RUDN Journal of Agronomy and Animal Industries. ISSN 2312-797X (Print). ISSN 2312-7988 (Online)
Вестник РУДН. Серия: АГРОНОМИЯ И ЖИВОТНОВОДСТВО
2025;20(3):433—444
http://agrojournal.rudn.ru

Animal breeding
Животноводство

DOI: 10.22363/2312-797X-2025-20-3-433-444
EDN WNOHOA
UDC 591.613

Research article / Научная статья

Meat qualitative composition of broiler chickens and feed digestibility when introducing a new organo-mineral feed additive into the diet as an alternative to antibiotics

Anastasia P. Ivanishcheva ✉, Elena A. Sizova, Tatyana N. Kholodilina

Federal Scientific Center for Biological Systems and Agrotechnologies of the Russian Academy of Sciences, *Orenburg, Russian Federation*
✉ nessi255@mail.ru

Abstract. The search for alternative approaches to poultry farming aimed at improving the quality of meat and promoting health without the use of antibiotics is a vital task of modern poultry farming. Among the promising areas is the use as an alternative to antibiotics of complex multifunctional feed additives based on prebiotics, organic acids, and mineral components that contribute to the formation of healthy intestinal microflora, increasing the nonspecific resistance of poultry, as well as the quality of meat and productivity. The study is aimed at studying the effect of a new organo-mineral feed additive (OMFA) containing a prebiotic (lactulose), ultrafine silica dioxide particles, organic and amino acids, on the digestibility of nutrients, elemental, and amino acid composition of broiler chicken meat. The inclusion in the diet of a 4-component OMFA from the age of 7 and 15 days has a positive effect on nutrient absorption. An increase in the digestibility of crude protein, crude fat, and nitrogen-free extractives was noted. Early feeding period reduces the digestibility of crude fiber. The use of OMFA leads to an increase in the concentration of certain macro- and microelements in the tissues of broiler chickens, which has a positive effect on the quality of meat. The inclusion of OMFA in the diet is an effective way to optimize protein and fat metabolism, contributing to an increase in muscle mass and a decrease in the percentage of body fat. The ingredients of the feed additive increase the level of amino acids, which favorably affect the properties and nutritional value of broiler meat. When choosing the composition of the additive and

the timing of feeding (from the age of 7 and 15 days), it is recommended to use a four-component OMFA for broiler chickens from the age of 15 days.

Keywords: poultry, nutrient digestibility, mineral composition, organo-mineral complex

Authors' contribution: The authors contributed equally to the study and the preparation of the manuscript. All authors reviewed the final version of the manuscript and approved it.

Funding. The article was published as part of the state task № FNWZ-2024–0002.

Conflict of interest. The authors declare no conflict of interest.

Article history: received 17 March 2025; accepted 7 July 2025.

For citation: Ivanishcheva AP, Sizova EA, Kholodilina TN. Meat qualitative composition of broiler chickens and feed digestibility when introducing a new organo-mineral feed additive into the diet as an alternative to antibiotics. *RUDN Journal of Agronomy and Animal Industries*. 2025;20(3):434–444. doi: 10.22363/2312-797X-2025-20-3-434-444 EDN: WNOHOA

Introduction

A certain success in broiler chicken genetics led to early maturity and a good slaughter yield [1]. At the same time, the quality of meat may decrease. In addition, animal health and well-being at high growth rates are often associated with the use of feed antibiotics. In turn, the widespread use of antibiotics has led to the appearance of resistant bacteria and drug residues in animal products, which directly or indirectly threaten human health and environmental safety [2, 3].

Due to restrictions on the use of antibiotic growth stimulants, the focus of research has shifted to the search for other additives that can contribute in an acceptable way to the prevention of diseases, the formation of microbiota, the adjustment of the intestinal microbial ecosystem and, finally, the strengthening and maintenance of the health of its host by increasing immunity [4, 5]. Thus, in order to meet the demand for meat without losing its quality, it is necessary to use components of the diet that are alternatives to antibiotics.

The additives used in feed to replace antibiotics include probiotics, prebiotics, organic acids (OA), phytogenic additives with natural substances in the composition: herbs, spices, plant extracts, and essential oils [6]. Previous studies have shown that pre- and probiotics can improve the microbial balance of the intestinal environment [7–10] and are believed to contribute to the growth performance [11] and the quality of broiler meat [12, 13].

Among the many candidates for replacement with antibiotic growth stimulants, OA, both individually and as a mixture of several acids, has the potential as a feed additive in livestock [14]. They can modify the intestinal microbiota, reducing pH, suppressing pathogenic bacteria, and promoting the growth of beneficial microorganisms [15], which accelerates the conversion of pepsinogen to pepsin, thereby improving the rate of absorption of proteins, amino acids, and minerals [16].

Adding silicon to the diet of animals helps to increase productivity. Feed conversion is improved, which is expressed in more efficient use of nutrients for growth and devel-

opment [17]. This is especially important for young animals, since it ensures the healthy formation of the skeleton and muscles. In addition, silicon plays a role in maintaining an optimal pH level in the gastrointestinal tract, which contributes to better digestion of food and absorption of trace elements [18].

