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Utilization of black rice and red rice in value added products: A review

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Abstract
The nutritional benefits of rice are well-known. More than half of the world's population depends & consume rice as their staple meal. White rice has been always famous since it's production, processing & consumer demand is always on demand but the health benefits of the other rice varieties are still an alien concept for most of the people. Though now people have started being more conscious about their health so they are trying to study about the other rice varieties. Red & Black rice are getting popularized these days only because they are much healthier than white rice. Red & Black rice are not milled & didn't go through any processing keeping the nutritional components intact. Whereas the white rice which is easily available & consumed by all go through vigorous milling processing's & lost a lot of its nutritional value. Value- added based products are in demand these days people go to supermarkets & try to find the healthiest option but also keeping in mind about the taste. So, incorporation of these rice which are not easily accessible everywhere due to less demand, less production & high cost they can be introduced in the market. This review focuses on the nutritional composition, value-added products, commercial value & future opportunities of these rice varieties

Keywords: Red rice, black rice, anthocyanin, value-added products, *Oryza sativa*, pigmented rice

1. Introduction
Rice (*Oryza sativa*) is a one of the most important crop in the world belongs to family Poaceae approximately 95% of its production is in Asia. Red & black rice are the most nutritious types of rice. In comparison to white rice, they have higher levels of fibre, protein, and antioxidants. White rice has a lot of processing, which prevents it from giving you the essential nutrients you need and from filling you up as other types do. No matter what kind of rice you choose to consume, always pay attention to the serving amount. In general, rice has a lot of calories, and excessive intake of any food isn't a good for health.

Red rice (or red-kernelled rice) having scientific name *Oryza punctate* is a kind of rice containing tannin pigments giving the hulled rice a red or brownish red appearance. In the 14th and 15th centuries, China introduced the red Indica-type rice known as "Taitoumai" (the Medieval ages). Although its taste was subpar, this long grain variety of red rice had been widely grown in the central and south-western regions of Japan due to its early ripening, drought resistance, insect resistance, and high yield. Between the 16th and 18th centuries, it took up the largest amount of land for agriculture (the Edo era). These two varieties of red rice were gradually phased out of the Japanese paddy fields in the latter half of the 19th century (the Meiji era). As exceptions, some red rice from Japan, which was revered, was grown in shrines, while other red rice remained weedy rice in local areas. Cold noodles, cakes, alcoholic beverages, and other secondary items have all emerged as a result of the widespread demand for red rice, which has also promoted local social activities (educational programs, rice festivals, etc.) Red rice is also gaining popularity as a functional food due to its high polyphenol content (Itani, *et al*., 2004) [1]

Black rice is a type of rice species & its scientific name is *Oryza sativa* L. *indica*. This rice is mostly grown in Asian countries such as China, Japan, India, Sri Lanka, Thailand, Indonesia, Myanmar, and Bangladesh. Forbidden rice, purple rice, emperor's rice, fortune rice, and king's rice are some of the alternative names for black rice (Ito, *et al*., 2019) [2]. This rice is predominantly grown in India's north-eastern states of Manipur, Assam, and Meghalaya. This black rice is known by several names in different states. It is referred to as *Chakhao* in Manipuri and *Kola sawl* in Assamese. There are three different tribes in Meghalaya, and they all refer to it in various ways: the Garo tribe refers to it as *Migisim*, while the Khasi and Jaintia tribes refer to it as *Jaiong* (Kumar, *et al*., 2020) [3].

Red rice, due to its excellent nutritional contents, particularly its antioxidant properties, & it has a tremendous potential to be produced as a health-based food product, including baby food (Wasli, *et al*., 2019) [4]. Whereas in black rice also, anthocyanin is a trace element of antioxidant, is found in the kernel. People ate this rice because of its high nutritional value, which is beneficial to their health (Parameshwari, *et al*., 2021) [5]. It has been known throughout history for its nutritional and health benefits, and one of its frequent names is 'Imperial rice,' which was specially prepared for the Emperor's consumption. Red rice is the next largest reservoir of phytochemicals after black rice (Saenjum, *et al*., 2015) [6].

