The influence of poultry rations on its productivity and resulting products quality

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Abstract. The purpose of the study is related to the Food Security Doctrine priorities and is aimed at finding ways to implement import substitution with obtaining competitive poultry products – meat and eggs. Feed ration of the experimental poultry was as follows. The control group received basic diet (BD), 1st experimental group received BD with probiotic additive «Bacell-M» (Bacell-M). The 2nd experimental group received BD with vitamin-mineral feed concentrate «Tetra +» (VMFC), while 3rd experimental group received BD with feed concentrate complex (FCC). It was found that feed consumption of experimental groups broiler chickens is lower than in the control group (140.1 kg / 42 days) and is in the range 132.6 – 134.9 kg / 42 days, while the average broiler chicken live weight 2.32 – 2.35 kg/unit, and in the control group – 2.05 kg/unit. The maximum effect of live weight increase advancing when taking into account the reduction in feed consumption is achieved in broiler chickens of the 3rd experimental group. It is established that the feed additives use in the ration contributes to earlier output of replace herd laying-hens to the egg production. The increase in egg production in relation to the control group amounted to: 147 eggs for the 1st experimental group, 189 eggs for the 2nd experimental and 217 eggs for the 3rd experimental group. The nutritional value and biological active substances (BAS) concentration of broiler chicken meat and eggs from experimental group hens exceeds the nutritional value of control groups meat and eggs.

1. Introduction
The Russian Federation domestic market volume increase with high-quality livestock products is one of Food Security Doctrine priorities. Achieving this priority is possible by improving animal breeds, their living conditions and enriching feed rations with feed additives, which normalize metabolic processes and increase organism resistance to negative environmental factors effects. The most simple, in our view, for possible implementation, including the time slot, is the third option.

So, in feeds production software equipped with a fuzzy logic apparatus can be used, which makes it possible to balance the raw materials unstable quality indicators and the mixture recipe components interaction, by selecting their optimal ratio [1,2].

In [3,4] it was shown that the amaranth cake, in terms of quality and composition is not inferior to the rapeseed cake, and can be recommended for use in feed additives production.

There are known studies on the effect of feed additives on the quality of food and hatching eggs...
Thus, in [5], the complex effect of potassium iodide and probiotic - tetralactobacterin on the laying hens’ eggs quality was studied. The use of a complex feed additive in an amount of 0.9 mg/kg of feed allows to increase the iodine content in egg by almost 3 times and generally improves the eggs consumer properties. In [6], the positive effect of sorghum grain instead of corn grain addition in amount of 50 % into the ration of the laying hens parent flock for 52 weeks was established, while feed costs are reduced by an average of 0.03 kg for every 10 eggs with an increase in laying hens productivity up to 1.3% and an increase in egg mass.

It was shown in [7] that the use of a complex feed additive in the broiler chickens rations containing the sorbent «Kovelos-Sorb» and the probiotic «Sporoterr» provides an increase in average daily growth in live weight up to 8.8 % compared to control group broiler chickens. It has been established that the use in the broilerchicken rations complex feed additives, containing sorbents (glauconite, Antivir or Microsorb) and the Biosporin probiotic, provides the increase the raw protein digestibility up to 6.7 % [8].

Previously, in our studies [9], it was found that the use of FCC containing VMFC and Bacell-M in the broiler chickens rations provides positive changes in blood biochemical homeostasis due to a decrease in the indicator liver enzymes activity (alanine aminotransferase and aspartate aminotransferase).

Given this, it is relevant to study the influence of feed rations on the broiler chickens and laying hens productivity, as well as on the nutritional value of the resulting products - meat and eggs.

2. Materials and methods

The effectiveness of feed additives use to increase the broiler chickens and laying hens productivity was determined using feed additives: VMFC, including BAS complex – beta-carotene, vitamin E, vitamin C, organic selenium and phospholipids; Bacell-M, containing three strains of microorganisms Bacillus subtilis, Lactobacillus paracasei, Enterococcus faecium; FCC, including VMFC and Bacell-M 3:2 ratio. The scientific and production experiment on feeding broiler chickens for their productivity was carried out in the conditions of the Training and Methodological Center for Small Forms of Husbandry Development (Bryukhovetsky District, Krasnodarskykrai), while feeding laying hens replacing herd in the conditions of M. Guzenko private farming (Slavyansk District, Krasnodarskykrai) according to the scheme shown in Figure 1.

According to Figure 1, the broiler chickens livestock at 1 day age and «Adler silver» breed laying hens of meat and egg direction at 20 weeks age were divided into 4 groups of 100 animals each, while the control group received the basic diet (BD), the 1st experimental group additionally with BD received Bacell-M in the amount of 0.2% by BD weight, the 2nd experimental group – BD with VMFC in the amount of 0.3% by BD weight, and the 3rd experimental group – BD with FCC 0.3 % by BD weight. Broiler chickens were fed according to the scheme for 42 days, and laying hens – for 70 days.
Figure 1. Feeding scheme of laying hens replacing herd.