The inclusion of silicon additives in the diet of farm animals is a promising direction in improving the efficiency of animal husbandry. This allows not only to improve the health of animals, but also to improve the quality of the animal products.

Arginine is an essential amino acid that plays a key role in the metabolic processes of the body. Its introduction into the diet of broiler chickens leads to an improvement in the digestibility and absorption of minerals in meat, which, in turn, has a positive effect on the quality of the final product [19].

In addition, arginine is involved in the synthesis of nitric oxide, which regulates vascular tone and improves the blood supply to tissues, which contributes to more efficient transport of nutrients to muscles and other organs. As a result, broiler meat becomes more juicy, tender, and rich in minerals, which increases its consumer value [20].

The aim of the study is to study the effect of a new organo-mineral feed additive (OMFA) containing a prebiotic, UFP silica dioxide, organic, and amino acid, on the digestibility of nutrients, elemental, and amino acid composition of broiler chicken meat.

Materials and Methods

Experimental and laboratory studies were carried out based on the Shared Research Facility of Biological Systems and Agrotechnologies of the Russian Academy of Sciences (SRF BST RAS) (https://ckp-rf.ru/ckp/77384/).

The daily broiler chickens of the Arbor Acres cross (Orenburg Poultry Farm CJSC, www.pfo56.ru) were selected, and 4 groups (n = 35, control and three experimental) were formed by the method of analogue groups: the control group received the basic diet (BD), according to the recommendations of the All-Russian Research and Technological Institute of Poultry (VNITIP). The first experimental group received 4-component OMFA (lactulose, UFP silica dioxide, succinic acid, arginine) from the age of 7 days, the second experimental group received 3-component OMFA (without lactulose) from the age of 7 days, and the third experimental group received 4-component OMFA from the age of 15 days.

Nutrient digestibility was studied during balance experiments, according to VNITIP methods[1].

The chemical composition of broiler droppings, feed, and body tissues was determined according to standard methods GOST 31640–2012[2, 3], GOST 32044.1.2012, GOST[4]51479–99, GOST[5]23042–86, GOST[6]25011–81, and GOST R 53642–2009[7].

[1] Fisinin VI, Egorov IA, Draganov IF. Feeding poultry: textbook. Moscow: GEOTAR-Media, 2011.
[2] GOST 31640–2012. Forage crops Methods for determining the dry matter content. Moscow, 2020.
[3] GOST 32044.1–2012. Fodder, mixed fodder, mixed fodder raw materials. Determination of the mass fraction of nitrogen and calculation of the mass fraction of crude protein. Part 1. Kjeldahl method. Moscow, 2020.
[4] GOST R 51479–99. Meat and products Method for determining the mass fraction of moisture. Moscow, 2010.
[5] GOST 23042–86. Meat and products Fat determination methods. Moscow, 2010.
[6] GOST 25011–81. Meat and products Methods for determining protein. Moscow, 2010.
[7] GOST R 53642–2009. Meat and products Method for determining the mass fraction of total ash. Moscow, 2010.

The elemental composition of muscle and bone tissue included the determination of 25 chemical elements: Ca, Cu, Fe, Li, Mg, Mn, Ni, As, Cr, K, Na, P, Zn, I, V, Co, Se, Al, B, Cd, Pb, Hg, Sn, Si, Sr. The study was performed on an Agilent 7900 ICP-MS inductively coupled plasma mass spectrometer.

Statistical processing. The results were processed using the Statistica 12.0 software package (Stat Soft Inc., USA) and Microsoft Excel. Student's parametric t-test was used for statistical analysis.

Results and Discussion

The introduction of OMFA into the diet of broilers led to a change in the digestibility of feed components (Fig. 1). Thus, the digestibility of crude protein increased in all experimental groups by 3.6, 3.7, and 2%, respectively, compared to the control group. The coefficient of digestibility of crude fat also shows a positive trend in the experimental groups, increasing by 3.8, 6.6, and 4.7%, respectively, compared to the control group. Therefore, the introduction of OMFA contributes to the effective breakdown and absorption of fats, which is an important factor for the energy supply of the body.