Red & black rice are the most nutrient- rich types of rice. In comparison to white rice, they have higher levels of fiber, protein, and antioxidants. Globally, the rate of obesity and chronic dietary-related illnesses such type 2 diabetes, hypertension, cardiovascular disease, malignancies, and celiac disease is rising. Nutritionists and food scientists are now paying more attention to the connection between diet and various illness risks as a result of the rising prevalence of these diseases. Among other foods, rice has drawn more attention as a result of its importance in the diets of billions of people worldwide (Saleh, *et al*., 2019) [7]. Study shows whole rice's such as red & black rice has far more nutrients preserved than white rice. This review will evaluate the literature on black & red rice & its derivatives incorporating in various value- added products and will thereby narrow an existing information gap in black rice.

2. Nutraceutical values of black & red rice

Black rice possess to total anthocyanin content 79.5-473.37 mg, red rice possess anthocyanin content 7.9-34.4 mg. The values of carbohydrates, protein, and fat are given in the table. Calcium (Ca), Magnesium (Mg) iron (Fe) also mentioned in table. In conclusion from this study, black rice has antioxidant activity and nutrient content, these products are expected to be native functional foods. (Thomas, *et al*., 2013) [8]. Red rice compositional values for its moisture, protein, fat, calcium, phosphorus, iron were given in the table.

It contains a variety of nutritive and bioactive substances, such as essential amino acids, functional lipids, dietary fibre, vitamins (B complex, A, and E), some minerals (K, Fe, Zn, Cu, Mg, Mn, and P), anthocyanins, phenolic compounds, tocopherols, and tocotrienols, as well as phytic acid in the bran layer & embryo (Kushwaha, *et al*., 2016) [10]. Anthocyanin is the major constituent in both the rice varieties, found more in black rice varieties than red, is an antioxidant with anti-carcinogenic, anti-inflammatory, and anti-allergic characteristics. Manganese and calcium are two dietary components that are abundant and support a healthy metabolism and stronger bones.

The following table below describes the main elements of black rice & red rice:

Table 1: Components of both the rice & their nutritional values

Components	Black Rice (g 100 g-1)	Red Rice (g 100 g-1)
Moisture	11.07 ± 0.2	12.51
Proteins	8.16 ± 0.3	10.53
Fats	0.07 ± 0.2	1.49
Total fiber	8.47 ± 0.2	1.19
Carbohydrates	78.26 ± 0.6	74.40
Anthocyanin	0.0795-0.4737	0.0079-0.0344
Calcium	0.395	0.02
Phosphorus	0.264	0.21
Iron	0.387	0.004
Zinc	3.16 ± 0.05	0.005
Energy (kJ)	1457.72±0.7	1425

Source*:* Thomas, *et al*., 2013 [8]; Thakur, *et al*., 2020) [9]

3. Value added products of the rice varieties

3.1 Black Rice in Value Added Products

3.1.1 Black rice in Cookies/Biscuits

There is no difference between the name's biscuits and cookies. It's just that the name varies depending on the country. Biscuits are known in the United Kingdom, England, Scotland, Wales, and Northern Ireland, whereas cookies are known in the United States, Brazil, Canada, Mexico, and Colombia. Biscuits have a low moisture content and are thin and crunchy, whereas cookies have a higher moisture content and are thick and chewy. These products are commonly recognized as being identical all across the world. Many people enjoy snacking on these products at all times. The properties of black rice powder included cookies were examined based on prior research. In preparation of cookies 20% of the black rice has been replaced with wheat flour, and the dish has been made according to conventional procedures (Kim, *et al*., 2006). Dough qualities were evaluated in additional research, and it was discovered that adding black rice powder to cookie dough enhanced the pH. It demonstrates that black rice powder has a high moisture level in the dough and absorbs more water due to its sticky nature and high fibre content (Savage, *et al*., 2018) [12]. The cookies have been prepared, and the organoleptic assessment has been completed. Even after adding the black rice, the texture of the cookies did not change. The inclusion of black rice has boosted the spread ratio (Klunklin, *et al*., 2018) [12]. The panelists approved the use of 20% black rice powder in place of white rice powder. The addition of more than 20% black rice resulted in a very strong flavour and texture, as well as bad sensory scores. In another study, black rice flour was included into biscuits at percentages of 100%, 50%, and 25%, and it was discovered that the protein digestibility rose as more black rice powder was added, while starch digestion rates decreased. Sensory study showed that 25 percent and 50 percent black rice powder substitutes are acceptable (Ling, *et al*., 2007) [13]. Finally, they discovered that adding black rice powder to cookies and biscuits can be used as a functional food for diabetic patients (Cherik, *et al*., 2021).

