The productive performance in broilers fed diets supplemented with new animal-derived protein additives

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Abstract. The efficiency of new dietary protein additives based on the wastes and by-products of the slaughter and primary processing of poultry was studied on four treatments of broilers (cross “Smena-8”, 1-38 days of age; 3 replicates per treatment, 35 birds per replicate) reared in similar conditions of management and nutrition. Control treatment 1 was fed vegetable diets without animal-derived ingredients; control treatment 2 was fed diets supplemented with fishmeal; in diets for treatments 3 and 4 fishmeal was substituted by two new protein additives produced by the fermentation of the preliminary hydrolyzed slaughter wastes (feathers, intestines, blood, meat-bone residues, etc.) by proteolytic enzymes in different conditions (2 hours at 55°C for treatment 3; 1.5 minutes at 160°C for treatment 4). The best productive performance in broilers was found in treatment 3: average live bodyweight at 38 days of age in this treatment was significantly higher by 8.47% in compare to control and by 4.57% in compare to treatment 2 (p≤0.05); feed conversion ratio was lower by 2.96 and 1.80%, respectively. In treatment 4 these parameters were slightly worse in compare to treatment 3 though better than in treatments 1 and 2. Treatments 3 and 4 also featured higher meat yield and better sensory characteristics of cooked meat and broth.

1. Introduction

The utilization of the wastes and by-products of the slaughter and primary processing of poultry is an important problem with economical and social background [1, 2].

At present up to 80% of these wastes does not find any effective utilization despite the fact that almost all large poultry farms have their own feed producing facilities. The use of the wastes in diets for broilers can solve the problem of the utilization with concurrent saving on the purchases of the expensive dietary protein ingredients.

The wastes of the slaughter (feathers, intestines, blood, meat-bone residues, etc.) after an appropriate processing can be an effective protein source in poultry diets. However, at present the wastes (at the best case) are undergoing long and severe thermal treatment in the boilers resulting in low-quality protein-containing products due to the intense denaturation of the native proteins [3]. Meanwhile, the shortage of high-protein ingredients for poultry diets is a well-known factor limiting the growth of poultry production [4].

High growth efficiency in broilers can be achieved only with the supplementation of the diets with animal-derived protein ingredients rich in the valuable and essential amino acids. The deficiencies of these amino acids (e.g. lysine and methionine) in compound feeds produced on-farm by Russian
poultry producers are frequently alleviated by the supplementation of the diets with the synthetic forms of the acids thereby increasing the resulting production costs [5]. There is a perception that broilers can be effectively reared on low-protein diets; we consider this opinion a misconception. Low-protein diets for broilers and other growing poultry is known to decrease the efficiency of growth and development, to deteriorate feed conversion ratios (FCR), to decrease the resistibility to many diseases. Furthermore, the digestibility and effectiveness of animal-derived dietary protein is substantially higher in compare to vegetable protein sources.

The most effective (and hence the most popular) source of dietary animal-derived protein for poultry is fishmeal. However, the fishmeal of high quality is an increasingly expensive ingredient and the feedmills purchasing fishmeal “at the reasonable prices” are presently encountering the high risk of the purchasing of counterfeited product with poor nutritive characteristics [6]. Therefore, the search for the alternative sources of animal-derived protein rich in the essential amino acids is an actual problem of poultry nutrition.

We had developed a prospective technology of easily digestible protein additives for poultry based on the two-stage hydrolysis of the slaughter wastes combining short-term thermal hydrolysis and subsequent fermentation by proteolytic enzymes [7]. This technology allows for the preservation of ca. 85% of the initial amount of essential amino acids within the wastes; other advantages include low energy expenses for the production and high resulting digestibility of the protein in poultry (up to 92-93%). The use of the processed wastes in the on-farm production of the compounds feeds for broilers will increase the profitability of broiler production and the competitiveness of the farms.

Earlier we have examined the efficiency of dietary protein ingredients for broilers produced by the two-stage hydrolysis of different keratin- and collagen-containing poultry wastes and obtained the promising results [8].

In accordance with the foregoing, the aim of the study presented was the assessment of the efficiency of new waste-based ingredients produced with different processing regimes as the protein sources in diets for broilers.

