



BLACK RICE: THE NEW AGE SUPER FOOD (AN EXTENSIVE REVIEW)

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Abstract: Black rice is a super nutritious type of rice species *Oryza sativa L.* which is black colored, glutinous, nutty flavoured, packed with high levels of nutrients. Black colour of this rice is due to the presence of flavonoids pigments called "anthocyanins" which are powerful antioxidants equivalent to that of blue and black berries. Being a treasure house of antioxidants, fiber, mineral and amino acids it is capable of combating and preventing a wide spectrum of health problems ranging from cardiovascular disease, cancer, diabetes mellitus, allergies to Alzheimer's disease. Black rice is considered as nature's most well balanced "super food" by scientist and researcher. As it is still less popular than white and brown rice so it is necessary to establish its different aspects that are beneficial to human health. A significant increase in black rice consumption may be achieved by stressing and publicizing its health promoting effects.

Keywords: Black rice; anthocyanins; anti-oxidants; super-nutritious; cancer; super-food

I. Introduction

Rice is the foremost cereal food crop in many developing countries. About half of the world population consumes rice as their major source of carbohydrate. Almost 95% of the rice production is recorded in Asian countries [1]. White rice is the most commonly consumed rice, but there are several rice cultivars which contain color pigments, such as black and red rice. Rice varieties with colored pericarp (other than white and red) are usually known as "black rice" [2].

Black rice is a type of the rice species *Oryza sativa L.* which is black in colour, glutinous, packed with high level of nutrients and mainly cultivated in Asia. It is actually heirloom rice means it is open pollinated, was grown at earlier times in the history and is not grown on a large scale in modern agriculture. It also comes in a number of short grain, long grain and glutinous varieties similar to brown rice with a slightly nutty flavour and its texture is smooth, firm not at all sticky like most white rice. Black rice includes many more varieties of dark colour rice like Forbidden rice, Purple rice, Japonica black rice, Chinese black rice, Indonesian black rice and Thai black rice. The reason they are grouped under the term "Black Rice" is the unusual dark/black colour of the grain. The pericarp (outer part) of kernel of this rice colour is black due to presence of high amount of a powerful pigment known as anthocyanins, which are flavonoids that perform as antioxidants in the body. This anthocyanin is most typically observed in fruits such as blueberries and blackberries. Once cooked, the color lightens into deep purple/violet colour. That's why it is also called "purple rice". This unusual colour makes it very popular for dessert.[3]

Black rice now widely considered as a 'super food' by researchers and scientists. The term 'super food' is used to describe food items with extremely high nutritional value. Black rice is a super nutritious type of rice that is high in fiber, antioxidants, vitamins B, vitamin E, iron, thiamine, magnesium, niacin and phosphorous.[3] [4]

Not only it is the type of rice that is richest in powerful disease fighting antioxidants but also it contains anti-inflammatory, anti-carcinogenic properties and has an ability to stop the development of diabetes mellitus, cancer, heart disease, and even weight gain. [5]

Demand for this rice is growing fast in the USA and European countries due to its value as a healthy food and its attractive organic food color. It has been eaten throughout Asia for thousands of years and has a significant history of use in China, India and Thailand. This rice is becoming popular among rice consumers and dieticians day by day mainly because of its high nutritive and medicinal value. Therefore, black rice is becoming the new "IT" organic food that everyone is talking about and the attention it is getting is well deserved. [3]

II. Aims and Objective

- To study the scientific literature on black rice (*Oryza sativa L.*).
- To provide information about the nutritive value and phytochemical properties of black rice to people.
- To get idea about its medicinal and therapeutic benefits.

- To list out its culinary uses.
- To increase its production and exporting by considering both positive and negative impact.
- To create awareness and promote the consumption of black rice among consumer.

