Chemical Composition of Buckwheat Groats from Various Russian Manufacturers

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Abstract. Buckwheat groats are produced from buckwheat seeds. Buckwheat is characterized by a unique chemical composition, which determines its highest nutritional value and functional properties. The indicators of the chemical composition of buckwheat are of great importance in the production of plant-based fermented alternative dairy products. The chemical composition is characterized by a wide range of fluctuations in the quantitative content of components depending on the climatic zone of buckwheat growth and weather conditions during the vegetative period. The objects of this study were the samples of the top-grade quick-cooking unground buckwheat groats of the “Mistral”, “Agro-Alliance”, “Uvelka”, “Altaiskaya skazka” brands. This article shows that the considerable differences were observed in the content of fat, protein, and starch in buckwheat. It was found that in the unground buckwheat produced by various Russian manufacturers in the spring of 2021 an average protein content was 18.67%, fat – 4.6%, carbohydrates – 62.21%, and the content of starch was on average 49.78%. These indicators of the chemical composition of unground buckwheat groats should be considered when developing fermented alternative buckwheat-based dairy products.

1. Introduction
Buckwheat groats are obtained by processing buckwheat seeds. Buckwheat is a plant belonging to the Polygonaceae family, which includes three species Fagopyrum multifolium, Fagopyrum tataricum, and Fagopyrum esculentum. The annual species Fagopyrum esculentum or common buckwheat is grown for food purposes [1–15]. Common buckwheat seeds have a shape of triangular grains and gray-green-brown color. Seeds are used to produce cereals and flour, and by-products are used as the detergent (potash) and feed to farm animals (husk, straw, chaff) [5]. The bioflavonoid rutin is obtained from the leaves and flowers of buckwheat. Rutin regulates permeability, increases the strength of blood vessels, and has an antitumor and antioxidant effect. In addition, buckwheat contains phytochemicals, for example, phenolic acids, condensed tannins, and phytosterols. These compounds are beneficial and have anti-oxidative properties [1, 2, 3, 6, 11]. There are two types of buckwheat, which are obtained from buckwheat seeds, unground buckwheat, and crushed buckwheat. Unground buckwheat includes whole kernels of buckwheat seed. Crushed buckwheat is a byproduct of an unground buckwheat production and consists of broken kernels of buckwheat seed. The chemical composition and nutritional value of unground and crushed buckwheat do not differ significantly. Hydrothermal treatment of grain is carried out during the production of buckwheat groats. This treatment includes processing the grain with live steam at 100°C and overpressure, followed by drying with hot air. A partial biomodification of the constituent parts of the grain occurs during hydrothermal processing. Biomodifications include some

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starch gelatinization, formation of dextrins, and diffusion of vitamins and minerals from the hulls of the grains into the kernel. As a result, the biological value and shelf life of buckwheat groats increase. Buckwheat groats obtain a pleasant light brown color, smell, and taste, and it cooks faster [4].

Buckwheat groats have a unique chemical composition, which determines its high nutritional value and positive physiological effect on the human body. Also, buckwheat contains bioactive compounds that may prevent cardiovascular diseases, hyperglycemia, obesity, and hypertension. This groats has substances with anti-oxidative, cardioprotective, anti-cancer, anti-hypertension, anti-inflammatory, anti-diabetic, and cholesterol-lowering effects [1–15].

Unlike other types of cereals, buckwheat groats is characterized by the highest protein content, which ranges from 10 to 21% or more. Buckwheat protein does not contain allergenic gluten, but soluble albumin and globulins that are well absorbed by humans prevail. The amino acids in buckwheat protein are well balanced, and the content of essential amino acids is increased (especially lysine, leucine, isoleucine, valine, threonine, phenylalanine). Lysine in buckwheat lowers the level of cholesterol and helps remove bile acids. Also, buckwheat contains natural bioactive peptides that have antibacterial properties as well as angiotensin I converting enzyme inhibiting activity [1, 3, 4, 5, 6, 7, 9, 10].

The amount of carbohydrates in buckwheat is about 70%. The main carbohydrates are starch and dietary fiber. Buckwheat starch mainly consists of resistant starch, and dietary fibers are soluble compounds. Dietary fibers help prevent diabetes, heart diseases, and cancer. Also, buckwheat has iminosugars that may decrease insulin resistance and oxidative stress. Most common iminosugar in buckwheat is D-fagomine, and its concentration is about 43 mg/kg. Because of this unique carbohydrate composition, the glucose absorption from buckwheat products is slowed down, and cholesterol levels are reduced [1, 3, 4, 5, 6, 7, 9, 10].

Buckwheat fat contains significant amounts of lecinthin and the therapeutic triterpenoid miliacin. About 70% of fatty acids are unsaturated fatty acids, and buckwheat especially rich in oleic and linoleic acids. Buckwheat fat is highly stable during storage because of the high content of vitamin E.

Buckwheat groats, compared to other cereals, has the highest content of vitamins B1, B2 (0.53 and 0.24 mg%, respectively), PP (24.6 mg%), and E (6.65 mg%), as well as minerals Fe, Mg, and Si (8, 200, and 81 mg%, respectively) [4].