2. Materials and methods
The trial was performed at the Center for Genetics & Selection “Zagorskoye EPH” (branch of the Federal Scientific Center “All-Russian Research and Technological Institute of Poultry” of Russian Academy of Sciences) on four treatments of broilers (cross “Smena-8”, 1-38 days of age; 3 replicates per treatment, 35 birds per replicate) reared in similar conditions of management (floor housing on sawdust) and nutrition according to 4 phases of growth.

Control treatment 1 was fed vegetable diets without animal-derived ingredients; control treatment 2 was fed diets supplemented with fishmeal; in diets for treatments 3 and 4 fishmeal was substituted by two new protein additives produced by the fermentation of the preliminary hydrolyzed slaughter wastes (feathers, intestines, blood, meat-bone residues, etc.) by proteolytic enzymes in different conditions (2 hours at 55°C for treatment 3; 1.5 minutes at 160°C for treatment 4).

The productive performance, part yields, and sensory characteristics of cooked meat and broth (determined by the taste panel test) in broilers were assessed at the slaughter age. The results were statistically analyzed using paired Student’s t-test.

3. Research results
The productive performance in broilers at slaughter (38 days of age) is presented in table 1. Mortality in all four treatments was 0%. The growth and feed efficiency in control treatment 1 (fed only vegetable protein ingredients) was substantially lower than in other treatments fed animal-derived protein sources. This fact supports our theory that animal protein sources are necessary for broilers since these can provide better supply of the essential amino acids indispensable for body growth, biosynthesis of enzymes, antibodies, certain hormones and other substances important for the metabolism and protective reactions.
Comparison of the productive performance at 38 days of age in control treatments 1 and 2 evidenced the predominance of the latter: average live bodyweight (ALBW), average daily weight gains (ADWG), eviscerated carcass weight, dressing percentage, and percentage of high-grade carcasses were higher in treatment 2 by 3.74; 3.47; 4.0; 0.5 and 6%, respectively, while FCR was lower by 1.20%.

Table 1. The productive performance in broilers at 38 days of age.

| Parameter                  | Treatments (protein source) |     |     |     |     |
|----------------------------|-----------------------------|-----|-----|-----|-----|
|                            | 1 (vegetable)               | 2 (fishmeal) | 3 (long fermentation) | 4 (short fermentation) |
| ALBW, g                    | 2010±31.2                   | 2076±34.2 | 2180±31.3\(^a\) | 2141±30.4\(^a\) |
| in males, g                | 2134±31.2                   | 2227±37.1 | 2308±29.5\(^a\) | 2295±23.3\(^a\) |
| in females, g              | 1878±30.6                   | 1934±27.5 | 2044±30.7\(^ab\) | 1995±21.7\(^a\) |
| Arithmetic mean of males and females, g | 2006                   | 2081               | 2176               | 2145               |
| ALBW, % to treatment 1     | -                           | +3.74              | +8.47              | +6.93              |
| ALBW, % to treatment 2     | -3.60                       | -                  | +4.57              | +3.08              |
| ADWG, g                    | 51.8                        | 53.6               | 56.3               | 55.3               |
| Mortality, %               | 0                           | 0                  | 0                  | 0                  |
| FCR, kg/kg                 | 1.69                        | 1.67               | 1.64               | 1.65               |
| Eviscerated carcass weight, g | 1449±22.50              | 1507±24.83         | 1607±23.07         | 1571±22.31         |
| Dressing percentage        | 72.1                        | 72.6               | 73.7               | 73.4               |
| Carcass categories, %:     |                             |                    |                    |                    |
| high grade                 | 77.0                        | 83.0               | 88.0               | 86.0               |
| middle grade               | 23.0                        | 17.0               | 12.0               | 14.0               |

\(^a\) - difference with control treatment 1 is significant at \(p \leq 0.05\)

\(^b\) - difference with control treatment 2 is significant at \(p \leq 0.05\)

All parameters of the productive performance in treatments 3 and 4 were better in compare to control treatments 1 and 2. The productive performance in treatment 4 was slightly worse in compare to treatment 3 though substantially better than in treatments 1 and 2.

ADWG in treatment 3 was higher in compare to treatment 1 (only vegetable protein) by 8.69%; dressing percentage by 1.6%; eviscerated carcass weight by higher by 158 g or 10.90%; the percentage of high-grade carcasses higher by 11%; FCR was lower by 2.96%.

