Efficiency of protein-rich plant and animal additives in feeding broiler chickens

B T Abilov, A P Marynich, A V Boldareva and S A Nechaev
North Caucasus Federal Scientific Agrarian Center, Moscow, Russia
E-mail: marap61@yandex.ru

Abstract. Recently, there has been a need to find new ways to intensify the poultry industry thus maximizing the net yield. The inclusion of such protein-rich feed additives as maize gluten and Organic in the diet of broiler chickens in the amount of 3 % of mixed feed weight both separately and in the mixture increased the body weight gain by 8.8–19.2 %, survival rate – by 3.3 %, feed efficiency – by 0.23–0.26 of energy feed units or by 9.1–9.8 %, productivity index (European Production Efficacy Factor) – by 47.9–91.7 units or 35.5–36.7 %. Besides, their meat quality was improved: the content of dry matter, protein, fat and ash increased by 8.44–8.54 %; 1.56–1.6 %; 0.89–0.98 %; 0.16–0.2 %. The total tasting score of pectoral muscles increased by 5.8–6.3 %. Additional profit per head increased by 7.94–19.65 rubles, the level of profitability of broiler chicken cultivation increased by 5.37–13.14 %.

1. Introduction
The development of new domestic agents, which would replace fodder antibiotics prohibited for use is extremely important for poultry farming [1–3]. The introduction of new growing technologies and agents is currently the main factor that increases the efficiency of poultry meat production and reduces the costs of poultry enterprises [4, 5]. In order to achieve high economic results, as well as the full disclosure of genetic potential in poultry, it is necessary to ensure its good level of feeding, compliance with all veterinary and sanitary measures and introduction of scientifically sound programs for the use of effective feeding agents [6, 7].

For modern crossing poultry with high genetic features, it is necessary to use high-quality raw materials for the production of fodder mixtures, as well as careful balancing of diets according to the complex of nutrient and biologically active substances [8].

Fodder is the main source of biologically active substances that serve for the formation of enzymes, hormones, RNA, DNA biomolecules, as well as other structurally functional elements in the poultry body [9]. But in practice, the natural components of the feed mixture are not balanced due to insufficient amount of essential nutrients in the required ratios and amounts [10, 11].

Therefore, various additives of biologically active substances of natural, similar to natural, synthetic origin are used to correct diets. Such additives are vitamins, amino acids, probiotics, prebiotics, minerals, antioxidants and others [12]. In this regard, the use of secondary raw materials of processing industries of dairy and starch production of agribusiness, wastes of oil extraction and food industry, which determined the purpose of our study, seem ever more relevant.
2. Problem statement

The use of antibiotics in poultry farming leads to drug resistance of microorganisms, as well as their accumulation in eggs and meat, and thus has a negative impact on the human body, especially children. Due to the growing demand of consumers for safe environmentally friendly products in EU countries, the use of antibiotics was prohibited to stimulate the growth of farm animals and birds [13]. Therefore, it became necessary to find new ways to intensify the industry thus obtaining the maximum net yield taking into account the ecology [14]. The purpose of this study was to determine the feasibility and efficiency of using domestic protein-rich feed additives from maize gluten and Organic, being secondary raw materials of agribusiness industries, in the feeding of broiler chickens.

3. Materials and methods

Scientific and production experiment was conducted in the conditions of SP Azamat in Kabardino-Balkar Republic. The object of the study was Kobb-500 crossing broiler chickens.

Eight groups were formed for the scientific and production experiment following the principle of pair-analogues of 30 heads to determine the optimal doses of fodder additives: I – control, II – experimental (1 % gluten was added to complete feed – prestarter ration (CF)), III – experimental (CF with 3 % gluten), IV – experimental (CF with 5 % gluten), V – experimental (CF with 1 % Organic), VI – experimental (CF with 3 % Organic), and VII – experimental (CF with 5 % Organic) and VIII – experimental (CF with 3 % gluten and 3 % Organic).

At the age of 1–2 days (equalizing period), the broiler chickens of all groups received complete feed – prestarter ration (CF). Starting from the age of 3 days until the end of growth, the protein-rich additives were added in different percentages to the representatives of experimental groups.

During the experiment the broiler chickens of all groups received three-phase feeding according to the recommendations of the All-Russian Research and Technological Institute of Poultry Farming: first phase – 1–14 days, second phase – 15–28 days, third phase – 29–42 days [15]. The household diet was used for feeding chickens of experimental and control groups. Besides, the poultry of all groups additionally received Bacell probiotic additive in the amount of 0.2 %.

Plant-based feed was the basis of the combined feed. According to the recommendations for this crossing, the feeding was normalized with free access to water.