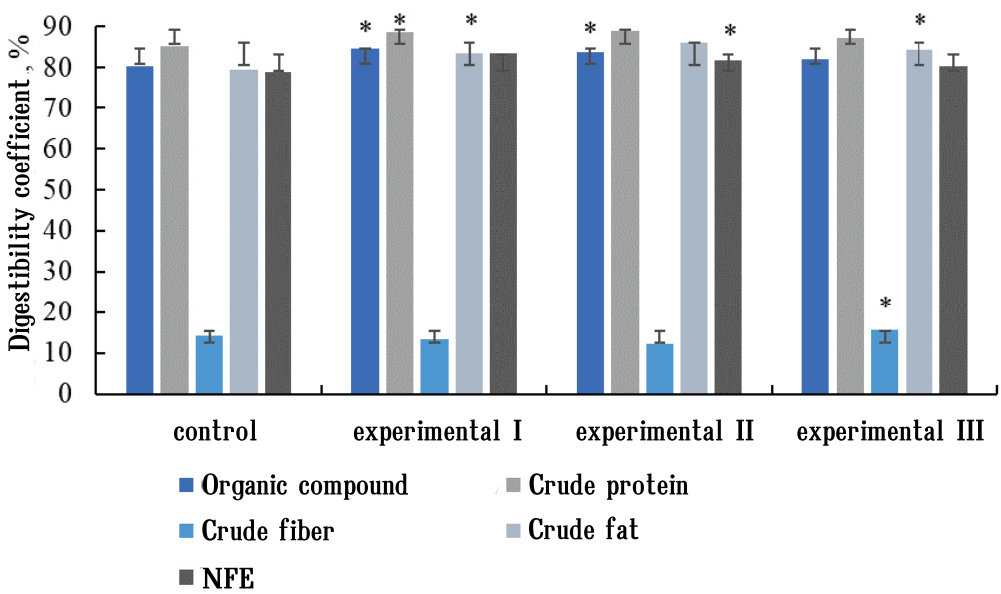

Fig. 1. Digestibility coefficient of feed nutrients, %

Note. * Significant difference between the experimental groups and the control group ($p < 0.05$).

Source: compiled by A.P. Ivanishcheva, E.A. Sizova, T.N. Kholodilina using MS Excel.

At the same time, the effect of OMFA on the digestibility of crude fiber was ambiguous. The inclusion of 4-component OMFA in the diet from the age of 15 days (group III) led to a slight increase in fiber digestibility by 1.3%. However, the early start of feeding (from 7 days of age) had the opposite effect, reducing fiber digestibility by 0.8 and

2.1% in groups I and II, respectively, compared to the control group. This may be due to the peculiarities of the development of the digestive system of young animals and its adaptation to new components of the diet.

The indicator of nitrogen-free extractive substances (NFES) when fed with OMKD also increases in all experimental groups, in the range from 1.5 to 4.7% compared to the control.

It is known that organic supplements optimize the morpho-functional activity of the intestinal mucosa, and also play an important role in the formation and maintenance of a balanced intestinal microflora, which, in turn, can reduce the presence of toxins that negatively affect the morphology of the intestine [21] and improve the digestion and absorption of nutrients [22].

Thus, the increase in the bioavailability of nutrients when using a feed additive with lactulose is associated with its ability to optimize digestion and absorption processes. Lactulose modifies the morphology of intestinal microstructures and modulates the composition of the microbiota, which together lead to more effective absorption of nutrients [23].

At the same time, an important aspect of feeding OMFA is the timing of entry into the diet. Thus, the late term — 15 days of age — is a priority compared to the earlier — 7 days, probably due to the onset of structural and functional maturity of the intestine.

After analyzing the data obtained, we can say that the introduction of OMFA into the diet of broiler chickens leads to changes in the chemical composition of the body (Fig. 2). The concentration of fat decreases in groups I and II by 1 and 0.8% compared to the control.

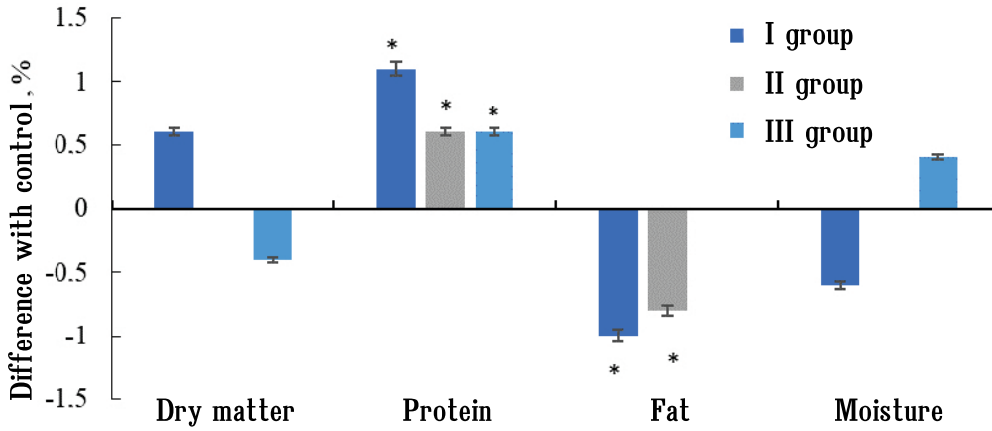

Fig. 2. The difference in the chemical composition of the muscle tissue of Arbor Acres broiler chickens at the age of 42 days (vivarium experiment, $M \pm m$), %

Note. *Significant difference between the experimental groups and the control group ($p < 0.05$).

Source: compiled by A.P. Ivanishcheva, E.A. Sizova, T.N. Kholodilina using MS Excel.

The level of protein increases in all experimental groups in the range from 0.6 to 1.1% when fed with OMFA, regardless of the additive composition and age of administration.

These changes in the chemical composition of the muscles can have a positive effect on the nutritional value and consumer qualities of broiler meat.