3. Results and discussion
To determine the effectiveness of feed additives use in order to improve feed conversion, we studied its effect on feed consumption consumed by broiler chickens in comparison with live weight increase, for this purpose consumed feed measurements were carried out weekly. The data on total feed consumption by all groups of broiler chickens in a two-week section and for the entire period of the experiment are presented in table 1.

Table 1. Feed consumption during broiler chickens feeding for different feed ration.

| Feeding period    | Control BD | BD + Bacell-m | BD + VMFC | BD + FCC |
|------------------|------------|---------------|-----------|----------|
| 1st and 2nd weeks| 18.2       | 18.2          | 18.2      | 18.2     |
| 3rd and 4th weeks| 53.6       | 53.8          | 52.1a     | 53.1a    |
| 5th and 6th weeks| 68.3       | 62.9a         | 63.1a     | 61.3a    |
| Total for the entire period | 140.1 | 134.9a        | 133.4a    | 132.6a   |

*aThe reliability degree p<0,05 compared to control.

The table 1 analysis shows that all experimental groups that received feed additives with BD consumed less feed than the control group over the entire feeding period. The maximum difference in feed consumption is observed in 3rd experimental group that received FCC, which can be explained by the synergistic effect of two components – VMFC and Bacell-M. Bacell-M cellulolytic enzymes provide cell membranes lysis and feed digestibility increase, therefore, the satiety onset occurs at a lower feed consumption, and VMFC provides the growing organism with biologically active substances.

Table 2. The effect of feed ration on broiler chickens live weight increase.

| Broiler chicken age, weeks | Average broiler chicken live weight by group, kg | Control BD | 1 BD + Bacell-m | 2 BD + VMFC | 3 BD + FCC |
|---------------------------|-------------------------------------------------|------------|----------------|-------------|-----------|
| 3                         | 1.29                                             | 1.39a      | 1.33a          | 1.36a       |
| 4                         | 1.47                                             | 1.58a      | 1.54a          | 1.58a       |
| 5                         | 1.72                                             | 1.92a      | 1.86a          | 1.90a       |
| 6                         | 2.05                                             | 2.38a      | 2.32a          | 2.35a       |

*aThe reliability degree p=0,05 compared to control.

The table 2 data indicates a more active dynamics of broiler chickens live weight increase in the experimental groups compared to the control. So, the 3rd experimental group, receiving BD with FCC, outstrips the broiler chickens live weight increase in the control group by 14.6%.

For a detailed assessment of the feed rations on productivity and feed consumption impact, Figure 2 shows the data of the experimental groups relative to the control group in the graphs form.

From the graphs presented in Figure 2, it can be observed that, despite high increase rates in broiler chickens live weight (16.1 % compared with the control group), when feeding Bacell-M into the ration, feed consumption decreases by only 3.71 %, while this indicator when using FCC is 5.35%.
The nature of the dependence of feed consumption in comparison with the live weight increase dynamics shows that when broiler chickens were fed by BD with the addition of Bacell-M (1st experimental group), the live weight increase compared to the control group is outstripped by partial feed cleavage by probiotic microflora, and therefore, a more complete feed digestion. Organism satiety with physiologically important substances, involved in the regulatory processes in organism, thus in this case occurs only partially due to the BD.

Figure 2. The effect of feed additives on the broiler chickens live weight increase dynamics and feed consumption compared with the control group

In turn, the VMFC addition (2nd experimental group) into the ration allows to reduce feed consumption in a greater degree, but is inferior in its digestion degree by 1st experimental group broiler chickens. In addition, the high BAS content in VMFC, which have regulatory properties in metabolic processes, can involve nutrients in poultry adaptive mechanisms activation, increase activity and mobility, which also reduces live weight increase dynamics.

In the group fed with BD with FCC (3rd experimental), there is a relatively high broiler chickens live weight increase dynamics and a maximum decrease in feed consumption, which is explained by the probiotic microflora and BAS synergistic effect.

At the end of the scientific and production experiment, a control slaughter of broiler chickens from each group was carried out with the subsequent determination of the nutritional value of meat (table 3).

The table 3 data shows that the content of protein, phospholipids, vitamins A, E and C in meat of 2nd and 3rd experimental groups broiler chickens is higher than content of these food nutrients in meat.
of control group broiler-chickens.

Table 3. The effect of the feed ration on the broiler chickens meat nutritional value.

| Broiler chicken group | Indicator name and value | mass fraction in muscles, % | vitamins, mg/100 g |
|-----------------------|--------------------------|----------------------------|--------------------|
|                       |                          | protein | fat | phospholipids | A   | E   | C   |
| Control group (BD)    |                          | 19.08   | 6.55 | 0.04          | 0.023 | 0.028 | 0.010 |
| 1st experimental group (BD + Bacell-M) | 19.06 | 6.51<sup>a</sup> | 0.04 | 0.031<sup>a</sup> | 0.613<sup>a</sup> | 0.017<sup>a</sup> |
| 2nd experimental group (BD + VMFC) | 20.46<sup>a</sup> | 6.62<sup>a</sup> | 2.09<sup>a</sup> | 0.069<sup>a</sup> | 0.827<sup>a</sup> | 0.028<sup>a</sup> |
| 3rd experimental group (BD + FCC) | 20.42<sup>a</sup> | 6.71<sup>a</sup> | 1.87<sup>a</sup> | 0.048<sup>a</sup> | 0.760<sup>a</sup> | 0.027<sup>a</sup> |

<sup>a</sup>The reliability degree p<0.05 compared to control.