According to the approved plan, which was adopted at the poultry farm, all veterinary and preventive measures were performed.

During the scientific and industrial experiment, all physiological studies were carried out according to the standard practice. From the age of 1 day the body weight was recorded weekly throughout the whole growing period, at the same time the weighing of stock was done individually.

The safety of broiler chickens of control and experimental groups was taken into account by counting the dead population indicating the reasons for disposal.

The consumption of the combined feed was taken into account weekly by weighing the given feed at each delivery and taking into account the feed residues.

For the hematological study of blood indices, the samples were taken from the axillary vein – 5 samples from each group. Protein, glucose, erythrocytes, leukocytes, hemoglobin, calcium, phosphorus, magnesium, etc. were determined in blood and serum.

The control slaughter of broiler chickens was carried out according to GOST 18292–85 [16, 17]. During slaughter the anatomic cutting of carcasses and accounting of such indicators as preslaughter body weight, carcass weight, carcass yield, yield of edible and inedible parts was made, the boning of carcass parts was also carried out and the weight of meat and bones were measured [8]. In order to carry out laboratory studies and determine the presence of antibiotics, the samples of white and red meat were taken.

Dry maize gluten (TU 9189-002-00343579-99) is a by-product of starch industry and represents a corn protein containing a large amount of highly digestible amino acids and other important components (beta-carotene, xanthophyl, minerals and water-soluble vitamins). It includes proteins, fats and fiber. Maize gluten is a protein supplement to carbohydrate-rich animal and poultry feed, but
it is not balanced in terms of limiting amino acids (arginine, lysine and tryptophan), so cannot be the only feed. In terms of its exchange energy gluten is the second after fat and contains 10.4 % moisture, 54.1–62.0 % protein, 5.0 % fat, 11.5 % fiber, 12.3 % nitrogen-free extractive substances. The availability of its limiting amino acids is higher by 3.2–7.5 % compared to corn and by 7.6–10.1 % relative to soybean.

Maize gluten is being currently widely introduced into the production of combined feed and concentrates for poultry animals. It is used as a fodder additive in pig feeding in the amount of up to 15 %, cattle (up to 20 %), as well as meat and laying poultry.

Organic is a homogeneous mixture of protein-rich agent containing up to 90 % crude protein, which is enriched with vitamins, amino acid complex and microelements. Organic is a valuable source of organic protein for enriching animal and poultry diets that is ground to the required fraction and does not contain genetically modified organisms. It is a monocomponent product of organic origin, which was obtained by extruding chromium wastes of leather production (cutting, velour, chevrette, flap obtained from sheep, goat, pork skins, as well as horsehide). It contains the optimal amount of all amino acids, and the content of raw protein is not less than 83 %.

Organic is used to improve digestive processes and the gastrointestinal tract, which leads to increased transportability and absorption of feed nutrients, and increases the natural resistance of animal and bird bodies.

Bacell is a fodder probiotic supplement containing the spore-forming bacteria Bacillus subtilis 945 (B-5225), acidophilic bacteria Lactobacillus acidophilus L917 (B-4625). Ruminococcus albus 37 (B-4292) promotes the production of biologically active substances in the animal and poultry body, enzymes that provide cleavage of cellulose and intermediate products of its hydrolysis, as well as improve transportability and absorption of nutrients and prevents the development of opportunistic pathogenic microflora. It is used to activate digestive processes, improve gastrointestinal tract activity, as well as to normalize metabolic processes in the body, which strengthens the nonspecific immunity reaction, increases productivity, preserves animals and birds and increases the accessibility of complete feed.

The probiotic additive Bacell includes sunflower extraction cake, beet molasses, skimmed milk and water. The content of bacteria of each species in 1 g of probiotic additive is not less than $1 \times 10^8$ CFU. The strains are isolated from natural sources and have not undergone genetic transformation.

4. Results and Discussion

The use of maize gluten and Organic in protein–rich feed additives in broiler chicken diets in the amount of 3 % of the weight of complete feed both alone and in a mixture contributed to the increase of the body weight gains (Table 1).

By the end of the growing period, the body weight was higher in broiler chickens of the III, VI and VIII experimental groups compared to the control group analogues with the difference making 8.7 %, 15.9 and 18.9 %, respectively. The obtained pattern was also obtained for the body weight gain – by 8.8 %, 15.2 and 19.2 %, respectively. The best safety indicators were observed in broiler chickens of the II, III, V, VI, VIII experimental groups and amounted to 100 %.

