Effect of preparation Dihydroquercetin on growth-weight indices of broilers

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Abstract. Research is devoted to the study of the feasibility of using a natural antioxidant of plant origin as a biologically active additive to the basic diet and assessing the effectiveness of its use to increase the meat productivity of broiler chickens. In our work we examined the broiler chickens productivity and quality when using the drug ‘Dihydroquercetin’ (LLC ‘Kakhor’, Zima, Irkutsk region, Russia) in diets and established the amount of feed consumed and its costs per unit of production. Based on the studies, the addition of the preparation enables to increase the safety of broiler chickens by 20…30%, live mass – by 12…33%, mass of ripped carcass – by 15…38%, muscle tissue – by 3%, thoracic muselles – by 0.3…2%, and edible parts of carcass – by 2…6%. Moreover, the additive reduces the feed consumption by a head during the fattening period by an average of 46.09 g compared to the control.

1. Introduction

Poultry farming is one of the most cost-effective agricultural industries in the world, the first to enter the path of industrialization and provide the population with dietary foods [1]. The bird differs from other farm animals in the higher intensity of exchange processes, which is closely related to its speed and preservation. Domestic and world experience in poultry farming convincingly indicates that the full realization of the genetic potential of modern breeds and crosses can be achieved with a balance of feed combinations not only in amino acids, fats and carbohydrates, but also in vitamins, minerals and other biologically active additives that help to achieve maximum productivity [2-4]. The most important problem of modern poultry farming remains increased productivity due to higher efficiency of nutrient use, maximum safety of the livestock and prevention of various diseases. This is the basic concept of the modern science of feeding agricultural poultry. The organization of scientifically based feeding is not only to fully provide the birds with the necessary feed, but also to help them extract the maximum possible amount of nutrients from the diet. In addition, factors leading to diseases should be eliminated in feed. The tightening of environmental safety requirements for poultry products has led the world to review many methodological approaches to optimizing cultivation and recognize the need to develop a new generation of environmentally friendly drugs that can take their place in the poultry production system. At the present stage of the development of domestic poultry farming, in order to solve the problem of improving the physiological condition and productive qualities of broiler chickens, a special role is given to the use of biologically active substances [5]. Quite effective preparations include the natural antioxidant ‘Dihydroquercetin’ (DHQ) (LLC ‘Kakhor’, Zima, Irkutsk region), which has a wide
spectrum of effects on the poultry body and the functional and technological properties of the obtained meat raw materials [6-8].

Studies of scientists prove that DHQ stimulates the average daily gain in live weight of poultry by an average of 8.13%, while young birds more intensively increase productivity with age, reduces feed costs for live weight gain (feed costs for an increase of 1 kg of live weight are reduced by 4.59%), improves product quality, increases egg production and average egg weight [9].

In this regard, our research aimed at a comprehensive study of the effectiveness of the use of the drug ‘DHQ’ in combination with full-nutritional feed of broiler chickens, namely, live mass gain, livestock safety, meat productivity and meat quality, are relevant and of great scientific and practical interest [10, 11].

The popularity of natural antioxidants to protect human and animal health and to increase the shelf life of products from animal origin has increased during the past decade [12, 13]. Flavonoids being a major sub-group representing plant polyphenols, are considered antioxidants from natural sources and as such, have been attracting attention for use in animal nutrition [14]. DHQ, also known as taxifolin, a flavonoid extracted from various conifers including Siberian Larch (Larix sibirica), longleaf Indian Pine (Pinus roxburghii), Himalayan Cedar (Cedrus deodara) and Chinese Yew (Taxus chinensis var. mairei), has been widely applied as an antioxidant.

DHQ has also been incorporated in animal diets in order to enhance production performance. Data on the effectiveness of the use of DHQ as dietary supplement in animal production and reported enhancement in growth performance and blood variables of poultry and pigs. The breast meat from 42-day age broilers fed DHQ supplemented diet had higher dry matter, lower fat, lower tryptophan and the same protein content when compared to birds fed control diet only. Revealed that feeding DHQ to broilers increases the number of red blood cells and haemoglobin concentration compared to control. Revealed increased protein concentration in the organs and tissues of broiler chickens when fed DHQ, however, the experiment was not designed to study the effect of DHQ on growth performance variables.

