Black Rice: An emerging 'super food'

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ABSTRACT: Rice (*Oryza sativa* L.) is the major cereal crop in most of the developing countries. Black rice is a type of pigmented rice with black bran covering the endosperm of the rice kernel. Black rice 'Chakhao' is an aromatic and pigmented rice variety popular in Asia, whose demand and consumption is increasing day by day in India as well as in the world due to its numerous health benefits. Black rice is grown under rainfed condition in both upland and lowland rice ecosystem. It is not consumed as staple food but consumed as the functional foods because of its anthocyanin content, acts as major bio-active compound. Accumulation of anthocyanin (Cyanidin-3-glucoside, cyanidin-3-rutinoside, and peonidin-3-glucoside) in the pericarp, tegmen and aleurone layer promotes black color to rice grains. Anthocyanins are water soluble pigment which is responsible for the antioxidative and anti-inflammatory properties of black rice. It has potential use in nutraceutical or functional food formulation.

Key words: Aromatic, anthocyanin, antioxidative, black rice, water soluble pigment

"A spoonful of black rice bran contains more health promoting anthocyanin antioxidants than in a spoonful of blueberries, but with less sugar, more fiber and Vitamin E antioxidants."

-Dr. Zhimin Xu

Rice (*Oryza sativa* L.) is the staple food for more than half of the world's population. In India, it is cultivated over an area of 43.86 million hectares with 117.47 million tones of production (DAC&FW, 2019-20). It plays a significant role in the nation's economy. Rice is of different types based on the size of grains, texture, aroma, maturity duration, growing environment and colour (polished, black, red, purple and brown). The colored rice varieties are considered to have numerous health benefits. Black rice (*Oryza sativa* L. indica), is a special cultivar of rice which contains remarkably high anthocyanin pigments in the aleurone layer than white and red rice which account for its violet or dark purple color (Hou *et al.,* 2013).

Black rice is locally known as 'Chakhao', means delicious rice in Manipuri language is cultivated mainly by Meitei farmers of Manipur. There are four landraces of black rice in Manipur which includes *Chakhao amubi*, *Chakhao angouba*, *Chakhao poireiton* and *Chakhao pungdol amubi*. Black rice is almost six times richer in antioxidant activities, have high protein content (8.16%) and low fat content (0.07%) (Thomas *et al.,* 2013) as compared with other rice varieties, is gluten free, gut friendly and a natural cleaner with many medicinal values (Jha *et al.,* 2017). Black rice contains essential amino acids like lysine, tryptophan, functional lipids, dietary fibre, vitamins such as vitamin B1, vitamin B2, vitamin E, folic acid and phenolic compounds (γ-oryzanols, tocopherols, tocotrienols). It has a mild nutty flavor and is slightly sticky when cooked. It is rich in macro and micro nutrients including iron, zinc, calcium, phosphorus and selenium and low in calories. Black rice is rich in nutrients and protein content compared with the other varieties of rice grown in northeast India. It is often mixed with white rice before cooking to increase flavor, quality and palatability. Due to higher fiber content it has lower digestibility, takes more time to cook than white rice and feels rubbery while chewing. To overcome this, black rice is parboiled to reduce cooking time and improve the textural quality of grains but color might be lost during this process. In recent time, it has become popular in food, cosmetic, nutraceutical and pharmaceutical applications owing to its numerous health benefits. Black and red rice is resistance to insect and pest than the brown rice. In black rice anthocyanins are found in higher concentrations than in dark fruits, such as blueberries, blackberries, dark grapes and dark cherries. Hence, it is better source of antioxidants than blueberry (Kushwaha, 2016). A recent study reported that pigmentation in black rice results from the activity of the Kala4 gene, which is necessary for anthocyanin synthesis (Pratiwi *et al.,* 2017).

History

Black rice has been consumed for centuries in Asian countries such as China, Korea and Japan. It has been reported that black rice has greater antioxidant activity than white rice. In Asian countries, China and Indonesia common people were not allowed to store/ cultivate/ consume black rice during imperial period without permission of the authorities and was solely consumed by royals and elite personalities and used as a tribute food. In ancient times it was believed that black rice would

increase the life span and good health of king and was considered very superior and rare. Black rice is known by many names such as forbidden rice, imperial rice, king's rice, purple rice, heaven rice and prized rice (Kushwaha, 2016) and is packed with high level of antioxidants and micronutrients. Now, black rice is consumed and grown in many countries. In India, black rice is grown in Manipur on small scale by traditional farmers. China is the richest country in the black rice resources (62%) followed by Srilanka (8.6%), Indonesia (7.2%), India (5.1%), Bangladesh (4.1%) and few in Malaysia (Chaudhary, 2003). So far they have developed 200 varieties including 52 high yielding varieties (Biswas, 2018).