Broiler chickens fed with 3 % Organic and a mixture of 3 % gluten with 3 % Organic gave the best food return. Feed consumption per 1 kg of the body weight gain in the VI and VIII experimental group compared to the control group analogues decreased by 0.23 and 0.26 energy feed units (EFU) or by 8.7 and 9.8 %.

The production index (European Production Efficacy Factor) in broiler chickens of the VI and VIII experimental groups compared to the analogues of the control group was higher by 35.5 and 36.7 % and amounted to 340.1 and 343.0 units, which corresponds to the index of the best enterprises in Russia.

The feeding of Kobb-500 broiler chickens with protein–rich feed supplements in different proportions had a positive effect on the chemical composition of poultry’s pectoral muscles (Table 2). The largest amount of dry matter in meat was in the VI and VIII experimental group, and compared to the control group analogues the difference was 8.44 % and 8.54 %, respectively.
Table 1. Body weight gain, feed consumption per 1 kg of gain and productivity index (European Production Efficacy Factor) for Kobb-500 crossing broiler chickens

| Indicator | I | II | III | IV | V | VI | VII | VIII |
|-----------|---|----|-----|----|---|----|------|------|
| Safety, % | 96.70 | 100.0 | 100.0 | 93.33 | 100.0 | 100.0 | 93.33 | 100.0 |
| Body weight of 1 head, g: | | | | | | | | |
| at the beginning of the experiment | 45.4±0.10 | 45.0±0.10 | 45.2±0.10 | 45.2±0.10 | 44.9±0.10 | 45.4±0.10 | 45.0±0.10 | 45.3±0.10 |
| at the end of the experiment | 2901.4±19.1 | 3153.2±4.63*** | 3027.2±4.63*** | 3068.9±3363.4±1.56*** | 3069.0±3.07*** | 3027.2±6.87*** | 3153.2±6.77*** | 3027.2±6.87*** |
| in % to control | 100.0 | 102.9 | 108.7 | 104.3 | 105.8 | 115.9 | 105.8 | 118.9 |
| Body weight gain, g: | | | | | | | | |
| absolute average daily | 2856±16.62 | 2940±3.27*** | 3108±70±0.07*** | 3108±74±0.07*** | 3108±72±0.07*** | 3108±72±0.07*** | 3108±74±0.07*** | 3108±72±0.07*** |
| in % to control | 100.0 | 102.9 | 108.7 | 104.3 | 105.8 | 115.9 | 105.8 | 118.9 |
| Feed consumption per 1 head, kg: | | | | | | | | |
| throughout the experiment | 7.57±0.02 | 7.49±0.01*** | 8.01±0.06*** | 8.01±0.06*** | 7.51±0.01*** | 7.51±0.01*** | 7.51±0.01*** | 7.51±0.01*** |
| per 1 kg of gain | 2.65±0.02 | 2.56±0.01*** | 2.58±0.01*** | 2.52±0.01*** | 2.50±0.01*** | 2.41±0.01*** | 2.49±0.01*** | 2.39±0.01*** |
| in % to control | 100.0 | 102.9 | 108.7 | 104.3 | 105.8 | 115.9 | 105.8 | 118.9 |
| European Production Efficacy Factor | 252.1 | 277.6 | 300.0 | 266.9 | 292.3 | 332.3 | 273.9 | 343.8 |

*P≤0.05; **P≤0.01; ***P≤0.001

Table 2. Chemical composition of pectoral muscles of Kobb-500 crossing broiler chickens, %

| Group | Indicator | Water | Dry matter | Protein | Fat | Ash |
|-------|-----------|-------|------------|---------|-----|-----|
| I–control | 79.42±0.07 | 20.50±0.07 | 22.24±0.08 | 2.64±0.05 | 1.06±0.02 |
| II–experimental | 74.38±0.15*** | 26.26±0.19*** | 23.40±0.06*** | 1.92±0.06*** | 1.04±0.02 |
| III–experimental | 75.32±0.09*** | 26.80±0.14*** | 23.42±0.08*** | 2.00±0.05*** | 1.06±0.02 |
| IV–experimental | 72.92±0.04*** | 27.10±0.09*** | 23.60±0.05*** | 2.00±0.04*** | 1.10±0.03 |
| V–experimental | 73.80±0.01*** | 26.10±0.15*** | 23.68±0.04*** | 1.98±0.06*** | 1.18±0.02*** |
| VI–experimental | 71.00±0.07*** | 28.94±0.05*** | 23.80±0.05*** | 2.33±0.04*** | 1.22±0.04*** |
| VII–experimental | 73.00±0.07*** | 27.14±0.09*** | 23.44±0.04*** | 2.02±0.06*** | 1.12±0.04*** |
| VIII–experimental | 70.94±0.05*** | 29.04±0.05*** | 23.84±0.07*** | 2.42±0.04*** | 1.26±0.02*** |