2. Materials and Methods

Studies were carried out on cross-country broiler chickens KOBB-500 in the production conditions of LLC ‘Zverokhochnost Kiznerskoye’. For the production experience, 40 heads of daily broiler chickens of cross KOBB-500 were selected, with an average living mass of 39.80 ± 0.13 g, and four groups of 10 heads in each were formed from them, according to the principle of analogues, which received the corresponding main diet, consisting of, respectively, starter, growth and finishing feed used at the poultry farm. All chickens, according to the periods of the experiment, received the main diet, consisting, respectively, of starter, growth and finish feed used at the poultry farm.

Feeding of broiler chickens was carried out by full-diet feed, in accordance with the recommendations of the originator [15] for poultry of this cross, taking into account age. In terms of energy nutrition and nutrient content, they were the same and differed between groups in the amount of DHQ additive administered (Ametis Company, Russia). In our experiment, there were three groups of animals. The chicks of the control group (I group) received only a combination (basic diet), the II, III and IV test groups received an additional antioxidant additive ‘DHQ’ in an amount of 0.50, 0.75 and 1.00 g, respectively, of the DHQ per 100 g of feed.

DHQ, an antioxidant, bioflavonoid of natural origin, obtained from Siberian and Daurian larch, has a decongestant, capillary protective, and antioxidant property. It is a small crystal or amorphous odorless powder from light yellow to yellow with slightly bitter taste. DHQ regulates metabolic processes, has a positive effect on the functional state of the internal organs of the body, creates mechanisms for protecting healthy body cells from pathologies caused by chemical poisoning, exposure to electromagnetic radiation and radiation, by neutralizing radical activity, viral and bacterial processes. It is not toxic, harmless, and resistant to thermal and mechanical effects. DHQ is necessary for birds in their breeding, production of poultry production in areas technogenic for heavy metals and radionuclides, as well as industrial enterprises susceptible to pollution of chemical, metallurgical, petrochemical and other types of industry. Due to capillaroprotective and antioxidant properties of DHQ,
metabolism at the cell and capillary interface and correction of the body's antioxidant status are significantly improved. The antioxidant effects of DHQ, like other flavonoids, are one of the non-specific mechanisms for realizing many of its other biological properties. The tested drug increases the average daily gain in live weight, while the young grows more intensively with age, reduces the cost of feed to increase live weight, improves product quality, increases egg production and average egg weight.

The duration of the experiment was 40 days, and to clarify the effectiveness of increasing the duration of the poultry fattening period, it was extended to 60 days. Broiler chickens were grown floor, temperature and light conditions, air humidity, feeding front and drinking of poultry during the experiment met the recommended standards of the All-Russian Research and Technological Institute of Poultry Breeding (Russia)[16], in accordance with Russian GOST 28731-90 [17].

Different mixed feeds were used for different ages of chickens (table 1). The starting compound feed was served to chickens from zero day to 10 days. Growth feed was used for 14-16 days, that was, from 11 days to 25. Finishing compound feed was used from the age of 25 days until slaughter.

The growth of broilers and the efficiency of feed conversion is higher if the physical structure of the feed is regulated. Therefore, the "start" feed was in the form of a grain or micro-granules, the growth and finishing feed was in the form of a pellet.

| Age                      | Feed structure and size                                      |
|--------------------------|-------------------------------------------------------------|
| 0-10 days                | Sifted grits or mini-granules                               |
| 11-24 days               | Granules (2…3.5 mm) or a coarse-ground scattering            |
| 25 days and before slaughter | Granules (3.5 mm) or a coarse-ground placer                   |

Microclimate indicators in poultry premises are shown in table 2.

| Parameters          | Age 7 days | Age 14 days | Age 21 days | Age 28 days | Age 35 days |
|---------------------|------------|-------------|-------------|-------------|-------------|
| Air temperature, °C | 32-34      | 27          | 24          | 21          | 19          |
| Humidity, %         | 40-60      | 60-70       | 65-70       | 65-70       | 65-70       |
| Illumination, lux   | 15-20      | 15-20       | 15-20       | 10-15       | 7-10        |

The live weight of the bird was determined by weekly individual weighing on day 1-, 7-, 14-, 21-, 28-, 35- and 42-day age. The safety of the livestock was taken into account by the number of fallen birds by the 40- and 60-day age. Feed consumption (table 3) was determined daily by groups by weighing the specified feeds and their residues during the whole period of the experiment, followed by recalculating them per 1 kg of live weight gain. Meat productivity was determined by anatomical cutting of carcasses by FSC ‘VNITIP’ RAS method. The following indicators were taken into account: live mass, mass of a rippled carcass, slaughter yield, meat-bone indices of carcasses, mass of a set of shocks with a neck, mass of a head without a neck, mass of legs and mass of feather-puff raw materials [18].