III. Discussion

HISTORICAL BACKGROUND OF BLACK RICE:-

Black rice has an incredibly rich cultural history. In ancient china and Indonesia black rice was considered so superior, tasty and rare that it was exclusively reserved for the emperor and used as a tribute food. Common people were not allowed to have this. So it was called “Emperor’s rice”. The Emperor says, “Hands off the black rice! It’s mine”. Royal families and kings of ancient China used to eat this special rice to ensure their longevity and good health.

It was also known as “Forbidden rice” as the name might imply, consuming it without approval from the proper authorities can have life threatening consequences for those involved. [3][5]

But times have changed and now it is available to the different parts of world. Black rice is commonly cultivated and eaten in Manipur, called “*Chakho ambi*” in, Manipuri language which is eaten during community feasts. “Chakho” means delicious and “amubi” means black, thus translating the name to “delicious black rice”. [6]

ORIGIN AND SPREAD OF BLACK RICE:-

Although the events surrounding the origin and spread of black rice traits remain unknown, varieties with black grains due to anthocyanin accumulation are distributed in various locations throughout Asia. A paper published in *The Plant Cell* reveals the answer to the long-standing question of how black rice became black and, moreover, traces the history of the trait from its molecular origin to its spread into modern-day varieties of rice. Researchers from two institutions in Japan collaborated to meticulously examine the genetic basis for the black color in rice grains. They discovered that the trait arose due to a rearrangement in a gene called *Kala4*, which activates the production of anthocyanin. Both the *Rc* and *Kala4* genes activate upstream flavonol biosynthesis genes, such as *chalcone synthase* and *dihydroflavonol-4-reductase*, and downstream genes, such as *leucoanthocyanidin reductase* and *leucoanthocyanidin dioxygenase*, to produce the respective specific pigments. They concluded that this rearrangement must have originally occurred in the *tropical japonica* subspecies of rice and that the black rice trait was then transferred into other varieties by crossbreeding. According the study’s lead scientist, Dr. Takeshi Izawa, “The birth and spread of novel agronomical traits during crop domestication are complex events in plant evolution.” This new work on black rice helps explain the history of domestication of rice by ancient humans. [7]

Black rice was actually only first introduced to United States in the 1990s although it has been enjoyed in other part of the world for many more years. Chaudhury and Tran (2001) reported that black rice might be originated from Srilanka, Phillipine, Bangladesh, Thailand, Myanmar and Indonesia. 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. [8][9]

TYPES AND VARIETIES:-

Black Japonica Rice: It is a combination of black short-grain rice and mahogany medium-grain rice grown together in the same field. It has an earthy flavor with a mild, sweet spiciness.

Black Glutinous Rice: - It also known as black sticky rice is short-grain rice with a sweet flavor and sticky texture. The grains are unevenly colored and are often used to make sweet dishes in Asia.

Italian Black Rice: - It is long-grain rice that combines Chinese black rice with Italian rice. It has a rich, buttery flavor.

Thai Black Jasmine Rice: - It is medium-grain rice from Thailand that combines Chinese black rice with jasmine rice. It has a subtle floral aroma when cooked. [9]

AROMATIC COMPONENT OF BLACK RICE:-

Black rice has a relatively intense flavor that is distinctly different from other types of aromatic rice. Flavor is considered the single most critical quality trait in rice affecting consumer preference [10]. Black rice has magical aromas. It has deliciously nutty taste, soft texture and a beautiful deep purple colour that makes it a striking presence in any dish. [3]

Thirty-five volatile compounds were identified by gas chromatography-mass spectrometry using a dynamic headspace system with Tenax trapping. There were 10 aromatic, 4 nitrogen-containing, 6 alcohol, 10 aldehydes, 3 ketones, and 2 terpenoids compounds. The relative proportion of the main classes of volatiles in 100% black rice was significantly different from that in 100% white rice. The relative proportion of aromatic and nitrogen-containing compounds in black rice was significantly greater than in white rice, whereas white rice had higher relative proportions of alcohols, aldehydes, ketones, and terpenoids.