3.1.2 Black rice powder in cakes

Cake is a well-known bakery product in which the major ingredient is wheat, which provides the cake's structure since it includes gluten. Black rice is rich in protein, so it can be

used to make cakes instead of wheat flour. Black rice flour was incorporated in different concentrations with the base flour (wheat) in chiffon cakes. Black rice (BR) powders were used to substitute 10%, 20%, 30%, 40%, 50%, 60%, 70%, 80%, 90%, and 100%(w/w) of wheat flour to manufacture chiffon cakes, assigned as BR10, BR20, BR30, BR40, BR50, BR60, BR70, BR80, BR90, and BR100, respectively (Lee, *et al*., 2017). Black rice flour has 0.4% fat, 0.9% fiber, 1.5% ash, 89% carbs, and 8.0% protein on a dry basis (Sangnark, *et al*., 2016) [14]. The black rice powder incorporated baked cake was found to be hard, crumbly crust, color, and chewiness increased during the evaluation process. Overall, the antioxidant activity of the cake increased. The sensory evaluation yields the best results in 10% to 60% of cases, with less sensory scores of 70% to 100% (Thanuja, *et al*., 2018) [15]. Because black rice has a high nutritional level, it can provide a higher nutritional profile and can be used instead of wheat flour in traditional cakes (Parmeshwari, *et al*., 2021).

3.1.3 Black rice flour in bread

The black rice flour contains 60.40% starch, 7.94% protein, 2.17% fat, 1.38% ash, 12.71% water, and 0.049% total phenolics. To make the bread dough- flour, salt (1.5%), yeast (5.3%), sucrose (6%), shortening (3%), and water (60%). In a 5-speed mixer, in which all the ingredients were kneaded for 8 minutes, first round for 3 minutes, and second round for 5 minutes. The dough was placed in a pan and fermented for 90 minutes at 30°C and 85% humidity (RH). After fermentation, the doughs were baked in an electric oven at 190°C for 40 minutes. Before measuring other parameters, the loaf was immediately taken from the toast box (15 X 7 cm) and allowed to cool to room temperature (Kaori,*et al*., 2019) [16]. Hence this study, showed that extruded black rice flour can be used in the bread industry to produce higher-quality products than the raw material.

3.1.4 Black rice in breakfast cereals

Approximately 100 kg of black rice, some broken grains, were stored in plastic bottles under refrigeration (4 °C ± 2 °C) and light protection before being processed in an analytical mill. The rice flour (≥ 60 mesh to ≤ 250 μm) was treated with water for 5 minutes in a kitchen mixer 24 hours before the extrusion. The exact amount of water that should be added to the rice flour to get the desired consistency. ZKS 30 Werner and Pfleiderer co-rotating twin-screw extruder was used for the extrusion. Extrusion was carried out at 75, 100, and 125 ° C in the first, second, and third barrel zones, respectively. The screw speed (250 rpm) and feed rate (15 kg/h) were kept constant. Following extrusion, the material was dried in a forced-air tunnel until it reached a moisture content of ≤ 7%. Extrusion was applied to successfully manufacture very appealing colored breakfast cereal with desirable expansion, texture, and color attributes from black rice varieties (Meza, *et al*., 2019) [17].

