Live weight and digestibility of feed nutrients when using amino acids and silicon in the diet of broilers

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Abstract. The article presents the results of a study to determine the effect of ultra-large silicon dioxide and amino acids (arginine + lysine+methionine) both separately and in a complex on the live weight of broiler chickens. The average daily gains, as well as the coefficients of digestibility of the main components of feed were determined. It was found that the combined use of UFP SiO₂ and amino acids increased the live weight of the experimental bird for 21 days by 6.1% (p≤0.05), and by the end of the experiment for 12.3% (p≤0.05). The average daily increase 83.18 g in live weight was noted by the end of the experiment, which is 12.77 grams higher than in the control group. There was also an increase in the digestibility coefficients of dry matter of mixed feed by 4.2% (p≤0.01), organic matter - by 3.7% (p≤0.05), crude fat and crude protein – by 3.4% (p≤0.05). Thus, the data obtained in the experiment are consistent with the results of other researchers describing the effect of preparations of various ultra-large metals and amino acids on the productivity of poultry.

1. Introduction

Animal husbandry is an important component of the country's economy, as it supplies high-quality and environmentally friendly food to the population.

Poultry farming is one of the most dynamic and well-organized sectors of agriculture. Today, the most developed branches of poultry farming are considered to be egg and meat poultry farming. However, the industrial production of poultry meat and eggs is more important for providing the population of the country with inferior protein and the complex of essential amino acids contained in it [1].

Over the past few years, the poultry industry has demonstrated excellent growth rates in the production of chicken meat, due to the fact that poultry has a maximum growth rate, which allows the conversion of feed nutrients into components of poultry products, thereby increasing the profitability of the industry [2].

The productive qualities of poultry largely depend on the full-fledged feeding, namely the content of biologically active and mineral substances in the diets. The high growth rate of young meat poultry requires special attention to the balancing of diets and compound feeds in terms of the content of macro- and microelements, which have a great importance in the process of metabolism. That is why the use of mineral feed additives, various biologically active substances and their complexes are considered relevant.
In this regard, the aim of our work was to study the complex effect of amino acids and silicon dioxide in ultrafine form on the live weight and digestibility of the nutritional components of feed in the broilers’ body.

2. Materials and methods of research
For the study, 120 heads of healthy ArborAcres cross broilers were selected in the vivarium of the Federal Research Center of Biological Systems and Agrotechnologies of the Russian Academy of Sciences. Groups of 30 heads were formed according to the principle of analogues by random sampling. The conditions of detention corresponded to the recommendations of the Russian Scientific Research and Technological Institute of Poultry Breeding [3].

Feeding of the experimental bird was carried out in the morning and in the evening at a strictly defined time with dry mixed feed, which corresponded in terms of nutritional parameters to the recommendations of the Russian Scientific Research and Technological Institute of Poultry Breeding [4]. During the accounting period, the poultry of the I experimental group were additionally injected with amino acids, the poultry of the II experimental group-300 mg of ultrafine silicon dioxide per kg of feed after dispersion (45 min) in saline solution using UZDN-2T (35 kHz, 300 W, 10 μA, 45 min), the poultry of the III experimental group – a complex of amino acids and silicon dioxide, and the poultry of the control group – received the main diet.

Feed methionine, lysine monochlorohydrate, and arginine hydrochloride at doses of 2 g/kg, 6 g/kg, and 7 g/kg, respectively, were selected from a wide range of amino acid preparations. Rational doses of amino acids for the introduction into the diet were chosen taking into account previous experiments and the positive effect on the body of broilers [5].

Ultrafine silicon dioxide was used as a silicon preparation. It does not change the usual color and smell of the feed and contains at least 99.8% silicon. When dispersed with saline, its hydrodynamic diameter is $6-8\,\text{nm}$. The rational dose of 300 mg/kg of feed was chosen taking into account previous studies [6-8].

The basis of the starting and growth feed was a wheat-corn mixture. The starting compound feed contained 12.1 MJ/kg of exchange energy, and the growth feed contained 11.8 MJ/kg of compound feed.

The experimental bird was monitored throughout the study, while growth and development were controlled, the feed consumption and feed intake were taken into account, and individual weighing of broilers was carried out once a week. The obtained data allowed us to determine the changes in live weight and calculate the absolute and average daily gains.

A balance experiment on broilers was conducted to study the digestibility of feed nutrients. The chemical composition of manure and compound feed was determined in the conditions of the Common Use Center of the Federal Research Center of the Russian Academy of Sciences according to generally accepted methods and on the approved equipment.

