Chemical composition and physicochemical properties of extruded buckwheat

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Abstract. The article analyzes the chemical composition of extruded buckwheat. The fatty acid composition of extruded buckwheat oil is obtained. The water-binding and fat-binding ability of extruded buckwheat was studied. The chemical composition of extruded buckwheat is compared with other components. The directions of using extruded buckwheat in brewing for the intensification of biotechnological processes are considered. Due to its high fiber content and low glycemic index, the use of extruded buckwheat can be recommended when creating a new line of fortified bakery products for diabetic purposes.

1. Introduction

New non-traditional types of raw materials are important and relevant for expanding the range of products of various functional orientations. This raw material has the necessary technological properties and chemical composition. The structural components of this raw material will enrich mass types of products with a complex of biologically active substances.

Due to the high content of soluble and dietary fiber, extruded buckwheat is an interesting product from the point of view of using beer and beer drinks in the formulation [1].

Extrusion is currently used to produce many food products. Thermoplastic extrusion is an improved version of extrusion and allows you to get products with certain properties, change the structure of starch and protein [2, 3, 4].

Creating new grain products with animal and herbal additives or enriching bakery and flour confectionery products use extruded semi-finished products from grain flour. However, extruded whole grain cereals can also be used in the creation of final food products. Moreover, according to the classical technology, the extrudable raw material is exposed to atmospheric pressure when exiting the extruder die.

We studied the raw materials and the final product (buckwheat extrudate), which was obtained in an extruder with a vacuum chamber. The processing technology was the action of low pressure on the extrudable buckwheat when exiting the extruder die [5, 7].

In this study, the goal was to study the chemical composition and properties of extruded buckwheat for use as additives in brewing and cooking.

2. Materials and methods

Native and extruded buckwheat was used in the experiment.

Starch was determined by polarimetric analysis. The starch contained in the grain or its processed products was dissolved in a hot dilute hydrochloric acid solution, dissolved protein substances were
precipitated and filtered, and the optical rotation angle of the starch solution was measured.

Humidity was determined by the method of dehydration of a sample of crushed grain in an oven with fixed parameters: temperature, drying time and calculation of humidity as a percentage of its weight change by weighing a sample before and after drying.

The protein was determined by mineralization of the organic substance with sulfuric acid in the presence of a catalyst.

The content of reducing sugars was determined by the Bertrand method. The lipid content was determined by the method in the extraction of crude fat from the product with a solvent, subsequent removal of the solvent, drying and weighing the extracted fat. Dextrins were determined by the spectrophotometric method.

The water-binding capacity of the buckwheat extrudate was determined by centrifuging a swollen portion of the ground extrudate at a rotation speed of 3000 min\(^{-1}\). The fat-binding ability was determined by centrifugation of a sample of a crushed sample at a rotation speed of 3000 min\(^{-1}\) [6].

The content of triacylglycerides was determined by gas-liquid chromatography on a Crystal 5000.1 chromatograph. Analysis conditions: capillary column HP - FFAP; injector temperature - 250 °C; detector temperature - 280 °C; gas is nitrogen; analysis duration - 60 min; the size of the injected sample is 1 μl. Chromatograms were quantitatively processed in the Chromatek Analytic 2.5 program.

3. Results and discussion

The content of the main components of the chemical composition of native and extruded buckwheat, as well as other grain raw materials for brewing, is shown in figure 1. The starch content in extruded buckwheat is lower than in native buckwheat due to the decomposition of starch during extrusion [2, 3, 4].

![Figure 1](image_url)

**Figure 1.** The chemical composition of native and extruded buckwheat, unmalted barley and brewing malt

Extruded buckwheat contains a large amount of dextrins (2.6%). For comparison, unmalted barley (0.12%) and native buckwheat (0.17%) have the lowest dextrin content. Thus, the increase in the content of dextrins is due to the destruction of starch in the grain under the influence of extrusion. In the process of buckwheat extrusion, the greatest changes occur with its carbohydrate complex. Intensive dextrinization of starch occurs with the formation of dextrins and reducing sugars.
Modification of the carbohydrate complex indicates a high extractive extruded buckwheat. This circumstance plays a huge role in the production of beer wort. The increased content of dextrins and reducing sugars in extruded buckwheat makes it a good component for use as an ingredient in brewing.

During the process of extrusion of buckwheat onto proteins, several factors simultaneously cause denaturation: mechanical stresses, heating. A study of the protein content in extruded buckwheat showed a decrease in its amount. This circumstance is associated with the denaturation of the protein from a hydrophilic to a hydrophobic state. Protein modification after extrusion increases the ability of buckwheat globular proteins to form enzyme-substrate complexes. Extruded processed buckwheat containing denatured proteins can be used in brewing technology [7].

The highest lipid content was found in native buckwheat, while approximately the same amount was found in extruded buckwheat and other raw materials. Extruded buckwheat is prepared for the preparation of beer wort due to the gelatinization of starch, an increase in the content of dextrins and simple sugars in the extrudate, as well as protein degradation.

The functional and technological properties of extruded buckwheat (fat-binding ability and water-binding ability) were investigated and compared with the indicators of native buckwheat and wheat flour.

Water-binding ability is characterized by adsorption of water with the participation of hydrophilic amino acid residues. The fat-binding ability is associated with the adsorption of fat due to hydrophobic amino acid radicals. The water-binding and fat-binding ability of extrudates determine the functional and technological properties of food textures.

To determine the amount and composition of lipids in extruded buckwheat, a chromatographic analysis of the fatty acid composition of the extruded buckwheat oil was made.

The chromatogram report of the fatty acid composition of extruded barley oil, buckwheat oil is shown in figure 2.

![Figure 2. Chromatogram of the fatty acid composition of extruded buckwheat oil.](image)

Polyunsaturated fatty acids (PUFAs) are important in increasing the resistance of yeast cells to ethyl alcohol. This plays a huge role in brewing during the fermentation of wort, as well as in the processes of fermentation of dough in the bakery industry. It was found that the amount of PUFA in extruded buckwheat increased by 6.5%.
The results of the study of the water-binding and fat-binding ability of buckwheat extrudate flour are shown in fig. 3.

The water-binding ability of buckwheat extrudate flour is greater than that of wheat flour and native buckwheat flour. This difference in water binding capacity is due to protein modification and dextrinization during buckwheat extrusion. The technology and design of the extruder affects the water-binding capacity of buckwheat extrudate flour.

Flour confectionery and bakery products will be able to slow down the process of staling by introducing additives of extruded buckwheat.

![Figure 3. Water-binding and fat-binding ability of wheat flour, native buckwheat flour and extruded buckwheat.](image)

The fat-binding ability of extruded buckwheat flour is highest. Compared to native buckwheat flour, wheat flour has a lower rate. The use of extruded buckwheat flour in the production of flour confectionery and bakery products is justified by the increased fat-binding ability and increasing the biological value of the finished product.

4. Conclusion
From this study, we can conclude that the chemical and physical changes that occur in the extrudable raw materials during extrusion depend on the process conditions and the design of the extruder. The study of the fatty acid composition of extruded buckwheat oil showed an increase in the amount of PUFA in extruded buckwheat by 6.5%. The high rate of water-binding and fat-binding ability of extruded buckwheat flour characterizes it as a good component for use in the production of flour confectionery and bakery products. Extruded buckwheat is superior in physical and chemical properties to brewing malt.

The directions of using extruded buckwheat in brewing for the intensification of biotechnological processes are considered. Due to its high fiber content and low glycemic index, the use of extruded buckwheat can be recommended when creating a new line of fortified bakery products for diabetic purposes.

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