight), sunflower press cake was used as a protein source – 16.0-18.0%, 6.0% rapeseed and 30.0% protein-vitamin-mineral concentrate (PVMC). The basis of growth CF was identical to that in the starting CF, but with a slightly larger proportion of wheat – 22.8-34.3% and rapeseed – 8.0%, while the amount of PVMC was reduced to 25.0%. The basis of the finishing CF was corn, wheat, sunflower press cake and rapeseed, the share of which was 64.3-7.3%, as well as PVMC in the amount of 20.0%.

During the experimental period, all poultry was monitored daily, including assessment of general condition and physiological status (clinical examination). Growth indicators, development and safety of broiler chickens were taken into account based on visual signs (body weight, physiological development, mobility, condition of feather cover, feed and water consumption). To control the growth rate of chickens at the age of seven days and then according to the rearing periods – on 14, 28 and 42 days, individual weighing was carried out. To prevent infectious and invasive diseases, veterinary preventive measures were carried out.

Biochemical blood parameters were determined on the Vitalab Selectra Junior automatic analyzer (manufactured by Vital Scientific N.V. Netherlands) using reagents from ELITech Clinical Systems (France) and Analyticon biotechnologies AG (Germany). Ultrasound examination of the abdominal cavity of broiler chickens was carried out according to the basic principles of ultrasound diagnostics. For the study a Chison Qbit 7 model device and a linear sensor at a frequency of 10.2 MHz were used. Before the ultrasound, the poultry was kept on a 4-6-hour starvation diet, after which feathers were plucked in the area of interest for study to better detail the internal organs.

All obtained digital data were processed by methods of variation statistics with the determination of Student's t-criterion for reliability and the level of reliability of differences in indicators by group.

3 Results

It was determined that at 14 days the live weight of chickens in the control and experimental groups was at the same level. At 28 days the poultry of the second group in live weight exceeded the control group by 3.2%. At the end of the study at 42 day the live weight of the poultry in the first group was 2308.2 g, in the second group this indicator significantly exceeded the control by 6.9% ($p>0.05$), amounting to 2467.5 g. The average daily increase in live weight for the period of feeding the studied supplements from the age of 7 to 42 days in the experimental group was 65.6 g, versus 61.0 g in the control group.

During the control slaughter, it was determined that the output of the eviscerated carcass in the first and second groups was at the same level and amounted to 74.5%. The proportion of pectoral muscles to the weight of the gutted carcass in the second group was higher by 0.2% compared to the first group (27.6%). The thigh muscles developed more intensively in the experimental group, exceeding the control indicator by 0.5%. The specific weight of the lower leg muscles in the first group was 8.5%, in the second group this figure was higher by 0.7%. In terms of the sum of the specific output of all muscles, the second group, the chickens of which received feed additives based on grain processing products and the hepatoprotective drug selephlan with CF, exceeded the control group by 1.4%.

During the control slaughter, no pathologies of internal organs were detected; they developed within normal limits for the given species and age of the poultry. There were no significant differences in the relative weight of the heart in the study groups. At the same time, intestinal weight in the second group tended to decrease by 7.1% compared to the control. The relative weight of the intestine significantly decreased with the use of selephlan by 0.77% ($p<0.05$)

Based on biochemical analysis data, it can be noted that the combination of CF + 2.0% feed additive and 10.0% CE+P+CG with the addition of 1% selephlan had a significant preventive effect on the occurrence of pathological changes in the morphofunctional state of the liver.

The introduction of the highly nutritious type of feeding into the technological process of raising poultry in most cases leads to the development of metabolic liver damage. Highly concentrated feed allows to provide a rapid growth of poultry, but in this case the organs of the hepatobiliary system cannot cope with the increased load, especially when using feed contaminated with mycotoxins, pesticides and other xenobiotics, which entails the occurrence of a cytolytic shift due to an increase in the level of alanine aminotransferase and aspartate aminotransferase. In this case, the regeneration process of liver cells is damaged, their dysfunction occurs, various types of dystrophy develop and, as a result, the barrier function of the organ decreases.

The administration of 1% selephlan to experimental chickens made it possible to level out the high load on the liver when 2.0% feed additive and 10.0% CE+P+CG were introduced into the complete feed. The level of indicator enzymes in this group at the end of the experiment was the lowest (alanine aminotransferase – 21.7±2.33 U/l, aspartate aminotransferase – 92.7±7.06 U/l), which was lower than the control indicators at 39.2% (ALT) and 13.4% (AST), respectively. In the second group, the level of protein in the blood serum relative to the control increased by 3.2%, glucose – by 3.8%. The urea concentration in the second group increased by 3.1%. The level of phosphorus tended to increase by 1.5%, while in the Ca:P ratio there was a trend toward a decrease in this indicator relative to the control by 1.8%. There was a dynamic increase in the level of creatinine in the blood serum of poultry of the experimental group by 9.3%. At the same time, all changes occurring in the poultry blood were recorded within the boundaries of the reference normal values.