Statistical processing of the obtained data was carried out using the software package Statistica 10.0 and the software package "MSExcel 2016". The data are presented as: mean (M) ± standard error of mean (m). The results were considered reliable at $P \leq 0.05$.

3. Results and discussion
When tested, the live weight of daily broilers averaged 52 grams. During the use of the studied preparations, the broilers of the experimental groups began to outperform their peers from the control group in terms of live weight, which on the 21st day was greater than the mass of the control group chickens by 4.3 %, 1.5 % and 6.1 %, respectively, and this value for the III experimental group was significant ($p<0.05$) (figure 1).
A further significant increase was observed only for the III experimental group and was 8.5 % (p<0.01) by 28 days, 10.4 % (p<0.05) by 35 days, and 12.3 % (p<0.05) by 42 days compared to similar values of the weight of chickens in the control group. The live weight of broilers of the first experimental group was significantly higher than the values of the live weight of the control group by 7.8 % (p≤0.05).

![Figure 1](image1.png)

**Figure 1.** Change of difference (%) of live weight of broiler chickens of control and experimental groups. Note: * – p≤0.05, ** – p≤0.01 comparison with control group.

During the entire experiment, the case of the experimental bird was not detected, the safety at the end of the experiment was 100 %.

The average daily live weight gain of broilers of the experimental groups was higher than in the control group. By the middle of the experimental study, a similar trend was observed, the average daily increase in live weight of poultry in the experimental groups was higher than index of chickens in their control group by 7.6%, 2.1% and 11.2%, respectively, for the I, II and III experimental groups (figure 2).

![Figure 2](image2.png)

**Figure 2.** Difference (d) in the average daily live weight gain of broiler chickens in the experimental groups compared to the control group. Note: * – p≤0.05, ** – p≤0.01 comparison with control group.

By the end of the experiment, the average daily increase in live weight for broilers of the First experimental group was 81.22 grams, which is 15.4% more than in the growth of chickens of the control group. In broilers of the experimental group II, the average daily increase in live weight by the end of the
accounting period was only 6.7% higher, while in the experimental group III, this indicator was 18.1% higher than the control values.

The values of the absolute live weight gain of broilers of the experimental groups were also higher than the weight gain of control group chickens, and by 42 days the increase was 8.0% for the I experimental group, 3.4% for the II experimental group, and 12.4% for the III experimental group. Moreover, the feed costs per 1 kilogram of live weight gain were lower for the I experimental group by 6.3%, the II experimental group by 1.9%, and the III experimental group by 9.1%.

For a more complete understanding of the effect of feed nutrients on the growth and development of experimental birds, experiments were conducted on the digestibility of feed nutrients and the corresponding coefficients of nutrient digestibility were calculated. The increase in the digestibility coefficients of the main nutritional components of mixed feed is proved by the obtained differences in live weight and average daily gains in live weight of broilers of the experimental and control groups from the point of view of physiology and biochemistry (figure 3).

![Figure 3. Feed nutrient digestibility coefficients.](image)

The data showed that the digestibility coefficient of dry matter of mixed feed by broilers of the experimental groups is higher than the control value-by 2.8% (p≤0.05) for the I experimental group, 0.6% – for the II experimental group, 4.2% (p≤0.01) - for the III experimental group, and the difference in the coefficients of digestibility of organic matter of mixed feed by poultry of the experimental groups was 2.1% (p<0.05), 1.2% and 3.7% (p<0.05), respectively, compared to the same value of the coefficient of digestibility in the body of chickens in the control group. Crude fat was digested better in the body of broiler chickens of the experimental groups compared to the control group by 1.6% (p<0.05), 0.7% and 3.4% (p<0.05), respectively. The digestibility coefficient of raw feed protein in broilers of the experimental groups was significantly (p<0.05) higher than in the control group by 2.9%, 2.7% and 3.4%, respectively.

4. Conclusion
In the course of the study, it was found that the use of the amino acids arginine, lysine and methionine together with ultrafine particles of silicon dioxide increased the live weight of broilers to 8%, the average daily increase to 15%, and the absolute increase to 12%. We believe that the increase in the main zootechnical growth indicators of experimental poultry occurred against the background of an increase in the digestibility coefficients of the main components of feed in the body of experimental broilers. The data obtained in the experiment are consistent with the results of other researchers describing the effect of preparations of various ultra-sized metals-trace elements on the productivity of poultry [2,7-11].
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