The concentration of 2-acetyl-1-pyrroline (2-AP) was high, exceeded only by hexanal, nonanal, and 2-pentylfuran. 2-AP, guaiacol, indole, and *p*-xylene largely influenced the difference between the aromas in cooked black and white rice. 2-AP and guaiacol were major contributors to the unique character of black rice based on odor thresholds, relative concentrations, and olfactometry. [11]

PHYTOCHEMICAL PROFILES AND ANTIOXIDANT ACTIVITY:-

Several studies have shown that black rice is potent source of phytochemical. 23 secondary metabolites, comprising anthocyanins, flavones, flavonoids glycosides (Quercetin-3-O-glucoside, isorhamnetin-3-O-glucoside and myricetin-7-O-Glucoside), carotenoids, vitamin E (tocopherols and tocotrienols) and γ -oryzanols have been qualitatively and quantitatively characterized in the dehulled seeds of Japanese black-purple rice which provides health benefits and ensure the use of black rice as functional food. [12][13].

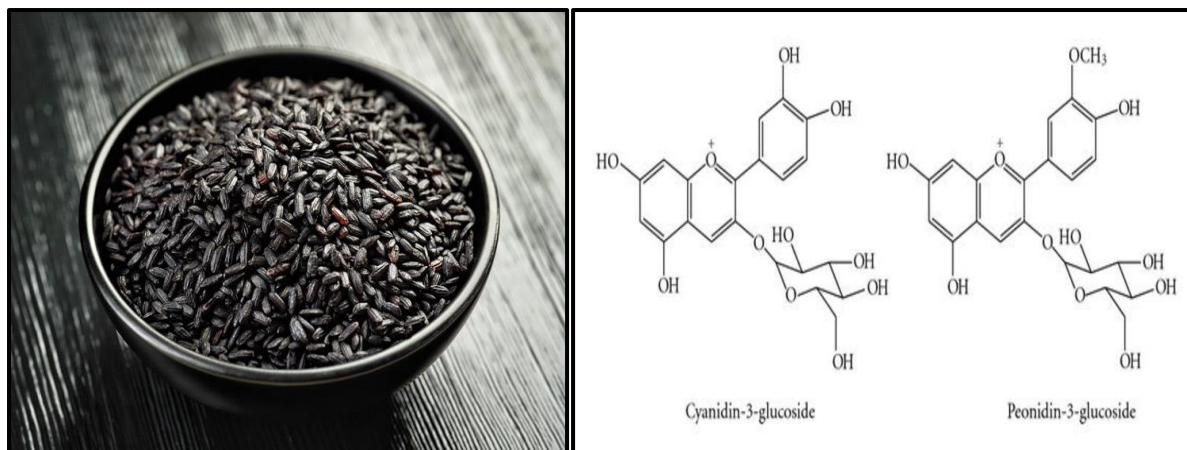


Figure 1:- Black rice and its anthocyanin components

The colour of this rice is due to the presence of a powerful pigment called “anthocyanin”. The anthocyanin components in black rice are about 26.3 %, and cyanidin-3-O-glucoside and peonidin-3-O-glucoside are the main effective constituents accounting for about 90 % [14].

Anthocyanins are the flavonoids pigments and are the source of antioxidants that protect against free radicals which cause aging, cancer and disease. It also helps support memory function and coordination. [15] Black rice has been found to rival blueberries in terms of antioxidant power. A study presented in 2010 at the American Chemical Society by Dr Zhimin Xu, reports that one spoonful of black rice bran contains more anthocyanin than a spoonful of fresh blueberries.[3][4]

NUTRITIVE VALUE OF BLACK RICE:-

Nutritive value of black rice is superior to any other rice. This rice is free of gluten, free of cholesterol, low in sugar, salt and fat. It is a whole grain, super nutritious type of rice that is high in fiber, anthocyanin, antioxidants, vitamins B complex and E, iron, thiamine, magnesium, niacin and phosphorous. It is estimated that 50 gm of black rice provides 35% of RDA of selenium, copper, zinc and magnesium per day. Quality and quantity of protein is higher than any other rice varieties. It contains 18 amino acids .Being a naturally good source of iron it is excellent for those concerned about getting enough iron on a plant based diet. One half serving of cooked or 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, no cholesterol. [3].