Processing of the digital data on the research results was carried out by the method of variation statistics as for the reliability of differences between the compared indicators (P<0.05-0.001) using Microsoft Office Excel application software.
Table 3. Recipes of compound feeds for broiler chickens.

| Indicator                  | Start          | Compound feed | Finish       |
|----------------------------|----------------|---------------|--------------|
| Age, days                  | 0-10           | 11-24         | 25-slaughter |
| Energy, kcal/ MJ           | 3000/12.55     | 3100/12.97    | 3200/13.39   |
| Lysine, %                  | 1.44           | 1.29          | 1.19         |
| Methionine+Cystine, %      | 1.08           | 0.99          | 0.94         |
| Methionine, %              | 0.56           | 0.51          | 0.48         |
| Threonine, %               | 0.97           | 0.88          | 0.81         |
| Valin, %                   | 1.10           | 1.00          | 0.93         |
| Isoleucine, %              | 0.97           | 0.89          | 0.83         |
| Arginine, %                | 1.52           | 1.37          | 0.26         |
| Tryptophan, %              | 0.23           | 0.21          | 0.19         |
| Leucine, %                 | 1.58           | 1.42          | 1.31         |
| Raw protein, %             | 23.0           | 21.5          | 20.0         |
| Calcium, %                 | 0.96           | 0.87          | 0.81         |
| Phosphorus, %              | 0.480          | 0.435         | 0.405        |
| Magnesium, %               | 0.05-0.50      | 0.05-0.50     | 0.05-0.50    |
| Sodium, %                  | 0.16-0.23      | 0.16-0.23     | 0.16-0.23    |
| Chlor, %                   | 0.16-0.23      | 0.16-0.23     | 0.16-0.20    |
| Kalium, %                  | 0.40-1.00      | 0.40-0.90     | 0.40-0.90    |
| Copper, mg/100 g           | 16             | 16            | 16           |
| Iodine, mg/100g            | 1.25           | 1.25          | 1.25         |
| Iron, mg/100g              | 20             | 20            | 20           |
| Manganese, mg/100g         | 120            | 120           | 120          |
| Selenium, mg/100g          | 0.30           | 0.30          | 0.30         |
| Zinc, mg/100g              | 110            | 110           | 110          |

3. Results and discussion

The objectivity of the assessment of the effectiveness of the use of a biologically active substance in feeding broilers is determined not only by the increments of living mass, but also by the meat qualities of the experimental population. Data on the productivity of poultry, in connection with the use, in their cultivation, of the antioxidant additive DHQ, made it possible to analyze the meat qualities of broiler chickens as one of the criteria for the effectiveness of their cultivation. The study of the slaughter indices of the experimental number of broilers strongly indicates the positive effect of the biologically active substance (table 4).

The control slaughter of the experimental number of chickens of all groups and the subsequent anatomical cutting of carcasses made it possible to evaluate the main indicators characterizing their meat characteristics. The use of the antioxidant preparation DHQ provided a reliable increase in the weight of carcasses in the II test group by 15.41% (P < 0.01), and in the III and IV test groups, respectively, by 20.11 (P<0.01) and 38.06% (P < 0.001), relative to this indicator in control (table 3).

The obtained results indicate that there is no significant effect of the studied preparation on the mass of by-products, but there is a tendency to increase it. This most significantly affected the mass of internal organs of group IV chickens, it was 1.4 times more than the control. A similar picture was observed in the effect of the antioxidant on the yield of heads, legs and downy raw materials.
Table 4. Characteristics of killing indicators of broiler chickens.