3.1.5 Black rice in muffins

To prepare the muffins: Coconut butter with an 80% fat, brown sugar, hen eggs, wheat flour, and black rice was taken. The batter for the muffins was prepared in the following manner: The coconut butter was continually mixed with salt and brown sugar until the sugar was dissolved and a froth formed then the eggs were added, followed by only wheat flour (S1 sample, considered control), both wheat and black rice flour (1:1) (S2 sample), only black rice flour (S3 sample), and baking powder. To get a consistent composition, the batter was mixed for 10 minutes at 300 rpm. Finally, the batter was poured into paper cups and baked in a convection oven with forced air circulation for 25 minutes at 185 °C. When compared to the control sample baked with wheat flour, the muffins baked with black rice flour had a higher anthocyanin content and antioxidant activity. The addition of black rice increased stiffness, springiness, and chewiness, according to the textural study. These findings suggested that value added muffins made with black rice flour could be a good alternative for persons who are gluten intolerant while also providing a considerable quantity of polyphenolic content, which may have several health benefits (Andronoiu, *et al*., 2018) [18].

3.2 Red Rice in Value-Added Products

3.2.1 Red rice flour in cake

For red rice cakes refined wheat flour, 15.9% sugar powder, 12.0% sunflower oil, 31.7% whole eggs, 15.9% milk, and 0.7% baking powder were the ingredients. Using a domestic mixer, the dry ingredients (flour, sugar powder, and baking powder) were combined for 5 minutes. Using the same mixing tool, the liquid whole egg, milk, and sunflower oil were each combined separately for 5 minutes. The liquid mixture was then added to the dry mixture, which was stirred for 10 minutes. The prepared batter was placed into moulds for baking that were 10 cm in diameter. The moulds were put in a home oven which was heated to 190 °C, and baked for 30 minutes (Das, *et al*., 2019) [19].

3.2.2 Red rice flour in gluten free-bread

Red rice purchased from a store in Campina Grande, PB that was produced by Patoense and had an initial water content of about 11% w.b. Red rice flour, cassava starch, water, sugar, dry yeast (Saccharomyces cerevisae), flour improver (Zeas; containing corn starch, stearoyl lactylate, ascorbic acid, and amylase), apple vinegar, salt, powdered milk (Nestle), eggs, canola oil, antimold (Adnor), inulin, & MTgase (Ajinomoto) were the raw materials used in the production of breads. In a laboratory mill (Tecnal, Brazil) with knives set to 1 mm and a 10 Mesh sieve, batch grinding of rice samples (10 g) was performed. After being ground, rice flour with a moisture content of 11 gm 100 g-1 (on a wet basis) was packaged in polyethylene and maintained at room temperature at 25 °C (Gusmao, *et al*., 2019) [20]

3.2.3 Red rice in Cookies with pinto beans

Red rice (*Oryza sativa* L.) and pinto beans (*Phaseolus vulgaris* L.) BRS Cometa were used and provided by the Brazilian Agricultural Research Corporation (Embrapa). For around 12 hours, pinto beans were soaked in water at a ratio of 1:5 (w/v). After being drained, the beans were cooked in a pressure cooker for 30 minutes at a water-to-bean ratio of 1:2 (w/v). The dried beans were divided among trays and heated to 60 °C for 19 hours in an air-circulating kiln (Tecnal TE-394/2, So Paulo, Brazil). Red rice, on the other hand, was cooked for 30 minutes in a 1:1.25 (w/v) water ratio. After cooking, the rice was given out in trays and placed in a kiln with air circulation at 70 °C for 5 h. Using a rotor mill (Tecnal TE-651/2, So Paulo, Brazil) with a 2 mm mesh screen, pinto beans and red rice, both raw and processed, were ground separately. Pinto bean flour (PBF) and red rice flour (RRF), both raw and processed, were designated as the flours obtained. Prior to usage, all flours were packaged and kept in

a glass container with refrigeration (5 °C) (Ascheri, *et al*., 2022) [21]

3.2.4 Red rice in peel powder mixes

The red rice grains were purchased from the neighbourhood market. The technique previously reported elsewhere, with modifications, was used to extract starch. The red rice was first soaked in a sodium metabisulfite solution (0.2 percent) (Sigma-Aldrich, So Paulo, Brazil) in a ratio of 1:2 (w/v) for 48 hours before being washed under running water. The starch suspension was then created by homogenising the treated red rice with distilled water at a ratio of 1:2 (w/v) for 5 minutes in an industrial blender (Manufacturer Kohlbach, model KM42A). To boost the yield of the process, the filtration residue was once more homogenised. To prevent enzymatic or fermentative activity during the settling process, the starch suspension was decanted for 24 hours in a refrigerator at 7 °C. The decanted starch was dried using convection at 50 °C until it reached a consistent weight. Finally, to prevent the loss of bioactive chemicals, the native starch was vacuum-packed, kept at room temperature (25±3 °C), and protected from light (Almeida, *et al*., 2021) [22].