HEALTH BENEFITS OF BLACK RICE:-

1. ANTI-INFLAMMATORY PROPERTIES: Researchers from the University of Suwon in South Korea carried out animal tests on both black rice bran and brown rice bran for their effectiveness against skin inflammation. They found that black rice bran did suppress dermatitis while brown rice bran did not. They suggest that black rice may be a “useful therapeutic agent for the treatment and prevention of diseases associated with chronic inflammation.” [16] Another study suggests that the main constituent of black rice (C3G) is highly effective at suppressing inflammation in the body. [17]
2. WEIGHT MANAGEMENT:- Black rice is associated with the reduction in weight when consumed regularly. Black rice is basically unpolished rice and therefore it is rich in fiber. This will make the person feel full easily. Thus the proportion of food ingestion is reduced. Besides, the fiber content also facilitates easy bowel movements. Thus it helps in detoxification.
3. Moreover it has low fat, low calories which help in weight loss. Research shows that black rice extractive suppress adipogenesis. In cell stimulated with black rice extractive the rate of fatty acid synthesis was

significantly decreased but there was no effect on the rate of fatty acid oxidation, resulting in reduced intracellular lipid accumulation. [3][18]

4. **CARDIOVASCULAR DISEASE PREVENTION:-** American Health Association, and the 2005 Dietary Guidelines for Americans recommended an increase in the consumption of black rice to prevent heart disease.[19] Antioxidant present in black rice named anthocyanin lowers LDL cholesterol level thus decreasing the chances of atherosclerosis and heart attack, lower blood pressure and keeps our heart healthy. It also inhibits cholesterol absorption. [3][20]
5. **ANTI-CANCER EFFECTS:-** Anthocyanins, like other antioxidants, help protect the body from free-radical damage, which can lead to cancer A study showed that anthocyanins extracted from black rice drastically inhibit the spread of specific cancers by restricting the damage of DNA. A more recent study, has also indicated that black rice anthocyanins have the potential to stop tumor metastasis in breast cancer cells.[3][21]
6. **ANTI-DIABETIC EFFECTS:-** Black rice contains low quantities of sugar and high amounts of fiber which are known to protect the body from diabetes mellitus. It does not trigger fluctuations in blood glucose levels that white rice tends to cause. Black rice also contains essential minerals which help to regulate blood pressure. Therefore diabetics stand to benefit considerably by including black rice in their diet.[3]
7. **REDUCES ALLERGIES:-** Studies have shown that black rice may help to alleviate the inflammation that occurs in allergies and other illnesses. The bran or outer husk of the rice may help to restrict the release of histamine. Histamine is responsible for the symptoms of allergies. Black rice also helps to soothe the irritation and swelling that occurs due to allergic contact dermatitis. [3]
8. **PREVENTION OF CONSTIPATION:-** Black rice is rich source of fibers. So this is useful for patients suffering from chronic constipation as it helps in improving the bowel movements.[3]
9. **ROLE IN ANAEMIA:-** Black rice is rich source of iron. The dark colour of it is due to the iron content in it. Iron when ingested in natural form is easier to get absorbed in the body. Thus it is beneficial for people who are anaemic to improve overall total iron in their body. [3]
10. **SKIN AND HAIR CARE:-** The antioxidants in black rice that is anthocyanins helps to protect the body from damage caused by free radicals. Antioxidants help to prevent premature skin ageing and promote good health of the hair and skin. It helps to maintain skin firmness, restore elasticity and promote hair growth. [3]

More over regular intake of black rice also enhances health, increases longevity, improves digestive health eye vision, lowering the risk of developing cataracts, macular degeneration and other vision problems, protects from osteoporosis and reduces risk of asthma.