The components that make up OMFA affect the absorption of macro- and microelements. Thus, the concentration of Mg and K increased in all experimental groups by 12.5% and 2.97% (group I); 12.5% and 15.8% (group II ($p < 0.05$) and 2.97% (potassium in group III), respectively, compared to the control one (Table 1). The level of Na decreases with the feeding of OMFA from the 7-day age by 4.3%, and with the addition of the additive from the 15-day age, on the contrary, it increases by 8.7% relative to the control group. The concentration of Ca increases when OMFA is added to the diet from both the 7th and 15th day of age (groups I and III) by 40 ($p < 0.05$) and 100% ($p < 0.05$), when lactulose is excluded from the composition of the feed additive (group II), this indicator decreases by 40% relative to the control group. Studies have shown that the administration of prebiotics can improve nutrient digestibility [24]. At the same time, the main reason for the good absorption of minerals may be an increase in beneficial bacteria in the intestine [25], as well as an improvement in antioxidant properties and a decrease in the overall level of oxidants [26].

Table 1

The concentration of macro- and microelements in the muscle tissue of broiler chickens at the end of the experiment

Elements	Groups			
	Control	I	II	III
Macroelements, g/kg				
Na	2.3 ± 0.12	2.2 ± 0.11	2.3 ± 0.12	2.5 ± 0.13
Mg	0.8 ± 0.01	0.9 ± 0.05	0.9 ± 0.05	0.8 ± 0.01
K	10.1 ± 0.51	10.4 ± 0.52	11.7 ± *0.59	10.4 ± 0.52
Ca	0.5 ± 0.03	0.7 ± 0.04*	0.3 ± 0.02*	1.0 ± 0.05*
Microelements, mg/kg				
Mn	0.8 ± 0.08	1.0 ± 0.05*	0.7 ± 0.03	0.9 ± 0.05*
Ni	0.4 ± 0.02	0.2 ± 0.01**	0.3 ± 0.02*	0.2 ± 0.01
Cu	1.8 ± 0.04	1.1 ± 0.06*	1.3 ± 0.06*	1.5 ± 0.07
Fe	22.7 ± 1.20	20.4 ± 1.30	21.0 ± 1.11	26.4 ± 1.48
Zn	36.8 ± 1.91	41.4 ± 2.52	36.2 ± 2.09	39.2 ± 2.19
Cr	0.5 ± 0.04	0.6 ± 0.03	0.4 ± 0.03	1.1 ± 0.09*

Note. *Significant difference between the experimental groups and the control group ($p < 0.05$).

Source: compiled by A.P. Ivanishcheva, E.A. Sizova, T.N. Kholodina.

The concentration of essential elements in the muscle tissue also changed. So, when using a 3-component OMFA (group II), there is a decrease in all studied elements in the range from 1.6 to 27.8% compared to the control.

The level of Ni and Cu decreases compared to the control when the 4-component OMFA is added to the diet:

– from the 7-day age — by 50 ($p < 0.05$) and 38.9%, respectively;
– from the 15-day — by 50 ($p < 0.05$) and 16.7%.

The concentration of Mn and Zn increases relative to the control group, respectively, by 25 ($p < 0.05$); 12.5% (group I) and 12.5 ($p < 0.05$); 6.5% (group III).

The increase in the growth rate of the poultry and the good rate of muscle building contribute to the frequent occurrence of "weakness" of the skeleton, which leads to lameness and mortality. This problem can be significantly mitigated by optimizing the supply of nutrients and, in particular, by the use of osteotropic components in the composition of mineral complexes that contribute to the improvement of bone development in poultry.

The components of OMFA, in particular ultrafine silicon dioxide, have a positive effect on the bone structure and the concentration of macronutrients in the bone tissue of broiler chickens (Fig. 3). The concentration of Ca significantly increased in all experimental groups in the range from 17.8 to 43.1% compared to the control group. The level of Mg also increased in the experimental groups, with the maximum manifestation in group III (26.7%) when fed with late-stage OMFA.

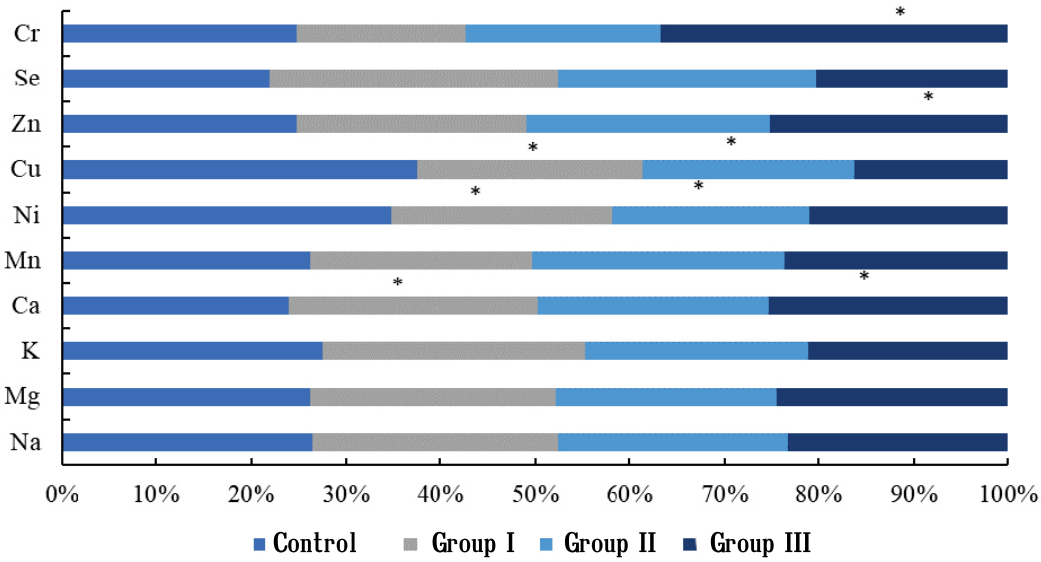

Fig. 3. The relative content of chemical elements in the bone tissue of broiler chickens, %
Note. *Significant difference between the experimental groups and the control group ($p < 0.05$).
Source: compiled by A.P. Ivanishcheva, E.A. Sizova, T.N. Kholodilina using MS Excel.