ADWG in treatment 3 was higher in compare to treatment 2 (fishmeal) by 5.04%; dressing percentage by 1.1%; eviscerated carcass weight by 6.6%; the percentage of high-grade carcasses higher by 5%; FCR was lower by 1.80%.

ADWG in treatment 4 was higher in compare to treatment 1 (only vegetable protein) by 6.76%; dressing percentage by 1.3%; eviscerated carcass weight by 8.42%; the percentage of high-grade carcasses higher by 9%; FCR was lower by 2.37%.

ADWG in treatment 4 was higher in compare to treatment 2 (fishmeal) by 3.17%; dressing percentage by 0.8%; eviscerated carcass weight by 4.25%; the percentage of high-grade carcasses higher by 3%; FCR was lower by 1.20%.

Part yields in the carcasses of broilers at 38 days of age are presented in table 2. No significant differences between the treatments were found. However, the yield of muscles in treatments 3 and 4 was higher by 1.9 and 1.5%, respectively, in compare to control treatment 1 and higher by 1.7 and 1.3% in compare to control treatment 2.

Higher muscle yields in treatment 3 and 4 resulted in higher percentage of edible parts in the carcasses: by 1.6 and 1.4%, respectively, in compare to control treatment 1 and by 1.0 and 0.8% in
compared to control treatment 2. The highest ratio of edible parts to inedible was found in treatment 3 (3.88); the lowest (3.52) in control treatment 1 fed vegetable diets.

**Table 2.** Part yields in broiler carcasses at 38 days of age, % to eviscerated carcass weight.

| Parameter                     | Treatment 1 (vegetable) | Treatment 2 (fishmeal) | Treatment 3 (long fermentation) | Treatment 4 (short fermentation) |
|-------------------------------|-------------------------|------------------------|---------------------------------|----------------------------------|
| Total yield of edible parts   | 77.9                    | 78.5                   | 79.5                            | 79.3                             |
| Yield of muscles              | 62.1                    | 62.3                   | 64.0                            | 63.6                             |
| Yield of skin                 | 14.5                    | 15.1                   | 14.2                            | 14.5                             |
| Yield of internal fat         | 1.3                     | 1.1                    | 1.3                             | 1.2                              |
| Total yield of inedible parts | 22.1                    | 21.5                   | 20.5                            | 20.7                             |
| Ratio of edible parts to inedible | 3.52                  | 3.65                   | 3.88                            | 3.83                             |

The averaged sensory characteristics of cooked meat and broth (in 5-score system) determined by the taste panel test are presented in table 3. The assessment of meat involved scores for aroma, taste, texture, and juiciness; broth was assessed for aroma, taste, transparency, and richness.

**Table 3.** The averaged sensory characteristics of meat and broth (5-score system).

| Treatment                          | Cooked meat | Broth |
|------------------------------------|-------------|-------|
|                                    | breast      | thigh |       |
| 1(vegetable)                       | 4.50±0.29   | 4.43±0.13 | 4.55±0.18 |
| 2 (fishmeal)                       | 4.63±0.24   | 4.63±0.24 | 4.50±0.29 |
| 3 (long fermentation)              | 4.88±0.13   | 4.75±0.14 | 4.63±0.24 |
| 4 (short fermentation)             | 5.00±0.00   | 4.63±0.24 | 4.75±0.14 |

No significant differences between the averaged scores were found. Products from treatments 3 and 4 (fed new protein additives) featured higher taste scores in compare to other treatments; no specific and/or unpleasant aftertastes and off-flavors in these products were found.

**4. Conclusion**

The best productive performance, meat yield, and sensory characteristics of cooked meat and broth were found in broilers of treatment 3 fed diets supplemented with a new protein additive produced by the fermentation of the preliminary hydrolyzed slaughter wastes (feathers, intestines, blood, meat-bone residues, etc.) by proteolytic enzymes during 2 hours at 55°C. The results in treatment 4 fed diets supplemented with another additive produced under other conditions (1.5 minutes at 160°C) were also higher in compare to control treatments.

The conclusion was made that the supplementation of diets for broilers with new easily digestible protein additives derived from the hydrolyzed wastes of slaughter and processing of poultry will allow for the saving on the expensive fishmeal; for improvement of the productive performance, meat yield and quality in broilers; and will help in the solving of the problem of utilization of slaughterhouse wastes on poultry farms.
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