3.2.5 Red Rice in GABA- enriched Yogurt

A study was conducted utilizing red rice that had been germinated to produce yoghurt with higher GABA levels. Ingredients used were 100 g of milk, Skim milk powder - 4 gm, Sucrose- 5 gm, 17gm of starter culture (*L. bulgaricus* and *S. thermophillus*) all this was given 5 minutes at 92°C milk heating. Sucrose and skim milk powder were then included. After being chilled to 45°C, the mixture was infused with the starter and allowed to ferment at room temperature. When the pH of the yoghurt hit 4.4–4.6 and it was kept at 4°C, the fermentation was terminated. In this experiment, commercial yoghurt served as a control. By adding 30, 35, and 40% (w/w) of germinated red rice paste to the formula instead of milk, the yogurt's GABA levels were increased. The GABA content of the final yoghurt recipe was then analyzed. (Jiamyangyuen, *et al*., 2009) [23].

4. Commercial value

The World Bank's Assam Agribusiness and Rural Transformation Project, is working to improve the crop's prospects. Study revealed that this year they worked to improve the productivity and marketability of black rice. They are also developing climate-resistant varieties is also their focus of study. The Assam Agricultural University's Regional Agricultural Research Station is close to releasing high-yielding varieties of the traditional black rice. Twelve high-yielding black rice lines have already been developed and evaluation is going on. The developed varieties will be available in the market within a year or two (Naqvi, *et al*., 2020) [24]

Red rice & black rice both fetches premium rates of Rs.300–500 per kg due to its limited production and growing recognition of its nutraceutical benefits. Both are available from numerous internet merchants. Red rice is offered by Indiamart under a number of brand names, including Himalayan Red Rice and Organic Red Rice. Sainj Valley Exotic Growers, Shimla (Red Rice), Himalayan Grassroot Organics, Kullu (Himalayan Red Rice), Sauhta Apples, Shimla (Red Rice from Himachal Pradesh), Spankil, Shimla (Himalayan Red Rice), and others are internet sellers of red rice (Thakur, *et al*., 2020) [9]. Black rice is also available in various E-commerce sites such as Amazon, Indiamart under different brand names that includes Swabhiman33, Organics Black rice, Weefa organic black rice & etc. all comes in different quantities and different prices.

5. Future prospects

Red & black rice farming is becoming extinct due to the development of high value cash crops including apples, vegetables, and other high producing rice varieties and hybrids. But right now, as people become more conscious of the relationship between nutrition and health, demand for foods high in nutrients is rising. A practical policy and marketing plan are urgently needed to encourage farmers and the development of rice in its traditional areas of agriculture in light of the rising demand and declining area under these rice varieties. It is urgently necessary to have a well-developed post - harvest value chain so that this naturally occurring gift, which is rich in nutraceuticals, can be enjoyed by consumers everywhere (Kumari, *et al*., 2020) [3].