The introduction of OMFA into the diet of broiler chickens led to a decrease in the content of such essential elements as Ni and Cu by 27.3 ($p < 0.05$), 27.2 ($p < 0.05$), 18.2% and 31 ($p < 0.05$), 27.6 ($p < 0.05$); 41.1%, respectively, in the I, II and III experimental

groups relative to the control group. The concentration of Mn decreased in group I by 3.7%, and in groups II and III, on the contrary, increased by 22.2% compared to the control one. The level of Zn increased in group I by 5.2%, in group II by 24.3%, and in group III by 37.4% ($p < 0.05$) compared to the control. The same effect was noted with the concentration of Se, namely, in groups I and II, an increase of 50%, and in group III, by 25% relative to the control. Thus, there is a tendency to increase the content of mineral substances in bones, which can contribute to strengthening bone tissue and reducing the risk of diseases of the musculoskeletal system.

Different sources of silicon may differ in their degree of degradation and dissolution throughout the gastrointestinal tract [27], as well as affect the rate of passage of chyme in the intestine, potentially affecting paracellular absorption [28]. To fully understand the effect of feed additives on mineral metabolism and their effects on the musculoskeletal system, it is necessary to take into account not only changes in the mineral balance but also detailed mechanisms of absorption and interaction of elements [29]. In addition, it is necessary to take into account the influence of various factors, such as age, physical activity, and the general health of the animal, on the absorption and metabolism of minerals. These data will allow the development of more effective and safe feed additives that contribute to the optimal development and functioning of the musculoskeletal system [30].

The introduction of OMFA into the diet leads to a change in the amino acid composition of the muscle tissue of broiler chickens (Table 2). Thus, the level of essential amino acids increased in all experimental groups I–III, respectively: arginine by 0.39, 0.42, and 0.7%; lysine by 0.55 ($p < 0.05$), 0.48 ($p < 0.05$), and 0.06% ($p < 0.05$); leucine + isoleucine by 0.98, 0.51, and 0.21% compared to the control. The concentration of valine increased in groups I and II by 0.56% ($p < 0.05$) and 0.44% ($p < 0.05$), and in group III, on the contrary, decreased by 0.21% relative to the control group.

Table 2

The amino acid composition of the muscle tissue of broiler chickens, %

Indicator	Groups			
	Cpntrol	I	II	III
Arginine	4.23 ± 0.21	4.62 ± 0.23	4.65 ± 0.23	4.93 ± 0.24
Lysine	6.53 ± 0.02	7.08 ± 0.35*	7.01 ± 0.35*	6.59 ± 0.32
Tyrosine	2.35 ± 0.11	2.79 ± 0.13	3.48 ± 0.17*	3.45 ± 0.17*
Leucine+Isoleucine	9.65 ± 0.48	10.63 ± 0.53	10.16 ± 0.51	9.86 ± 0.49
Valin	3.85 ± 0.19	4.42 ± 0.22*	4.29 ± 0.21	3.78 ± 0.19
Serin	3.12 ± 0.15	3.29 ± 0.16	3.20 ± 0.16	3.18 ± 0.16
Alanin	5.26 ± 0.26	5.44 ± 0.27	5.28 ± 0.26	5.05 ± 0.25

Note. *Significant difference between the experimental groups and the control group ($p < 0.05$).

Source: compiled by A.P. Ivanishcheva, E.A. Sizova, T.N. Kholodina.

The level of tyrosine increased in all experimental groups in the range from 0.44 to 1.13% compared to the control. The concentration of serine also increased, with the maximum manifestation in group I (0.17%) relative to their peers in the control.

The content of replaceable amino acid — alanine — decreased in group III by 0.21%, and in groups I and II increased by 0.17 and 0.02% relative to the control.

The chemical composition of chicken meat is important and usually determines the possibilities for storage or further processing [31, 32]. It is assumed that prebiotics, by stimulating the growth of beneficial microbiota in the intestine, contribute to improving the absorption of amino acids from feed. Organo-mineral complexes, in turn, can directly participate in the synthesis of certain amino acids or affect the metabolic processes in the poultry, leading to a change in the amino acid profile of muscles [33, 34].

Another opinion was expressed by Mehdipour et al. [35], who did not find changes in the physicochemical characteristics of the thigh muscles when quails were fed a diet with the addition of a synbiotic. These conflicting results can be attributed to clear differences in breed, duration of dietary supplementation, dosage, and other aspects of management.

Thus, the introduction of OMFA, regardless of the feeding period, has a positive effect on the content of amino acids in meat and thereby on the quality and biological value of the product.