Thus, the experimental data allow us to conclude that the feed additives use in broiler chickens rations, and especially FCC, containing probiotic microflora and BAS, improves feed conversion and contributes to production of meat with increased nutritional value.

At the next stage it was carried out the scientific and production experiment on feed ration influence on laying hens productivity. The results of feed ration effect on the amount of laying hens entered the productive phase are shown in Figure 3.
Figure 3. Feed ration effect on the amount of laying hens entered the productive phase

From the graphs presented in Figure 3, it can be seen that first laying hens entered the productive phase were receiving BD with feed additives containing in their composition BAS (VMFC and FCC). The control group and 1st experimental group receiving Bacell-M, only the productive phase at 24 weeks, that is 4 weeks after the experiment started.

Analyzing the graph data, it can be assumed that during the first three weeks BAS, feed concentrates (VMFC and FCC) participated in the laying hens reproductive system regulatory processes, which ensured earlier eggs maturation and, therefore, earlier egg-laying. The 1st experimental group receiving BD with Bacell-M, despite a week-long lag in the egg-laying start, showed high dynamics in the next two weeks and by the age of 25 weeks, egg production results were comparable with other experimental groups – about 80% of laying hens entered the productive phase (the control group reached 70% during this period).

At week 30, all laying hens groups, including the control, reached an egg-laying rate of over 95% of the total population.

We evaluated the effect of the feed ration on egg productivity of laying hens aged 25 to 30 weeks (table 4).

Table 4. The effect of the feed ration on the egg productivity of laying hens during the experiment (for 6 weeks)

| Laying hens group | Indicator name and value | eggs number by categories, units | egg category ratio, % on total amount |
|-------------------|--------------------------|----------------------------------|---------------------------------------|
|                   |                          | first | second | total | first | second |
| Control group (BD) |                          | 1760  | 1985   | 3745  | 47    | 53     |
| 1st experimental group (BD + Bacell-M) | | 1907  | 1985   | 3892  | 49    | 51     |
| 2nd experimental group (BD + VMFC)   | | 2046  | 1888   | 3934  | 52    | 48     |
| 3rd experimental group (BD + FCC)   | | 2060  | 1902   | 3962  | 52    | 48     |

From the table 4 data it is seen that for 6 weeks of egg production study of the laying hens replacing herd, entering the productive phase, significant changes are already noticeable depending on the ration. So, from 1st experimental group receiving BD with Bacell-M, increase in egg amount was 147 eggs, compared with the control group, from 2nd experimental group receiving BD with VMFC, 189 eggs, and from 3rd experimental group – 217 eggs.

Table 5 shows data on the effect of the feed ration on the eggs nutritional value.

Table 5. The effect of the feed ration on the eggs nutritional value

| Laying hens group | Indicator name and value | mass fraction of β-carotene in yolk, mg/100 g | mass fraction in the egg, mg/kg | vitamin A | vitamin E |
|-------------------|--------------------------|-----------------------------------------------|---------------------------------|-----------|-----------|
| Control group (BD) |                          | 6.00                                          | 9.00                            | 3.00      |
| 1st experimental group (BD + Bacell-M) | | 6.02                                          | 9.05                            | 3.07      |
| 2nd experimental group (BD + VMFC) | | 13.00a                                        | 9.30a                           | 3.20a     |
From the data given in table 5, it can be seen that introduction of feed additives containing biologically active substances (VMFC and FCC) into the laying hens diet allows one to increase the eggs nutritional value compared to the control group eggs due to increase of beta-carotene content in the yolk as well as vitamins A and E content.

4. Conclusion
The results of scientific and production experiments on the broiler chickens and on the laying hens replacing herd allow us to conclude that the use of feed additives helps to increase their productivity. The maximum effect is achieved with the use of complex additives containing both BAS that have a positive effect on poultry regulatory processes, and probiotic additives that improve feed conversion due to cellulolytic activity. So, the increase in the broiler chickens live weight growth of the 3rd experimental group in relation to the control group is 14.6 % in 42 days, and the additional increase in egg productivity of the laying hens replacing herd of the 3rd experimental group in relation to the control group is 5.8 % in the first 6 weeks from the moment of entering the productive phase. In addition, the nutritional value of the 3 experimental group broiler chickens meat and laying hens eggs is higher in comparison with the nutritional value of the control, 1st and 2nd experimental groups meat and eggs.

Thus, it has been established that the most effective in terms of increasing the broiler chickens and laying hens productivity, as well as increasing the obtained products nutritional value, is the use of FCC containing BAS and probiotics in the poultry ration.

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