6. References

1. Itani T, Ogawa M. History and recent trends of red rice in Japan. Japanese Journal of Crop Science. 2004;73(2):137-147.
2. Ito VC, Lacerda LG. Black rice (*Oryza sativa* L.): A review of its historical aspects, chemical composition, nutritional and functional properties, and applications and processing technologies. Food chemistry. 2019;301:125304.
3. Kumar N, Murali RD. Black Rice: A novel ingredient in food processing. J Nutr Food Sci. 2020;10(2):771.
4. Masni Z, Wasli ME. Yield performance and nutrient uptake of red rice variety (MRM 16) at different NPK fertilizer rates. International Journal of Agronomy, 2019.
5. Sangma HCR, Parameshwari S. Health benefits of black rice (*Zizania aqatica*)-a review. Materials Today: Proceedings, 2021.
6. Pengkumsri N, Chaiyasut C, Saenjum C, Sirilun S, Peerajan S, Suwannalert P, *et al*. Physicochemical and antioxidative properties of black, brown and red rice varieties of northern Thailand. Food Science and Technology. 2015;35:331-338.
7. Saleh AS, Wang P, Wang N, Yang L, Xiao Z. Brown rice versus white rice: Nutritional quality, potential health benefits, development of food products, and preservation technologies. Comprehensive Reviews in Food Science and Food Safety. 2019;18(4):1070-1096.
8. Thomas R, Wan-Nadiah WA, Bhat R. Physiochemical properties, proximate composition, and cooking qualities of locally grown and imported rice varieties marketed in Penang, Malaysia. International Food Research Journal. 2013;20(3).
9. Thakur AK, Kumari N. Red Rice in Himachal Pradesh: History, Tradition and Uses. International Journal of Economic Plants. 2020;7(2):060-065.
10. Sah SK, Kushwaha UKS. Book Review: Black Rice: Research, History, and Development. Advance Plants Agriculture Research. 2016;5(1):00165.
11. Kim YS, Kim GH, Lee JH. Quality characteristics of black rice cookies as influenced by content of black rice flour and baking time. Journal of the Korean Society of Food Science and Nutrition. 2006;35(4):499-506.
12. Klunklin W, Savage G. Biscuits: A substitution of wheat flour with purple rice flour. Advances in Food Science

and Engineering. 2018;2(3):81-97.
13. Guo H, Ling W, Wang Q, Liu C, Hu Y, Xia M, *et al*. Effect of anthocyanin-rich extract from black rice (*Oryza sativa* L. indica) on hyperlipidemia and insulin resistance in fructose-fed rats. Plant Foods for Human Nutrition. 2007;62(1):1-6.
14. Itthivadhanapong P, Sangnark A. Effects of substitution of black glutinous rice flour for wheat flour on batter and cake properties. International Food Research Journal. 2016;23(3):1190.
15. Thanuja B, Parimalavalli R. Role of black rice in health and diseases. Int. J. Health Sci. Res. 2018;8:241-248.
16. Ma J, Kaori F, Ma L, Gao M, Dong C, Wang J, *et al*. The effects of extruded black rice flour on rheological and structural properties of wheat-based dough and bread quality. International journal of food science & technology. 2019;54(5):1729-1740.
17. Meza SLR, Sinnecker P, Schmiele M, Massaretto IL, Chang YK, Marquez UML. Production of innovative gluten-free breakfast cereals based on red and black rice by extrusion processing technology. Journal of food science and technology. 2019;56(11):4855-4866.
18. Croitoru C, Mureșan C, Turturică M, Stănciuc N, Andronoiu DG, Dumitrașcu L, *et al*. Improvement of quality properties and shelf life stability of new formulated muffins based on black rice. Molecules. 2018;23(11):3047.
19. Das AB, Bhattacharya S. Characterization of the batter and gluten-free cake from extruded red rice flour. LWT. 2019;102:197-204.
20. Gusmão TAS, de Gusmão RP, Moura HV, Silva HA, Cavalcanti-Mata MERM, Duarte MEM. Production of prebiotic gluten-free bread with red rice flour and different microbial transglutaminase concentrations: modeling, sensory and multivariate data analysis. Journal of food science and technology. 2019;56(6):2949-2958.
21. de Magalhães CS, de Almeida Marques G, Bazán-Colque RJ, Moraes EA, da Silva EMM, Ascheri JLR. Impact on technological properties, sensory acceptance, bioactive compounds, and nutritional quality of blend pinto beans and red rice for novel cookies, 2022.
22. Almeida RLJ, dos Santos Pereira T, Almeida RD, Santiago ÂM, de Lima Marsiglia WIM, Nabeshima EH, *et al*. Rheological and technological characterization of red rice modified starch and jaboticaba peel powder mixtures. Scientific Reports. 2021;11(1):1-11.
23. Anawachkul M, Jiamyangyuen S. The study of GABA content and development of GABA-enriched yogurt from germinated red rice (Munpu rice). Agriculture and Natural Resources. 2009;43(5):224-231.
24. NAQVI S. In Assam, cultivation of this flood-resilient superfood has boosted farm income over four years. Retrieved 2020 Jul 26.