Conclusion

The inclusion of OMFA in the diet of broiler chickens is an effective way to optimize protein and fat metabolism, which contributes to an increase in muscle mass and a decrease in the percentage of body fat. The increased content of amino acids not only improves the taste characteristics of meat but also increases its biological value, making it more useful for the consumer. Ultimately, the use of this feed additive contributes to the production of better and more nutritious broiler meat.

When choosing the composition of the additive and the timing of feeding (from the 7th or 15th day), we recommend using a 4-component OMFA for broiler chickens from the age of 15 days.

References

1. Cai K, Shao W, Chen X, Campbell YL, Nair MN, Suman SP, et al. Meat quality traits and proteome profile of woody broiler breast (pectoralis major) meat. *Poultry Science*. 2018;97:337–346. doi: 10.3382/ps/pex284

2. Chiesa LM, Nobile M, Panseri S, Arioli F. Antibiotic use in heavy pigs: comparison between urine and muscle samples from food chain animals analysed by HPLC–MS/MS. *Food Chemistry*. 2017;235:111–118. doi: 10.1016/j.foodchem.2017.04.184

3. Li X, Wang L, Zhen Y, Li S, Xu Y. Chicken egg yolk antibodies (IgY) as non-antibiotic production enhancers for use in swine production: a review. *Journal of Animal Science and Biotechnology*. 2015;6:40. doi: 10.1186/s40104-015-0038-8

4. Mehdi Y, Létourneau-Montminy MP, Gaucher ML, Chorfi Y, Suresh G, Rouissi T, Brar SK, Côté C, Ramirez AA, Godbout S. Use of antibiotics in broiler production: Global impacts and alternatives. *Animal Nutrition.* 2018;4:170–178. doi: 10.1016/j.aninu.2018.03.002

5. Pliego AB, Tavakoli M, Khusro A, Seidavi A, Elghandour MM, Salem AZ, Rene Rivas-Caceres R. Beneficial and adverse effects of medicinal plants as feed supplements in poultry nutrition: a review. *Animal Biology.* 2022; 33(2):369–391. doi: 10.1080/10495398.2020.1798973

6. Ravindran V, Dryden GM. Additives. In *The Encyclopedia of Animal Nutrition*. CAB International: Wallingford, UK. 2023. doi: 10.1016/B978-0-323-85125-1.00209-X

7. Zhang L, Zhang L, Zhan X, Zeng X, Zhou L, Cao G, et al. Effects of dietary supplementation of probiotic, Clostridium butyricum, on growth performance, immune response, intestinal barrier function, and digestive enzyme activity in broiler chickens challenged with Escherichia coli k88. *Journal of Animal Science and Biotechnology.* 2016;7:3. doi: 10.1186/s40104-016-0061-4

8. Hagihara M, Kuroki Y, Ariyoshi T, Higashi S, Fukuda K, Yamashita R, et al. Clostridium butyricum modulates the microbiome to protect intestinal barrier function in mice with antibiotic-induced dysbiosis. *iScience.* 2020;23:100772. doi: 10.1016/j.isci.2019.100772

9. Alagawany M, Abd El-Hack ME, Farag MR, Sachan S, Karthik K, Dhama K. The use of probiotics as eco-friendly alternatives to antibiotics in poultry nutrition. *Environmental Science and Pollution Research.* 2018;25:10611–10618. doi: 10.1007/s11356-018-1687-x

10. Gadde UD, Oh S, Lee Y, Davis E, Zimmerman N, Rehberger T, et al. Dietary Bacillus subtilis-based direct-fed microbials alleviate LPS-induced intestinal immunological stress and improve intestinal barrier gene expression in commercial broiler chickens. *Research in Veterinary Science.* 2017;114:236–243. doi: 10.1016/j.rvsc.2017.05.004

11. Dela Cruz PJD, Dagaas CT, Mangubat KMM, Angeles AA, Abanto OD. Dietary effects of commercial probiotics on growth performance, digestibility, and intestinal morphometry of broiler chickens. *Tropical Animal Health and Production.* 2019;51:1105–1115. doi: 10.1007/s11250-018-01791-0

12. Upadhaya SD, Rudeaux F, Kim IH. Effects of inclusion of Bacillus subtilis (Gallipro) to energy- and protein-reduced diet on growth performance, nutrient digestibility, and meat quality and gas emission in broilers. *Poultry Science.* 2019;98:2169–2178. doi: 10.3382/ps/pey573

13. Yu L, Peng Z, Dong L, Wang H, Shi S. Enterococcus faecium NCIMB 10415 supplementation improves the meat quality and antioxidant capacity of the muscle of broilers. *Journal of Animal Physiology and Animal Nutrition.* 2019;103:1099–1106. doi: 10.1111/jpn.13097

14. Dibner JJ, Buttin P. Use of organic acids as a model to study the impact of gut microflora on nutrition and metabolism. *Journal of Applied Poultry Research.* 2002;11(4):453–463. doi: 10.1093/japr/11.4.453

15. Sultan A, Ullah T, Khan S, Khan RU. Effect of organic acid supplementation on the performance and ileal microflora of broiler during the finishing period. *Pakistan Journal of Zoology.* 2015;47(3):635–639.