*P≤0.05; **P≤0.01; ***P≤0.001

The use of such protein-ich feed supplements as maize gluten and *Organic* in different percentages when feeding broiler chickens also contributed to increased protein, fat and ash content in the meat of the experimental poultry thus confirming its higher quality. Thus, in terms of protein, fat and ash content, the best results were obtained in the VI and VIII experimental groups, where compared to chickens of the control group the difference in these indicators was respectively 1.56 and 1.60 %; 0.89 and 0.98 %; 0.16 and 0.20 %. The broiler chickens of other experimental groups also showed the increase in these indicators, but the difference was not reliable.

Thus, the inclusion of protein-rich maize gluten and *Organic* in the ration of experimental broiler chickens in the amount of 3 % of the feed weight improved their meat quality.

In order to evaluate the meat qualities of the experimental poultry, the taste of broiler chicken meat was assessed. The use of maize gluten and *Organic* in the feeding of experimental chickens also affected the taste qualities of meat. Analyzing the data in Table 3, it can be noted that the best tasting...
assessment of meat was obtained for chicken of the VI and VIII experimental groups. Thus, the taste assessment of pectoral muscles of these groups was 19.40 and 19.50 points, which is 5.8 and 6.3 %, respectively, more than this indicator for control group carcasses.

Table 3. Tasting assessment of Kobb-500 crossing broiler chicken meat

| Group          | Pectoral muscles | Indicator   | Flavor | Juiciness | Tenderness | Total score |
|----------------|------------------|-------------|--------|-----------|------------|-------------|
| I–control      | 4.66±0.05        | 4.52±0.04   | 4.62±0.04 | 18.34±0.09 |
| II–experimental| 4.68±0.07        | 4.74±0.02** | 19.00±0.06** |
| III–experimental| 4.76±0.05        | 4.74±0.02*** | 19.02±0.06*** |
| IV–experimental| 4.76±0.02**      | 4.62±0.04   | 18.66±0.10* |
| V–experimental | 4.76±0.05        | 4.74±0.02***| 19.40±0.07*** |
| VI–experimental| 4.84±0.02***     | 4.80±0.02** | 19.24±0.10*** |
| VII–experimental| 4.80±0.04**      | 4.80±0.03***| 19.50±0.04*** |
| VIII–experimental| 4.86±0.02**     | 4.85±0.03***| 19.50±0.04*** |

*Р≤0.05; **Р≤0.01; ***Р≤0.001

Consequently, the inclusion of protein-rich gluten and Organic in the diet had a positive effect on the chemical composition of Kobb-500 crossing chicken broiler meat.

Some economic calculations were made to determine the cost efficiency as well as the feasibility of using protein–rich maize gluten and Organic feed supplements in broiler chicken feeding (Table 4).

Table 4. Efficiency of growing broiler chickens using protein–rich feed additives during industrial check of the best groups

| Indicator                  | Group          | I–control | II–experimental | III–experimental | IV–experimental |
|----------------------------|----------------|-----------|-----------------|------------------|-----------------|
| Body weight upon sale, kg  | 3 % gluten     | 2.90      | 3.15            | 3.37             | 3.40            |
| Operating costs for growing of 1 head, rub | 3 % Organic | 183.57 | 191.47 | 193.67 | 197.07 |
| Including feed, rub  | 68.2            | 76.1      | 82.0            | 82.0             | 82.0            |
| Net cost of 1 kg of gain, rub | 63.3    | 60.78     | 78.3            | 78.3             | 78.3            |
| Selling price of 1 kg, rub | 82.0           | 82.0      | 82.0            | 82.0             | 82.0            |
| Revenue, rub/kg | 18.7           | 21.22     | 24.53           | 24.04            | 24.04           |
| Additional profit: | –                | 2.52      | 5.83            | 5.34             | 5.34            |
| rub/kg  | –                | 7.94      | 19.65           | 18.16            | 18.16           |
| rub/head | –                | 7.94      | 19.65           | 18.16            | 18.16           |
| Level of profitability, % | 29.54          | 34.91     | 42.68           | 41.48            | 41.48           |

The production test data (Table 4) show that at the same sales price in the II experimental group the revenue per 1 head was higher than in the control group by 20.5 rubles, in the III experimental group – by 38.54 rubles and in the IV experimental group – by 41.0 rubles. With a slight reduction in the cost of the body weight gain, more additional profit per head compared to the control group was obtained in the II experimental group – by 7.94 rubles, III experimental group – by 19.65 rubles, IV experimental group – by 18.16 rubles, the level of profitability of growing broiler chickens increased by 5.37, 13.14 and 11.94 % respectively.