CULINARY USES:

Black rice is commonly used as a condiment, dressing or as decoration for different types of desserts in many countries around the world. Because of its unusual purple colour it is very popular as desserts. This rice is suitable for making porridge, traditional Chinese black rice cake. Sushi, pudding, Noodles, biscuits also have been prepared from it. In Korea black rice is usually consumed mixed with white rice. Some popular products of black rice are black rice pasta, wine, chocolates, cookies, bread, porridge, chips etc. black rice extracts are excellent natural food coloring dye which is used as a alternative as artificial food color to different beverages and food. [3]

IV. Conclusion

Black rice is recently referred to as “Super Food” which it truly deserves.”Super Foods” are that types of foods which provide a wide variety of health benefits along with their inherent calorie and nutritive value. This review clearly establishes this fact. Regular consumption of this rice may completely eliminate the possibility of many long term diseases like Alzheimer’s disease, diabetes etc. Though the popularity of black rice is growing in western nations like US, but in India it is still remaining much less popular than white and brown rice and many people are not aware of it. [3] The recent successful venture of the Union Government at Amuguripara in Goalpara district in Assam, where a total of 12 tones of black rice were produced in 13.2 hectares, which comes close to a tone per hectare, is an inspiring example. It shows how, by providing infrastructure, market support and financial incentives, black rice can, indeed, be good bet for Indian rice producers and consumers, domestic as well as foreign [22]. Awareness should be created among the people about this “super food” due to its full nutritional and therapeutic properties so that more people learn about its benefits and demand it.

References

- [1] Bhattacharjee, P., Singhal, R. S., & Kulkarni, P. R., “ Basmati rice: A review”, *International Journal of Food Science & Technology*, 37(1), 1-12. <http://dx.doi.org/10.1046/j.1365-2621.2002.00541.x> , 2002
- [2] Yang DS, Lee KS, Jeong OY, Kim KJ, Kays SJ, “ Characterization of volatile aroma compounds in cooked black rice”, *J Agric Food Chem* 56:235–240, 2003.

