Exploring the potential of black rice for malt production

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Abstract. The aim of the study was to determine the biochemical indicators of several varieties of dark rice before and after malting. To determine and compare the degree of germination of different rice varieties under given laboratory conditions. Four varieties of rice were taken for the study: black rice "Southern Night", red rice "Ruby", red rice "Jasmine" and brown rice. Rice grains were used for analysis with subsequent comparison. In the process of malting, a malting system was used, which automatically maintained a temperature of 15-18^{o}C for 8 days. Further, laboratory analyzes such as total protein content, total nitrogen content, moisture, extractability and phenolic compound content were conducted on the obtained raw material. To compare laboratory indicators, analyzes were conducted on raw materials before and after malting. According to laboratory analysis, the best indicators were obtained for black rice "Southern Night". The probability of germination and extractability indicators are significantly better than other varieties. In addition to the above, black rice has high antioxidant and phenol indicators. In terms of total phenol indicators, black rice is more than 7 times ahead of red rice. The collected data indicate a great potential for the use of "Southern Night" black rice variety in the food industry.

1 Introduction

Rice is the main grain crop consumed as a staple food by over half of the world's population. Rice consumption is very high in developing countries and Asian countries. Almost 95% of rice is produced in Asian countries, and about half of the world's population consumes it.

Rice cultivation ranks third in agricultural production after sugar cane and corn. It is a primary source of energy in the diet of Asian and Pacific countries, as well as North and South American countries and African countries. Rice is rich in genetic diversity, with thousands of varieties grown worldwide.

In the Russian Federation, rice varieties of only domestic selection are cultivated (80% of them were created at the Federal Research Center for Rice), which differ in the size of grains: short-grain varieties, long-grain varieties, and large-grain, red-grain and other varieties are also grown. The products produced by the industry are in great consumer demand, and although rice groats are not the main food product in the Russian Federation,

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it is rice that occupies a leading place in the structure of consumption of groats. In addition, rice plays an important role in the development of the socio-economic infrastructure of rice-growing regions.

Consumers of rice prefer to consume white rice, despite other varieties containing valuable nutrients. Eating black rice has positive effects on the human body. For example, it improves gastrointestinal functions, reduces the likelihood of cancer, and also reduces the risk of developing heart failure. Higher consumption of anthocyanins and fruits rich in anthocyanins has been associated with a lower risk of developing type 2 diabetes.

Recently, different varieties of black rice have drawn the attention of researchers and the food industry because they are potential sources of anthocyanins. Red and black rice obtain their color from anthocyanin pigments, which are known to absorb free radicals and possess antioxidant properties, as well as other health benefits. It has been found that the levels of anthocyanins in black rice are higher than in other available sources of these compounds. These anthocyanins have antioxidant, anti-cancer, and anti-inflammatory activities. After consumption, anthocyanins can be metabolized into phenolic acids, such as protocatechuic acid [7]. Anthocyanins are not synthesized in the human and animal body[9], so people obtain these pigments from consuming plant-based foods. The main function of these compounds is their antioxidant activity. Due to their high antioxidant capacity, they protect human cells from the effects of strong oxidants and free radicals [8]. These compounds have a beneficial effect on metabolism by stabilizing anabolic and catabolic reactions [10].

Furthermore, black rice is an economically promising variety of rice because it does not lose its carbohydrate potential alongside its beneficial physiological properties. The aim of the study is to determine the biochemical indicators of several varieties of dark rice before and after the malt sprouting process. To establish the amount of phenolic compounds in black rice. To determine and compare the degree of germination of different varieties of rice under given laboratory conditions.

2 Materials and methods

The study included 4 varieties of rice: black rice "Southern Night", red rice "Ruby", red rice "Jasmine", and brown rice. Rice grains were used for analysis and compared with each other. The total amount of protein and nitrogen was determined by incinerating the raw material at a temperature of 400-450°C for an hour in the presence of sulfuric acid with a catalyst, followed by titration. This study was conducted using the Kjeltac 8300 device and the methodology described in reference [11].

The extractability was determined by mashing the rice malt and obtaining wort using the methodology for obtaining congress wort with the use of equipment from Anton Paar GmbH 14 [12].

Moisture content was determined using the Halogen Moisture Analyzer HB43. To determine the total amount of phenols in a wide range of objects, spectrophotometric methods based on their oxidation in an alkaline medium with the Folin-Ciocalteu reagent are most commonly used, which includes a mixture of different ligand molybdenum-tungsten heteropoly complexes of the Dawson structure.

3 Results and Discussion

During the study, the probability of germination of four rice varieties was determined (Table 1). This is one of the main parameters in malting, indicating the number of normally

sprouted seeds within a set period. The malting system used included the following automated processes:

- Air-water soaking at a temperature range of 14-18°C.
- Grain sprouting for 8 days.
- Grain drying at a temperature range of 55-90°C.