16. Park KW, Rhee AR, Um JS, Paik IK. Effect of dietary available phosphorus and organic acids on the performance and egg quality of laying hens. *Journal of Applied Poultry Research.* 2009;18(3):598–604. doi:10.3382/japr.2009-00043

17. Miroshnikov SA, Mustafina AS, Gubajdullina IZ. Evaluation of action of ultrafine silicon oxide on the body of broiler chickens. *Animal Husbandry and Fodder Production.* 2020;3(1);20–32. doi: 10.33284/2658-3135-103-1-20 EDN: TVZWNW

18. Ivanishcheva AP, Sizova EA, Kamirova AM, Vlasov EA, Musabaeva LL. Changes in the elemental composition of the muscle and bone tissue of broilers against the background of feeding them a complex organo-mineral supplement. *Ptica i pticeprodukty.* 2024;(1):24–27. doi: 10.30975/2073-4999-2024-26-1-28-31 EDN: QRUGHR

19. Ibatullin I, Il'chuk I, Krivenok N. Arginine in compound feeds for broilers. *Zhivotnovodstvo Rossii.* 2019;(9):15–17. doi: 10.25701/ZZR.2019.45.18.020 EDN: YNSVPD

20. Fathima S, Al Hakeem WG, Selvaraj RK, Shanmugasundaram R. Beyond protein synthesis: the emerging role of arginine in poultry nutrition and host-microbe interactions. *Frontiers in Physiology.* 2024;14:1326809. doi: 10.3389/fphys 2023.1326809

21. Garcia V, Catala-Gregori P, Hernandez F, Megias MD, Madrid J. Effect of formic acid and plant extracts on growth, nutrient digestibility, intestine mucosa morphology, and meat yield of broilers. *Journal of Applied Poultry Research.* 2007;16(4):555–562. doi:10.3382/japr.2006-00116

22. Pelicano ERL, Souza PA, Souza HBA, Figueiredo DF, Boiago MM, Carvalho SR, Bordon VF. Intestinal mucosa development in broiler chickens fed natural growth promoters. *Revista Brasileira de Ciência do Solo.* 2005;7:221–229. doi: 10.1590/S1516-635X2005000400005

23. Nguyen DH, Kim IH. Protected organic acids improved growth performance, nutrient digestibility, and decreased gas emission in broilers. *Animals.* 2020;10(3):416. doi: 10.3390/ani10030416

24. Zhao PY, Li HL, Mohammadi M, Kim IH. Effect of dietary lactulose supplementation on growth performance, nutrient digestibility, meat quality, relative organ weight, and excreta microflora in broilers. *Poultry Science*. 2016;95(1):84–89. doi: 10.3382/ps/pev324

25. Wu X, Yang P, Sifa D, Wen Z. Effect of dietary stevioside supplementation on growth performance, nutrient digestibility, serum parameters, and intestinal microflora in broilers. *Food & Function*. 2019;10(6):2340–2346. doi: 10.1039/C8FO01883A

26. Sohail MU, Rahman ZU, Ijaz A, Yousaf MS, Ashraf K, Yaqub T, Rehman H. Single or combined effects of mannan-oligosaccharides and probiotic supplements on the total oxidants, total antioxidants, enzymatic antioxidants, liver enzymes, and serum trace minerals in cyclic heat-stressed broilers. *Poultry Science.* 2011;(11):2573–2577. doi: 10.3382/ps.2011-01502

27. Diab R, Canilho N, Pavel IA, Haffner FB, Girardon M, Pasc A. Silica-based systems for oral delivery of drugs, macromolecules and cells. *Advances in Colloid and Interface Science.* 2017;249:346–362. doi: 10.1016/j.cis.2017.04.005

28. Tedesco E, Benetti F, Pezzani R. In vitro evaluation of different organic matrices used to modulate silicon bioavailability. *FASEB Journal.* 2020;34:12229–12238. doi: 10.1096/fj.202000060RR

29. Belton DJ, Deschaume O, Perry CC. An overview of the fundamentals of the chemistry of silica with relevance to biosilicification and technological advances. *FEBS Journal.* 2012;279:1710–1720. doi: 10.1111/j.1742-4658.2012.08531.x

30. Kim MH, Kim EJ, Jung JY, Choi MK. Effect of water-soluble silicon supplementation on bone status and balance of calcium and magnesium in male mice. *Biological Trace Element Research.* 2014;158:238–242. doi: 10.1007/s12011-014-9936-4

31. Abdulwahab AA, Horniakova E. Effect of dietary Lactobacillus spp. and Enterococcus faecium supplementation on muscle amino acid profile and protein properties in broilers. *Archiva Zootechnica.* 2013;16:31–40. doi: 10.1016/j.livsci.2018.02.010

32. Podolian JN. Effect of probiotics on the chemical, mineral, and amino acid composition of broiler chicken meat. *Ukrainian Journal of Ecology.* 2017;7(1):61–65. doi:10.15421/20178

33. Liu X, Yan H, Lv L, Xu Q, Yin C, Zhang K, Wang P, Hu J. Growth performance and meat quality of broiler chickens supplemented with Bacillus licheniformis in drinking water. *Asian-Australasian Journal of Animal Sciences. 2012*;25(5):682–689. doi: 10.5713/ajas.2011.11334