Comparison of different colored rice

Several study on nutrient analysis shows that nutritional value of rice depends on several factors such as soil nutritional quality, strain or variety i.e., black , red, brown, polished rice, degree of milling etc. Black rice varieties are exceptionally rich in protein and fibre while red rice is known for its high iron and zinc content.

Medicinal and therapeutic uses

Continuous consumption of white rice as staple food grain has resulted in malnutrition, anemia and aggravated diabetes (Jena and Mishra, 2019). In such case, black rice becomes an alternative as it is consumed as functional food due to its health benefits. Black rice has drawn attention of the scientific community and gained importance in recent times due to its high nutritive value, curative effect, anti-carcinogenic and anti-oxidant properties. So, black rice has the potential to become a functional food ingredient.

- Anthocyanins such as cyanidin-3-O-glucoside and peonidin-3-O-glucoside are the major constituents of black rice which function as antioxidants.
- Anthocyanin has a protective effect against inflammation, protection from cardiovascular diseases, atherosclerosis and carcinoma.
- Black rice is good for people suffering from diabetes and alzheimer's disease (Jena *et al.,* 2019).
- It helps to protect arteries, controls blood lipid, prevent oxidative DNA damage, reduces cholesterol levels as well as cancer cell invasion and decreases cancer risk/prevent tumors. (Adom and Liu, 2002; Kim *et al*., 2010).
- Vitamin E, an important antioxidant present in black rice is beneficial for maintain eye and skin health, skin firmness, restore elasticity and promote hair growth.
- Black rice bran is one of processed foods derived from plants and has a decreasing effect in blood sugar concentration. Extracts of black rice bran, possess strong scavenging activities for reactive oxygen species (ROS), inhibits the formation and protects the body from the action of free radicals.
- It also helps support memory function and coordination (Saha, 2016).
- Black rice is associated with the reduction in weight when consumed regularly as it has low fat and calories and also useful for patients suffering from chronic constipation as it helps in improving the bowel movements.
- It improves body's resistance to disease, improves damage to liver cells (hepatitis and chirrosis), prevents impaired kidney function, slows down anti-aging.
- Anthocyanins function as antioxidants, responsible for anti-adipogenic activities and other black rice components, such as ferulic acid and coumaric acid contribute to the proosteogenic effects (Jang *et al.,* 2015).
- Black rice can also increase immunity, improve liver function, prevent impaired kidney function, clean cholesterol in the blood, etc. It prevents hardening of the arteries and formation of uric acid in the body (Yuniarti *et al*., 2019)

Potential benefits of black rice

Black rice is similar to quinoa as a beneficial /super food and pack of nutrients. Farmers can be benefited from better market value and increased farm income due to its multi-nutritional quality and it will encourage farmers for its cultivation widely. Black rice consumption can mitigate the need of cereal with high nutritional status. Black rice is sold in the local market which fetches higher prices (Rs 150-200/kg) due to higher grain quality and more market value (Borah *et al.,* 2018). It presents a great importance in the food industry due to the high content of polyphenols which can be isolated as fractions to use them

Table1: Nutrient content of different colored rice is mentioned below based on nutrient composition

Rice	Protein (g)	Fat (g)	Iron (mg)	Zinc (mg)	Crude fibre (g)
Black rice	9.0	1.0	3.5	0.0	0.51
Red rice	7.2	2.5	5.5	3.3	0.45
Brown rice	8.4	2.2	2.7	1.7	0.42
Polished rice (white)	6.1	1.4	1.3	0.5	0.33

as functional colorants or as food ingredients. (Kushwaha, 2016) found that one-fourth cup uncooked black rice contains approximately (in daily recommended values) 160 kcal energy, 1.5 g of fat, 34 g of carbohydrate, 2 g of fiber, 7.5 g of protein, no saturated fat and cholesterol.

Other uses

- Black rice is a better source of anthocyanins than blueberries (Kushwaha, 2016).
- Water soluble anthocyanin pigment can be extracted while cooking and can be used as natural dye.
- It is used as anti-aging agent in cosmetic materials and healthy foods (Kaneda *et al.,* 2006).
- In Manipur, black rice is famous for preparing rice wine among tribal community of Manipur.
- Black rice is an excellent substrate for wine production with high polyphenol content and can be used as a functional beverage (Jha *et al.,* 2017).
- It is used in variety of Chinese and Thai dishes.
- Black rice is used in community feasts and rituals in Manipur.
- It is used for making kheer, porridge, bread, black rice cake etc.
- Black rice straws are preferred as thatching material because of higher culm length and durability.
- After threshing husk is used as livestock feed and also used in farmyard manure preparation.

