Effect of the extrusion process on the amino acid components profile of the broilers diet

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Abstract. The paper presents the studies results of the extrusion process effect on changes in the amino acid profile of the diet components for broilers. The amino acid composition of wheat bran was higher in all indicators relative to corn, so there was a predominance in the content of arginine by 77.5 %, lysine-62 %, valine-61.8 %, threonine-53.6 %, glycine-68.5 %, phenylalanine -52.9 %, threonine-53.6 % (p≤0.001), histidine – 60.5 % (p≤0.01). The extrusion of wheat bran led to a quantitative decrease in amino acids, there was a decrease in histidine by -28.95 %, valine -20 %, serine – 17.81 %, lysine-16 %, proline-14.9 %, threonine-10.72 %. At the same time, there was an increase in the concentration of amino acids in corn after extrusion relative to the native form, which was for arginine -80%, histidine -33%, proline-13%, alanine-11%. The concentration of tyrosine, on the contrary, decreased by 20%. At the same time, the extrusion process retained the predominance of the amino acid composition of wheat bran over corn for all the amino acids considered, except methionine.

1. Introduction

Today, the extrusion process is a well-established method that is actively used for the production of pharmaceuticals, feed and food products. However, the greatest interest in the extrusion process has emerged in the last few years. According to the resource data Pab.Med.gov the number of publications has tripled, this is due to the in-depth study of mechanical and chemical transformations in raw materials [1, 2].

Understanding the chemical reactions that occur during the processing is of great importance in the development of extruded products. Carbohydrate complex conversion and protein denaturation are the predominant extrusion reactions. However, proteins, starches, and non-starch polysaccharides can fragment to form new reactive compounds not found in nature [3].

Despite the fact that extrusion helps to unlock the potential of traditional raw material components, remove anti-nutritional factors such as protease inhibitors, damage to amino acids and breakage of intermolecular bonds can occur in the process [4].

Depending on the selected initial components for extrusion and the parameters of its performance, structural transformations in the final product can go both for the better and for the worse [5].

Wheat bran, due to its endosperm, is characterized by a high content of protein and dietary fiber, and it is a promising raw material for the production of feed [6]. However, the presence of large amounts of fiber limits their use in the diets of birds. Corn is the most popular and expensive component in the...
preparation of diets. Thus, the present work focuses on the study of the effect of high-temperature short-term processing in a single-screw extruder on the change in the amino acid profile of wheat bran and feed corn.

2. Materials and methods

2.1. Object of research
Wheat bran, corn.

2.2. Experiment scheme
The study was conducted in the conditions of the Center for Collective Use of the Federal Research Center of Biological Systems and Agrotechnologies of the Russian Academy of Sciences.

The parameters of the extrusion process were adopted based on the studies of a number of authors in order to avoid the negative effects of the Maillard reaction [7-10].

Before the extrusion process, samples of wheat bran and corn were moistened to 25%, mixed and cooled during the day. The extrusion was carried out on an extruder press, where the maximum temperature of the screw head of the extruder did not exceed 140°C. After extrusion, the samples were dried in the open air, ground and stored in plastic bags at a temperature of 4°C.

The parameters of the amino acid composition of the extruded and native samples were determined in three repetitions using standard methods in the Test Center of the Central Research Center of the Russian Academy of Sciences (conclusion № 2032 on the state of measurements in the laboratory dated 19.03.2019). The amino acid composition was determined in the samples using the capillary electrophoresis system according to GOST R 55569. The data is presented in terms of dry matter.

2.3. Equipment and technical means
Universal single-screw press-extruder PESH-30/4 (Russia), electronic laboratory scales VM 153 (OKB Vesta LLC, Russia), drying cabinet LOIP LF 60/350-VS1 with forced convection, “Kapel 105” (Russia).

2.4. Statistical processing
Data are expressed as mean values ± standard error of the mean. Statistical analysis was performed using Statistica 10.0 (StatSoft Inc., USA) and Microsoft Excel (Microsoft, USA). Significance of the group differences was estimated using Student’s t-test with p≤0.05 considered as significant.

3. Results
The data analysis showed that the amino acid profile of the protein of the studied samples undergoes changes in the course of structural transformations occurring during the extrusion process (figure 1).

![Figure 1](image-url)  
**Figure 1.** Amino acid profile of wheat bran and corn.
When comparing the protein quality indicators of the two feed components, it was found that the amino acid profile of wheat bran is higher in all indicators relative to corn. So, from the studied list of essential amino acids in bran was observed predominance by arginine at 77.5%, lysine – 62%, valine – 61.8% and the threonine – 53.6 percent glycine is 68.5%, phenylalanine–52.9% of the threonine – 53.6% (p≤0.001), and the histidine – 60.5% (p≤0.01).

Extrusion of wheat bran resulted in a quantitative decrease in amino acids (figure 2).

![Figure 2](image)

**Figure 2.** The effect of the extrusion process on the amino acid composition of wheat bran and corn.

The most significant changes occurred for histidine, the decrease was 28.95 %, valine-20 %, serine-17.81 %, lysine-16 %, proline-14.9 % threonine-10.72 %. At the same time, the increase in the concentration of amino acids in corn after extrusion was for arginine – 80%, histidine – 33%, proline–13%, alanine– 11%, the concentration of tyrosine decreased by 20 %. Fluctuations of other amino acids in the corn extrudate were not significant.

The extrusion process retained the predominance of the amino acid composition of wheat bran over corn for all the amino acids considered, except methionine (figure 3).

![Figure 3](image)

**Figure 3.** Amino acid profile of wheat bran and corn after extrusion.
4. Discussion
Extrusion is a short-term high-temperature process characterized by minimal losses of valuable nutrients and biologically active compounds, compared to other methods of heat treatment of raw materials [11]. Studies of the properties of protein-containing products, protein isolates and concentrates during extrusion are conducted in several directions: inactivation of anti-nutritional factors (in particular trypsin inhibitors), improvement of protein accessibility and digestibility, changes in the content and chemical modification of amino acids, the formation of Maillard reaction products involving amino acids, the formation of functional technological properties of extruded protein products.

During extrusion, there may be significant losses of the valuable amino acid lysine and the accumulation of products that pose a potential health hazard. If the extrusion is carried out quickly, at a temperature below 180° C, a humidity of at least 15%, and a limit on the content of reducing sugars in the ejected mixtures, it is possible to obtain a safe product with high nutritional value [12, 13].

In our studies it was found that the extrusion process for wheat bran led to a decrease in the content of amino acids for histidine, valine, serine, lysine, proline, threonine. At the same time, an increase in the concentration of amino acids in corn after extrusion processing was observed for arginine, histidine, proline and alanine. Scientists have found that the ratio of the number of essential amino acids to the total number of amino acids decreases by 0.02% after the extrusion process, which leads to some deterioration in the quality of the protein, but it increases its digestibility due to inactivation of anti-nutritional factors [14, 15].

5. Conclusion
Thus, the extrusion process affects the ratio of the amount of essential amino acids in wheat bran and corn. The extrusion of wheat bran led to a quantitative decrease in amino acids, but retained a predominance over corn in all the amino acids which was considered. In view of this, it is advisable to conduct additional studies in vivo, in order to study the digestibility of the studied feed components.

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