5. Conclusion

Thus, in order to increase productivity, safety, receive higher quality products and enhance growing profitability, it is recommended to use protein–rich maize gluten and Organic feed additives in feeding broiler chickens by adding them to the basic diet in the amount of 3 % gluten, 3 % Organic and 3 % maize gluten with 3 % Organic.
References

[1] Trukhachev V I, Epimakhova E E, Rastovarov E I and Ivashova V A 2019 Research on consumer commitment to organic Food in southern Russia Int. J. of Civil Engineer. and Technol. 10(3) 2766–74

[2] Skvortsova L N, Koshchaev A G, Shcherbatov V I et al 2018 The use of probiotics for improving the biological potential of broiler chickens Int. J. of Pharmaceut. Res. 10(4) 760

[3] Pogodaev Vladimir, Shcherbatov Vyacheslav, Slepuhin Vasily et al 2019 Meat productivity of turkeys by using biogenic stimulants Indoo americ. J. of Pharmaceut. Sci. 06(03) 6867–72

[4] Osheychik E A, Lukashenko V S and Saleeva I P 2018 The effects of preparation polyferon for the productive performance and meat quality in broilers The XV European Poultry Conference Conf. Inform. and Proc. (World's Poultry Science Association, Croatian Branch) p 496

[5] Saleeva I P, Lukashenko V S, Koshchaev A G et al 2018 Quality of broiler chicken meat with the use of various methods of growing J. of Pharmaceut. Sci. and Res. 10(11) 2979–84

[6] Ismailova D Y, Volik V G, Lukashenko V S et al 2019 Proteomic protein research in the samples of poultry grown under different conditions Res. J. of Pharmaceut., Biol. and Chem. Sci. 10(1) 2055–62

[7] Yang Z, Pirgozliev V R, Rose S P et al 2020 Effect of age on the relationship between metabolizable energy and digestible energy for broiler chickens Poult. Sci. 99(1) 320–30

[8] Pogodaev V A, Froliko S V, Marynich A P et al 2016 The Effectiveness of Growing Different Hybrids Turkeys Res. J. of Pharmaceut., Biol. and Chem. Sci. 7(4) 1349–52

[9] Shang H M, Zhao J C, Guo Y et al 2020 Effects of supplementing feed with fermentation concentrate of Hericium caput–medusae (Bull.:Fr.) Pers. on cholesterol deposition in broiler chickens Livestock Sci. 235 104009

[10] Andrées Massuquetto, Josiane C Panisson, Francielle O Marx et al 2019 Effect of pelleting and different feeding programs on growth performance, carcass yield, and nutrient digestibility in broiler chickens Poult. Sci. 98(111) 5497–503

[11] Ashayerizadeh A., Dastar B., Shams Shargh M et al 2018 Effects of feeding fermented rapeseed meal on growth performance, gastrointestinal microflora population, blood metabolites, meat quality, and lipid metabolism in broiler chickens Livestock Sci. 216 183–90

[12] Kiczorowska Bożena, Samolińska Wioletta, Al–Yasiry Ali and Zając Malwina 2020 Immunomodulant feed supplement Boswelia serrata to support broiler chickens' health and technological diet Quality Poult. Sci. 99(2) 1052–61

[13] Elmi Vahid Atabaigi, Moradi Soudabeh, Ghazi Shahab and Rahimi Morad 2020 Effects of Lactobacillus acidophilus and natural antibacterials on growth performance and Salmonella colonization in broiler chickens challenged with Salmonella enteritidis Livestock Sci. 233 103948

[14] Shang H M, Zhao J C, Guo Y et al 2020 Effects of supplementing feed with fermentation concentrate of Hericium caput–medusae (Bull.:Fr.) Pers. on cholesterol deposition in broiler chickens Livestock Sci. 235 104009

[15] Trukhachev V I, Epimakhova E E and Vrana A V 2016 Implementation of the genetic potential of young stock hens of cross–country “Ross–308” with optimized feeding program Research J. of Pharmaceut., Biol. and Chem. Sci. 7(3) 2318–22

[16] Saleeva I.P., Epimakhova E.E., Morozov V.Yu et al 2018 A method for improvement of the productivity in thermal stressed broiler chickens The XV European Poultry Conference Conf. Inform. and Proc. (World's Poultry Science Association, Croatian Branch) 548 p

[17] Epimakhova E E, Samokish N V and Barsukova M G 2018 Effect bio–destructor of litter on broiler productivity Res. J. of Pharmaceut., Biol. and Chem. Sci. 9(6) 1774–8