- [3] Ujjawak Kumae Singh Kushwaha, "Black rice Research, Hiastor and Development", Springer International Publishing (publisher), e-book-ISBN :978-3-319-30153-2, pp. 21-190, DOI: 10.1007/978-3-319-30153-2, 2016.
- [4] Whole Grain Council "Black Rice Rivals Blueberries As Antioxidant Source", Zhimin Xu, Louisiana State University Agricultural Center Study, presentation at the National Meeting of the American Chemical Society, Boston MA, August 26, 2010,
- [5] Dr Josh Axe, "The Forbidden Rice: Black rice Nutrition and Benefits and how to cook it", Available at : <https://draxe.com/forbidden-rice> (accessed on 14 th july 2016)
- [6] KP Prabhakaran Nair, "Rice: Can India Use this Black Beauty?", 5th February 2016. .
- [7] Oikawa, T., Maeda, H., Oguchi, T., Yamaguchi, T., Tanabe, N., Ebana, K., Yano, M., Ebitani, T. and Izawa, T, "The birth of a black rice gene and its local spread by introgression", *The Plant Cell*, Vol. 27,no. 9 2401-2414, DOI:10.1105/tpc.15.00310, 2015.
- [8] R.C Chaudhary, "Specialty rices of the world: effect of WTO and IPR on its production trend and marketing", *J. Food Agric. Environ*, vol. 1, pp. 34-41, 2003.
- [9] Black rice : Ingredient of the month , American Culinary Federation Education Foundation, 180 centre place way , St Augustin, February 2016.
- [10] Suwansri, S.; Meullenet, J. F.; Hankins, J. A.; Griffin, K, "Preference mapping of domestic/imported Jasmine rice for U.S.-Asian consumers" *J. Food Sci.*, vol. 67, pp. 2420-2431, 2002.
- [11] Dong Sik Yang, Kyu-Seong Lee, O-Young Jeong, Kee-Jong Kim, Stanley J. Kays, "Characterization Of Volatile Aroma Compounds In Cooked Black Rice", *J. Agric. Food Chem.*, vol. 56, no. 1, pp. 235-240, DOI: 10.1021/jf072360c , 2008. Irakli, M. N., Samanidou, V. F., Biliaderis, C. G., & Papadoyannis, N., "Simultaneous determination of phenolic acids and flavonoids in rice using solid-phase extraction and RP-HPLC with photodiode array detection..," *Journal of Separation Science*, vol. 35, pp 1603-1611, 2012.
- [12] Irakli, M. N., Samanidou, V. F., Biliaderis, C. G., & Papadoyannis, N., "Simultaneous determination of phenolic acids and flavonoids in rice using solid-phase extraction and RP-HPLC with photodiode array detection..," *Journal of Separation Science*, vol. 35, pp 1603-1611, 2012.
- [13] T. Sriseadka, S. Wongpornchai, and M. Rayanakorn, "Quantification of flavonoids in black rice by liquid chromatography-negative electrospray ionization tandem mass spectrometry," *J. Agric. Food Chem.*, vol. 60, no. 47, pp. 11723-11732, 2012.
- [14] Chang KK, Kikuchi S, Kim YK, Park SH, Yoon U, Lee GS, Choi JW, Kim YH, Park SC, "Computational identification of seed specific transcription factors involved in anthocyanin production in black rice", *Biochip J*, vol. 4(3), pp. 247-255.
- [15] Adom KK, Liu RH, "Antioxidant activity of grains", *Agric Food Chem.*, vol. 50, pp 6170-6182, 2002.
- [16] SP Choi, SP Kim, MY Kang, SH Nam, Mendel Friedman, "Protective Effects of Black Rice Bran against Chemically-Induced Inflammation of Mouse Skin", *J. Agric. Food Chem*, vol. 58 ,no 18, pp 10007-10015, DOI: 10.1021/jf102224b, August 23, 2010.
- [17] SW Min, SN Ryu, DH Kim, "Anti-inflammatory effects of black rice, cyanidin-3-O-beta-D-glycoside, and its metabolites, cyanidin and protocatechuic acid", *Int Immunopharmacol.*, Vol. 10, no 8, pp 959-66, 2010.
- [18] Se-Young Kim, Yeon-Ji Kim, Young Jae An, Hae-Jeung Lee, Sung-Hyen Lee, Jung-Bong Kim, Haeng-Ran Kim, Sung-Joon Lee, "Black Rice (*Oryza Sativa*, Heukmi) Extracts Stimulate Osteogenesis but Inhibit Adipogenesis in Mesenchymal C3H10T1/2 Cell", Vol. 40, no 2, pp-235-247, DOI: 10.1111/jfbc.12210, 2016.
- [19] USARiceFederation www.usarice.com (accessed on 14 th june 2016)
- [20] Jerzy Zawistowski, Aneta Kopec, David.D Kitts, "Effects of a black rice extract (*Oryza sativa* L. *indica*) on cholesterol levels and plasma lipid parameters in Wistar Kyoto rats", *Journal of Functional*, Vol.1, Issue1, pp.50-56, doi:10.1016/j.jff.2008.09.008, 2009
- [21] Luo LP, Han B, Yu XP, Chen XY, Zhou J, Chen W, Zhu YF, Peng XL, Zou Q, Li SY, "A nti-metastasis activity of black rice anthocyanins against breast cancer: analyses using an ErbB2 positive breast cancer cell line and tumoral xenograft model", *Asian Pac J CncerPrev*, Vol. 15, no 15, pp 6219-25, 2014.
- [22] KP Prabhakaran Nair, "Nothing to beat black rice", *The Hindu*, Businessline, 9th February 2016.