Constraints in black rice production

- Utilization of black rice as a product is still minimal in India.
- The potential of black rice is not yet optimally utilized which is one of the inhibiting factors for its low productivity.
- It is less popular among farmers due to its inherent undesirable traits such as low yield, highly photo-insensitive, longer vegetative phase, tall stature which causes its loading, are the main reason behind its un-adoption among farmers.
- Lower productivity and higher price are the reason behind in accessibility of nutrient enriched black rice by common people.

Future aspects

- More research needs to be done in black rice to strengthen sustainability by preserving the local black rice species of Manipur and can improve desirable traits in best rice varieties.
- Introduction of special rice (black rice, red rice etc.) as main crop and awareness among the people can eradicate the malnutrition issues to some extent.
- To develop varieties with desirable agronomic and marketable traits can increase its wide adoption for cultivation purpose in different regions in India.
- To obtain superior varieties, improvement of phenotype and genotype is necessary.
- Indian black rice 'Chakhao' is tolerant to drought stress and resistance to insect pests. Hence, it can be used to develop rice lines with improved grain quality, yield potential and antioxidant properties.
- Black rice productivity needs to be increased to compensate its long harvest time. So, it is necessary to develop varieties that can give early and higher yield.

REFERENCES

Adom, K.K. and Liu, R.H. (2002). Antioxidant activity of grains. *Journal of Agricultural and Food Chemistry,* 50(21): 6182-6187.

Biswas, J.K. (2018). A Few Words on Black Rice. *Malaysian Journal of Halal Research,* 1(1): 1-2.

Borah, N., Athokpam, F.D., Semwal, R.L. and Garkoti, S.C. (2018). Chakhao (Black Rice; *Oryza sativa* L.): A culturally important and stress tolerant traditional rice variety of Manipur. *Indian Journal of Traditional Knowledge,* 17(4): 789-794.

Chaudhary, R.C. (2003). Specialty rices of the world: effect of WTO and IPR on its production trend and marketing. *Journal of Food, Agriculture and Environment,* 1: 34-41.

DAC&FW, 2019-20. Second Advance Estimates of Production of Foodgrains. Directorate of Economics and Statistics. New Delhi, India: Ministry of Agriculture and Farmers Welfare, Government of India.

Hou, Z., Qin, P., Zhang, Y., Cui, S. and Ren, G. (2013). Identification of anthocyanin isolated from black rice (*Oryza sativa* L.) and their degradation kinetics. *Food Research International,* 50(2): 691-697.

Jang, W.S., Seo, C.R., Jang, H.H., Song, N.J., Kim, J.K. and Ahn, J.Y. (2015). Black rice (*Oryza sativa* L.) extracts induce osteoblast differentiation and protect against bone loss in ovariectomized rats. *Food and Function,* 6: 264-274.

Jena, J. and Mishra, S.R. (2019). Nutritional outlook of rice. *Agriculture and Food: E-Newsletter,* 1(12): 372-374**.**

Jha, P., Das, A.J. and Deka, S.C. (2017). Optimization of saccharification conditions of black rice (cv. Poireton) using microbial strains through response surface methodology. *Journal of the Institute of Brewing,* 123: 423-431.

Kaneda, I., Kubo, F., Sakurai, H. (2006). Antioxidative compounds in the extracts of black rice brans. *Journal of Health Sciences,* 52(5): 495-511.

Kim, C., Kikuchi, S. and Kimetal, Y. (2010). Computational identification of seed-specific transcription factors involved in anthocyanin production in black rice. *Bio Chip Journal,* 4(3): 247-255.

Kushwaha, U.K.S. (2016). *Black rice. Research, History and Development.* Springer (Ed), Switzerland, ISBN 978-3-319-30153-2.

Pratiwi, R. and Purwestri, Y.A. (2017). Black rice as a functional food in Indonesia. *Functional Foods in Health and Disease,* **7**(3): 182-194.

Saha, S. (2016). Black Rice: The New Age Super Food (An Extensive Review). *American International Journal of Research in Formal, Applied and Natural Sciences,* 16(1): 51-55.

Thomas, R., Wan-Nadiah, W.A. and Bhat, R. (2013). Physiochemical properties, proximate composition, and cooking qualities of locally grown and imported rice varieties marketed in Penang, Malaysia. *International Food Research Journal,* 20(3):1345-1351.

Yuniarti, A., Machfud, Y., Damayani, M. and Solihin, E. (2019). The application of various types of organic fertilizer and N, P, K combination on soil fertility, growth and yield of black rice. International Seminar and Congress of Indonesian Soil Science Society. IOP *Conference Series: Earth and Environmental Science,* 393 012019.

Received: May 4, 2020
Accepted: May 13, 2020