| Characteristics                          | I control            | II experimental  | III experimental | IV experimental |
|------------------------------------------|----------------------|------------------|------------------|-----------------|
| Live mass before slaughter, g            | 3638.57±44.51        | 4072.00±56.83*** | 4181.20±58.82*** | 4831.40±54.94*** |
| Mass of rippled carcass, g               | 2340.51±100.83       | 2701.10±69.46*   | 2811.30±53.49**  | 3231.20±56.80*** |
| including weight of lungs and kidneys, g | 28.74±3.63           | 31.35±3.58       | 33.87±3.72       | 38.17±3.91       |
| Slaughter yield,%                       | 64.32                | 66.33            | 67.24            | 66.88            |
| Weight of the set of shocks with neck, g | 303.75±5.98          | 342.15±5.42**    | 347.50±5.57***   | 425.16±5.73***   |
| including liver, g                      | 79.86±2.02           | 77.37±6.99       | 80.00±2.03       | 91.31±3.05*      |
| heart, g                                | 23.00±0.75           | 24.43±0.92       | 25.09±0.81       | 28.51±1.84*      |
| muscular stomach, g                     | 97.42±1.79           | 97.88±1.56       | 99.13±0.78       | 131.41±2.37***   |
| neck, g                                 | 103.17±3.29          | 142.93±1.88***   | 143.42±1.63***   | 173.93±10.82***  |
| Head mass without neck, g               | 142.11±1.91          | 142.73±4.05      | 143.57±2.90      | 171.03±3.02***   |
| Foot weight, g                          | 200.28±2.93          | 204.12±3.40      | 216.63±2.94**    | 232.01±2.42***   |
| Feather raw materials, g                | 203.40±2.04          | 206.52±2.89      | 208.08±2.68      | 229.95±2.97***   |
| Technical waste, g                      | 448.51±2.06          | 475.39±2.12***   | 454.15±2.35      | 542.01±2.40***   |

* P<0.05, ** P<0.01, ***P<0.001.

Currently, in the poultry processing industry there are no systematic recommendations for the development of standards for the output of parts of ripped poultry carcasses of various masses entering deep industrial processing. Determination of objective characteristics of meat advantages of ripped carcasses and their anatomical parts ensures rational use and effective price policy of production. One important indicator is the poultry meat index, which is calculated by the ratio of edible and inedible parts in the carcass (figure 1).

The edible portion of the carcasses in the test groups was found to be significantly larger than their counterparts in the control group (table 1). The average content of edible parts in the carcasses of the test groups exceeded the control, respectively, of 1.1, 1.3 and 1.5 times (P<0.001). Higher content of edible parts in carcasses objectively confirms improvement of meat qualities of broiler chickens of experimental groups due to inclusion of biologically active substance in their diet.

When determining the morphological composition of the carcasses of the experimental poultry, a reliable effect of the studied preparation on the output of muscle tissue was established, the proportion of which was within 48.04-50.67% (P<0.001) of the mass of the rippled carcass, which is on average 3.23% more than in the carcasses of the chicks of the control group. The amount of skin increased accordingly to increase the weight of the carcasses themselves, and its yield turned out to be, on average, only 0.60% more than the control (table 3), and the use of the antioxidant also did not have a reliable effect on the content of adipose tissue in chicken carcasses.

Studies have shown that the higher content of muscle tissue in the carcasses of chickens of experimental groups is mainly due to the content of the most valuable pectoral muscles in the carcasses. There was a significant difference between the experimental and control groups on their output – it turned out to be more, respectively, by 0.27, 1.76 and 2.13% (P < 0.05). A similar trend is observed in
the output of the femoral muscles – by 0.75, 1.14 and 1.20%, as well as the shin muscles – by 0.69, 0.73 and 1.01% (table 3).

When assessing the meat qualities of poultry, a fairly objective and important indicator is the ratio of the mass of the most valuable part of the carcass – muscles, to the mass of the least valuable part – bones. Meat-bone index is determined as to ratio of muscle tissue mass with skin to bone mass, and part index is determined as to ratio of part mass to bone mass. The studies established the unconditional influence of the biologically active substance in the diets of broiler chickens on the value of these indicators (figure 1).

If in the poultry carcasses of the control group the meat-bone index was 3.27, then in the carcasses of chickens of the II experimental group – 3.59; III and IV groups – 3.80 or 9.59 and 16.07% more.