34. Podolian JN. Effect of probiotics on the chemical, mineral, and amino acid composition of broiler chicken meat. *Ukrainian Journal of Ecology.* 2017;7(1):61–65. doi: 10.15421/20178

35. Mehdipour Z, Afsharmanesh M, Sami M. Effects of dietary synbiotic and cinnamon (Cinnamomum verum) supplementation on growth performance and meat quality in Japanese quail. *Livestock Science*. 2013;154(s1–3):152–157. doi: 10.1016/j.livsci.2013.03.014

About the authors:

Ivanishcheva Anastasia Pavlovna — Candidate of Biological Sciences, research associate at the Testing Center Laboratory, Federal Scientific Center for Biological Systems and Agrotechnologies of the Russian Academy of Sciences (FSC BST RAS), 29 9 Yanvarya St., Orenburg, 460000, Russian Federation; e-mail: nessi255@mail.ru ORCID: 0000-0001-8264-4616 SPIN-code: 9400–5652

Sizova Elena Anatolyevna — Doctor of Biological Sciences, Associate Professor, Chief Researcher, Head of the Department of Animal Physiology, Biochemistry, and Morphology, Federal Scientific Center for Biological Systems and Agrotechnologies of the Russian Academy of Sciences (FSC BST RAS), 29 9 Yanvarya St., Orenburg, 460000, Russian Federation; e-mail: sizova.l78@yandex.ru
ORCID: 0000-0002-5125-5981 SPIN-code: 9819–1051

Kholodilina Tatyana Nikolaevna — Candidate of Agricultural Sciences, Leading Researcher, Head of the Testing Center, Federal Scientific Center for Biological Systems and Agrotechnologies of the Russian Academy of Sciences (FSC BST RAS), 29 9 Yanvarya St., Orenburg, 460000, Russian Federation; e-mail: xolodilina@rambler.ru
ORCID: 0000-0002-3946-8247 SPIN-code: 2977–6059

Качественный состав мяса цыплят-бройлеров и переваримость корма при введении в рацион новой органоминеральной кормовой добавки как альтернативы антибиотикам

А.П. Иванищева, Е.А. Сизова, Т.Н. Холодилина

Федеральный научный центр биологических систем и агротехнологий Российской академии наук, *г. Оренбург, Российская Федерация*

✉ nessi255@mail.ru

Аннотация. Поиск альтернативных подходов к выращиванию птицы, направленных на повышение качества мяса и укрепление здоровья без применения антибиотиков — актуальная задача современного птицеводства. К перспективным направлениям относится использование в качестве альтернативы антибиотикам комплексных многофункциональных кормовых добавок на основе пребиотиков, органических кислот и минеральных компонентов, способствующих формированию здоровой микрофлоры кишечника, повышающих неспецифическую резистентность птицы, а также качество мяса и продуктивность. Исследование направлено на изучение влияния новой органоминеральной кормовой добавки (ОМКД), имеющей в составе пребиотик (лактулоза), ультрадисперсные частицы диоксида кремния, органическую и аминокислоту, на переваримость питательных веществ, элементный и аминокислотный состав мяса цыплят-бройлеров. Включение в рацион 4-компонентной ОМКД с 7- и с 15-суточного возраста положительно влияет на усвоение питательных веществ. Отмечено увеличение переваримости сырого протеина, сырого жира и безазотистых экстрактивных веществ. Ранний срок скармливания снижает переваримость сырой клетчатки. Применение ОМКД приводит к повышению концентрации некоторых макро- и микроэлементов в тканях цыплят-бройлеров, что положительно отражается на качестве мяса. Включение ОМКД в рацион является эффективным способом оптимизации белкового и жирового обмена, способствующей увеличению мышечной массы и снижению процента жира в организме. Ингредиенты кормовой добавки повышают уровень аминокислот, что благоприятно сказывается на свойствах и питательной ценности мяса бройлеров. При выборе состава добавки и сроков скармливания (с 7- и 15-суточного возраста) рекомендовано использовать четырехкомпонентную ОМКД для цыплят-бройлеров с 15 суток.

Ключевые слова: сельскохозяйственная птица, усвояемость питательных веществ, минеральный состав, органоминеральный комплекс

Вклад авторов: Авторы внесли равный вклад в проведение исследования и подготовку рукописи. Все авторы ознакомились с окончательной версией рукописи и одобрили ее.

Финансирование. Статья опубликована в рамках выполнения государственного задания № FNWZ–2024–0002.

Заявление о конфликте интересов. Авторы заявляют об отсутствии конфликта интересов.

История статьи: поступила в редакцию 17 марта 2025 г., принята к публикации 7 июля 2025 г.

Для цитирования: *Иванищева А.П., Сизова Е.А., Холодилина Т.Н.* Качественный состав мяса цыплят-бройлеров и переваримость корма при введении в рацион новой органоминеральной кормовой добавки как альтернативы антибиотикам // Вестник Российского университета дружбы народов. Серия: Агрономия и животноводство. 2025. Т. 20. № 3. С. 434–444. doi: 10.22363/2312-797X-2025-20-3-434-444
EDN: WNOHOA