The chemical composition of buckwheat is unstable. It changes under the influence of the geographical area of cultivation, buckwheat cultivar, and weather conditions [2, 6, 7, 9, 10]. Nowadays, the world leaders in buckwheat cultivation are Russia and China. The Altai Territory is the leader within Russia. It is followed by the Oryol Oblast, the Republic of Bashkortostan, the Orenburg and Novosibirsk Oblasts, and the Republic of Tatarstan. Buckwheat growing areas are large in the Kursk, Kemerovo, and Tula Oblasts of Russia. These regions are the large-scale suppliers of buckwheat to the producers of cereals. The chemical composition of buckwheat groats from seeds grown in different geographic and climatic zones can differ significantly [5]. In connection with the prospects of using buckwheat as a vegetable base for fermented alternative dairy products, the chemical composition of buckwheat from the large-scale producers was studied.

2. Materials and methods
The objects of this study were samples of the top-gradequick-cooking unground buckwheat groats of the following brands: Mistral, Agro-Alliance, Uvelka, Altaiskaya skazka, produced under GOST R 55290-2012 in the period from March to April 2021. The description of buckwheat samples is presented in table 1.

| Sample | Brand               |
|--------|---------------------|
| 1      | Mistral             |
| 2      | Agro-Alliance       |
| 3      | Uvelka              |
| 4      | Altaiskaya skazka   |
For the research, a trial sample of (50.0 ± 0.1)g was taken from a batch sample of 250g of buckwheat groats. A trial sample was ground in a laboratory mill and sieved through a sieve with a hole diameter of 0.25 mm.

The total protein content was determined by the Kjeldahl method. A mixture of 10.0g CuSO₄ and 300.0g K₂SO₄ was a catalyst. An alcohol solvent of methyl red and bromocresol green was an indicator. Mineralization was carried out in a Kjeldahl flask, where (0.5 ± 0.001) g of ground cereal, 2 g of catalyst, and 15 cm³ of H₂SO₄ were added. Ammonia was distilled off into a receiving flask, where 25 cm³ of 0.05 mol/dm³ of H₂SO₄ and 4 drops of the indicator were previously placed. The receiving flask was preliminarily connected to the Kjeldahl flask with a condenser. The distillate was titrated with a 0.1 mol/dm³NaOH solution until a green color of the solution appeared. A blank experiment was carried out in parallel. The experimentally determined mass fraction of total nitrogen was multiplied by the conversion factor of nitrogen to protein equal to 5.53 for buckwheat.

The total fat content was determined by the Soxhlet method. Ash content was determined by the ignition of a ground cereal sample with the following weighing of the residue. The moisture content was controlled by dehydrating a ground cereal sample in a drying oven at 105 °C. The ash content and moisture content were determined to calculate the carbohydrate content in buckwheat groats.

The starch content was determined by the polarimetric method by dissolving the starch present in the samples in a hydrochloric acid solution, with the following precipitation and filtration of the dissolved buckwheat protein. Then, the optical angle of rotation of the starch solution was determined.

The experiments were carried out in triplicate. When calculating, a 5% level of significance was assumed (α = 0.05).

3. Results and discussion
The research results showed the differences in the chemical composition of various brands of buckwheat. The content of the components in the groats samples is presented in table 2.

| Component     | Content, % in a sample |
|---------------|------------------------|
|               | 1          | 2          | 3          | 4          |
| Protein       | 14.25      | 23.62      | 16.20      | 20.60      |
| Fat           | 3.1        | 6.0        | 3.5        | 5.8        |
| Ash           | 2.4        | 3.6        | 2.6        | 3.5        |
| Moisture      | 11.5       | 11.5       | 11.5       | 11.5       |
| Carbohydrates | 68.75      | 55.28      | 66.2       | 58.6       |
| Starch        | 56.6       | 42.5       | 55.5       | 44.5       |

As it can be seen from table 2, the total protein content in buckwheat groats of different brands was considerably high. The total protein content ranged from 14.25 to 23.62%, an average value of 18.67%, and a range of 9.37%. The total fat content varied from 3.1 to 6.0%; an average value was 4.6%, and a range of 2.9%. The total carbohydrates content was from 55.28 to 68.75%, an average value of 62.21%, and a range of 13.47%. The starch content in buckwheat samples varied from 42.5 to 56.6%, an average value of 49.78%, and a range of 14.1%. The substantial differences between various brands of buckwheat were observed in the content of proteins, fat, and starch. The differences in chemical composition in buckwheat of Russian brands can be explained by the different climatic zones of buckwheat growth and the weather conditions during the vegetative period.

4. Conclusion
The content of the main components of the chemical composition in buckwheat groats from different Russian producers differs substantially. The range was 9.37% for proteins, 2.9% for fats, 13.47% for carbohydrates, and 14.1% for starch. The considerable differences were observed in the content of fat, protein, and starch. The differences in the chemical composition of buckwheat can be explained by
different climatic zones of buckwheat growth and weather conditions during the vegetative period. Unground buckwheat produced by various Russian manufacturers in the spring of 2021 had an average protein content of 18.67%, fat – 4.6%, carbohydrates – 62.21%, and starch of 49.78%. These indicators of the chemical composition of unground buckwheat should be considered when developing fermented alternative buckwheat-based dairy products.

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