The separation of sprouts was done manually 2. It was found that the probability of germination in the studied varieties ranged from 93% to 37%.

Table 1. Germination probability %.

Variety	
Black rice "South night"	93
Red rice "Ruby"	63
Red rice"Jasmine"	37
Brown rice	59

In the given conditions, black rice "Southern Night" performed the best with a 93% probability of sprouting after 8 days of malting. There were no significant differences in the sprouting rate between red rice "Ruby" and brown rice, with rates of 63% and 59%, respectively. Red rice "Jasmine" performed the worst with a sprouting rate of only 37%.

The moisture content of the raw and malted materials was determined. The moisture content values of the rice before and after malting are presented in Table 2.

Table 2. The moisture content of the samples, %.

Variety	malted	unmalted
Black rice "South night"	11.71	5
Red rice "Ruby"	11.2	4.2
Red rice"Jasmine"	11.4	4.34
Brown rice	11.4	4.3

The moisture content values were similar before and after drying, which allows for predicting a feasible process for industrial production.

Extractivity was determined using a mash device with an initial temperature of 45°C, followed by an increase to 70°C.[1]

Extractability indicates the proportion of particles that will completely dissolve in the mash, relative to the total mass of dry malt. Positive extractability values for rice malt range from 80 to 85%, and for unsalted rice from 85 to 90%. The data is presented in Table 3.

Table 3. Sample Extractivity, %.

Variety	malted	unmalted
Black rice"South night"	79.28	85.86
Red rice "Ruby"	56.34	79.28
Red rice"Jasmine"	53.2	72
Brown rice	55.1	75.3

The extract yield is one of the main economic and technochemical indicators in assessing the quality of malt. It depends on the varietal characteristics of the grain, in particular, on its protein content, filminess, cultivation area and climatic conditions. Along with this, the mode of malting is also important, which determines the cytolytic, proteolytic and amylolytic activity of enzymes in malt, and, consequently, the degree of its dissolution. [3]

Due to good germination, the extract yield of black rice is at a sufficiently high level. Based on this indicator, it can be assumed that black rice has a high potential for the food industry as an additive to food products or as a main component of finished products.

The total amount of protein is an important indicator for the food industry. High nutritional parameters have a positive impact on the final food value of the product.

The mass fraction of protein in the dry matter of malt indicates the content of so-called "raw protein" in malt. Raw protein is determined by multiplying the content of total nitrogen (protein nitrogen, amino acids, nitrate nitrogen, ammoniacal nitrogen, nucleic acid nitrogen), determined by the Kjeldahl method, by a factor of 6.25 (the coefficient is based on the average nitrogen content in protein of 16%). Therefore, the mass fraction of protein in malt depends not only on the variety characteristics of rice, but also on the agrotechnology of its cultivation, in particular, on the amount and timing of nitrogen fertilizers application. In addition, the mass fraction of protein in malt is determined by the regimes of malting and drying of malt. Usually, the protein content in malt is 1-1.5% lower than in rice.[5] The data obtained during the study of rice are presented in Table 4.

Table 4. The amount of protein and nitrogen, g\100g.

Variety	Protein	Protein (malt)	Nitrogen	Nitrogen (malt)
Black rice"South night"	8.6	7.6	1.38	1.2
Red rice "Ruby"	7.3	6.5	1.12	1.01
Red rice"Jasmine"	9.2	7.9	1.46	1.4
Brown rice	7.5	6.5	1.12	1.01

Based on the obtained data, it can be concluded that the protein content in the analyzed samples varies in accordance with traditional norms for protein fraction losses - within 10%. This will have a positive effect on the nutritional value of finished products made from this raw material.

A study was also made of the content of phenolic compounds in rice.

For example, 2 varieties were taken: red rice "Ruby" and black rice "Southern Night".

It was found that the sum of phenolic compounds in the studied samples was as follows:

- Back rice "Southern Night" - 8.1 mg / g
- Red rice "Ruby" 1.2 mg / g.

The rate of black rice is more than 7 times higher than that of red rice. Based on this, it can be argued that black rice has a fairly large amount of antioxidants in the composition and, therefore, antioxidant properties are potentially higher.[6] This property slows down the oxidation process by interacting with atmospheric oxygen (preventing its reaction with the product), interrupting the oxidation reaction (deactivating active radicals) or destroying already formed peroxides. This can be an important indicator in the final product, including for its long-term storage.

4 Conclusion

Under the conditions of rice malting used, black rice “Southern Night” showed itself best. This indicates that the grain is unpretentious to the conditions of germination and there should be no difficulties in industrial production.

Black rice showed high extract recovery, both before and after malting. This indicates a high potential for use in the food industry and can serve as an additive to the finished product, as well as the main raw material of the food object.

High levels of phenolic compounds in dark rice varieties indicate a large amount of antioxidants in raw materials. This will make it possible to produce functional food

products and increase the shelf life of finished products by reducing the activity of oxidative processes.

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