Thus, the introduction of 2.0% feed additive and 10.0% feed mixture (CE+P+CG) + 1.0% selephlan into the diet of broiler chickens did not have a negative impact on the main types of metabolism (lipid, carbohydrate and mineral).

To determine the state of the hepatobiliary system of broilers after the end of the experimental period, intravital screening monitoring of the liver condition using ultrasound diagnostics was carried out in the experimental and control groups. An ultrasound examination of the liver of the control poultry revealed focal hyperechoic inclusions in the liver, thickening of the free edge, overflow and expansion of the gallbladder with thickening of its wall. At the same time, the echostructure of the organ parenchyma was heterogeneous, and the vascular pattern was enhanced. The gallbladder was full, the contours were uneven, the shape was oval, the contents were heterogeneous, hypoechoic, the wall was thickened to 0.12 mm. In the poultry of the experimental group no significant changes in the liver parenchyma were detected. The location of the liver was typical, the contours were smooth and clear, the free edge of the right lobe was sharp, the echostructure of the parenchyma was homogeneous, the vascular pattern was moderate, and the echogenicity of the organ was increased in some areas.

Based on the carried out ultrasound diagnostics, it was determined that the inclusion of selephlan in the feeding scheme under conditions of intensive fattening makes it possible to maintain the healthy structure and functional activity of the liver of broiler chickens at a physiologically normal level throughout the entire productive period of rearing, which has a beneficial effect on the growth characteristics of meat poultry and the quality of the resulting livestock products.

4 Conclusion

Thus, obtained the results indicate that the combined use of feed additives based on grain processing products and selephlan as the part of complete feed for broiler chickens helps to increase the gross and average daily gain of live weight, improve feed conversion, without affecting the negative impact on the safety of the poultry population. The inclusion of a pharmaco-corrective agent, selephlan, in the new scheme for raising broiler chickens can significantly reduce metabolic stress on the detoxification and excretory organs, as well as prevent the development of hepatopathologies

References

1. A.V. Vypritskaya, Successful poultry farming: improving quality against the backdrop of sanctions, Poultry farming, **11**, 33–37 (2014)
2. R. N. Murtazaeva, I. V. Luchina, Broiler poultry farming in the Volgograd region, Poultry farming, **9**, 9–12 (2014)
3. V. I. Nechaev, Yu. I. Bershitsky, S. D. Fetisov, T. N. Slepneva, Current state and trends in the development of poultry farming in Russia, News of the Timiryazev Agricultural Academy, **4**, 102–111 (2014)
4. V.I. Fisinin, Broiler production: reserves and prospects, Animal husbandry of Russia, **6**, 8–11 (2004)
5. V. Fisinin, I. Egorov, Modern approaches to feeding poultry, Poultry farming, **3**, 7–9 (2011).
6. A. G. Koshchaev, I. S. Zholobova, G. V. Fisenko, M. N. Kaloshina, The influence of the feed additive Bacellas on the metabolism of broiler chickens, Proceedings of the Kuban State Agrarian University, **36**, 235–239 (2012)
7. V. A. Ponomarev, N. N. Yakimenko, L. V. Kletikovaet, al., Features of the influence of various feed additives on biochemical blood parameters in chickens, Agrarian Bulletin of the Upper Volga Region, **4(37)**, 48-53 (2021) doi:10.35523/2307-5872-2021-37-4-48-53
8. E.V. Serebryakova, Low-waste and waste-free technologies for processing fruit and vegetable products, Advances in modern natural science, **7**, 197–197 (2011)
9. A. S. Ryazantseva, A. E. Kovaleva, Microbiological bioconversion technology as a method for reducing the formation of production waste in the food industry, Problems of competitiveness of consumer goods and food products. Collection of scientific articles of the 2nd International Scientific and Practical Conference. Kursk, 342–346 (2020)
10. A.I. Tukhbanov, A.S. Dolgunov, Broiler diets: the influence of sorbents and probiotics on the digestibility of nutrients and protein metabolism, Feed production, **7**, 39–40 (2012)
11. A. A. Danilova, A. N. Ratoshny, D. V. Osepchuk et al., Combined use of probiotic and sorbent in poultry farming, Collection of scientific papers of the Krasnodar Scientific Center for Animal Science and Veterinary Medicine, **9(1)**, 338–344 (2020) DOI:10.34617/z3xs-rb65.

12. S.V. Kozhevnikov, The use of natural feed additives and probiotics in the diets of broiler chickens of the Smena-4 cross, Siberian Bulletin of Agricultural Science, **5**, 116–119 (2010)
13. S. D. Wintergoler, The use of hepatoprotectors in the treatment of poultry liver diseases, Scientific Research Center "Technical Innovations", **7**, 269-272 (2021)
14. I. I. Guseva, Use of hepatoprotectors in maintaining the liver function of industrial poultry, Poultry and poultry products, **2**, 50-53 (2022) doi:10.30975/2073-4999-2022-24-2-50-53.
15. M. P. Semenenko, E. V. Kuzminova, A. G. Koschaev, Realization of the bioresource potential of the broiler chickens when using the natural bentonites, Advances in Agricultural and Biological Sciences, **3(1)**, 19-24 (2017)