The calculation of the broiler carcass part indices also confirms the positive effect of the antioxidant drug on their magnitude. The keel meat index had significant differences in chicken carcasses of groups III and IV with respect to control – by 21.07 and 29.29% (P<0.001), respectively (figure 1). This objectively characterizes the best blindness of the most valuable part of the carcasses – the breast, in connection with feeding a biologically active substance. The hip meat index, on the contrary, decreased – depending on the level of DHQ feeding. The index of shin meat in the carcasses of experimental chickens also tended to decrease in the carcasses of the II, III and IV experimental groups, nevertheless it was higher than in control by 7…11% (table 3).

Data on the productivity of poultry, in connection with the use of the antioxidant additive DHQ in their cultivation, made it possible to analyze the main zootechnical indicators of the growth efficiency of broiler chickens (table 5).

At the beginning of the experience, the living mass at the daily age of broiler chickens of all groups was not different. The results obtained indicate that the inclusion of the drug ‘DHQ’ in their diet, significantly affected the difference in the live mass of chickens of experimental groups. So, at the age of 40, this indicator in the III experimental group turned out to be 16.51% more, and in the IV – by 33.56%, relative to control. The profitability of growing broilers depends on the consumption of feed per unit of increase in living weight. The minimum feed costs for the growing period were noted in chickens of the III and IV experimental groups – they turned out to be less than in the control group, respectively, by 12.87 and 23.98%.
Table 5. Effect of the drug on the efficiency of broiler chickens.

| Rates                              | I control | II experimental | III experimental | IV experimental |
|------------------------------------|-----------|----------------|------------------|-----------------|
| Adopted for cultivation, heads     | 10        | 10             | 10               | 10              |
| Growing time – 40 days             |           |                |                  |                 |
| Average live weight of daily chicken, g | 40.00     | 39.70          | 39.70            | 40.10           |
| Average live weight 1 head 40-day chicken, g | 1561.14   | 1798.78        | 1869.90          | 2349.70         |
| Feed consumption per 1 head for fattening period, g | 2945      | 2959.73        | 2967.09          | 2974.45         |
| Feed conversion for 40 days fattening, g | 1.94      | 1.68           | 1.62             | 1.29            |
| Productivity index, units          | 140.82    | 240.91         | 288.56           | 455.37          |
| Growing time – 60 days             |           |                |                  |                 |
| Average live weight 1 head 60-day chicken, g | 3638.57   | 4072.00        | 4181.20          | 4831.40         |
| Feed consumption per 1 head for fattening period, g | 6145.00   | 6175.73        | 6191.09          | 6206.45         |
| Feed conversion for 60 days fattening, g | 1.71      | 1.53           | 1.49             | 1.30            |
| Productivity index, units          | 248.25    | 399.22         | 467.70           | 619.41          |
| Safety,%                           | 70.00     | 90.00          | 100.00           | 100.00          |

The efficiency of broiler chicken production can be objectively judged by the productivity index, which reflects such important indicators as the living mass, safety and cost of feed. It is known that the average index values range from 190-210 units, from 211 to 230 units – good and over 230 units – different. In the experimental groups, it was to 399-619 units for the entire growing period, which was 150…371 units higher than the data obtained for the chicks of the control group, and the best result was noted in the broilers of the IV experimental group.

The results obtained suggest that the increase in productivity index and the decrease in feed cost per unit increase reflect the positive effect of antioxidant additive depending on the level of its introduction. Throughout the experimental period of cultivation, no cases were noted in broiler chickens of groups III and IV, while in the control group it was 30%, which allows one to indirectly judge the effect of the antioxidant on the increase in poultry resistance.

4. Conclusion

Complex researches on studying influence of antioxidant Dihydroquercetin feed additive on growth and meat efficiency of broilers are for the first time conducted. Influence of different levels of introduction of the preparation into diets of experimental poultry on its meat qualities is studied. New experimental data have been obtained, which expand scientific knowledge on the positive effect of DHQ on the economically useful features of agricultural poultry, due to corrective effect on metabolic processes, better use of nutrients of fodders and increased resistance. The obtained data are of great scientific importance, relevant and can be applied to the development of the agricultural sector not only in Russia, but also around the world.

Studies suggest that the most effective growth of broiler chickens of groups III-IV was found, and the best result was noted in the group of birds receiving 1 g of DHQ per 100 g of feed, which makes it possible to consider this level optimal. It has been found that longer cultivation (up to 60 days of age)
indicates its impracticability and even using the preparation DHQ, due to the unprofitability of its further use, and the low cost recovery for the purchase of the additive.

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