



# Black rice: A review on History, Traditional use, and Pharmacological aspect.

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## Abstract

Black rice (*Oryza sativa* L) originally referred to as “Emperor's rice” in ancient China, is today acknowledged as a functional food with several health benefits and a nutritional powerhouse. A large number of Asian countries primarily depend on Rice as a food supply. The southeast part of India significantly grows Black rice. Initially, it was grown only in and around Manipur, nowadays different varieties of BR are grown in south India. The efficacy of Black rice is foremost when compared to other colored rice in India. This study analyses the agroecological characteristics, where the harvesting time is between June and July. As nutritional composition is considered rich in Protein and fiber. The traditional use, and pharmacological properties of black rice with particular emphasis on the grain's high anthocyanin concentration. It is an excellent addition to the diet due to its high protein, fiber, and rich anthocyanin content. Its phytochemical profile underscores its potential for holistic wellness and supports its significant medicinal use. The primary bioactive component, known as anthocyanins has considerable antioxidants and anti-inflammatory properties. These characteristics support many health benefits, such as Anti-cancer activity where BR has photothermal properties, and anti-atherosclerotic properties. Since it has an inhibitory effect on cholesterol absorption will contemplate the Anti-hyperlipidaemic effect and hepatoprotective properties.

## Keywords

*Black rice, Anthocyanin, Anti-cancer, Anti- atherosclerotic, Antioxidant.*

## 1. Introduction

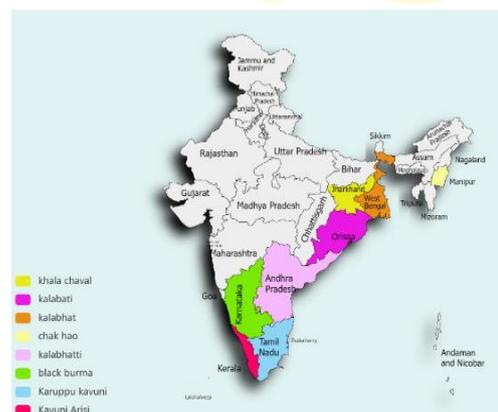
Rice (*Oryza Sativa* L.) is a staple food in several countries in Asia. Most varieties of rice have white grains, but some have brown, red, and black pigmentation. These different varieties of rice are categorized based on the physical appearance of the rice bran. Most of the Asian nations rely heavily on rice as a food source. Rice is a dominant part of the population's diet for one and half of the world's population (Ito et al., 2019). The majority of the rice cultivars have white grains; however, others have grains that are brown, red, and black. In Asia, rice genotypes with black, red, and purple bran layers have been harvested. The internal kernel of a rice grain

is protected by an impact-resistant husk. The pigmentation associated with particular phytochemicals influences the grain color (Xia et al., 2006). Rice genotypes with black, red, and purple bran layers have been cultivated for a very long time in Asia. Rice grains have a hard husk protecting the kernel inside. The grain color is determined by the pigmentation of certain phytochemicals. Black rice is considered a potential food due to its high secondary metabolite content and its high antioxidant activity. Black rice contains higher levels of protein, vitamins, and minerals. When compared to other types of colored rice. They also contain essential amino acids like lysine, and tryptophan, vitamins such as vitamins B1, and B2, and folic acid, and also black rice is a good source of minerals including iron, zinc, calcium, phosphorous, and selenium. Black rice has the highest bioactive substances, including tocopherols, oryzanols, polyphenols, B vitamins, and fiber, of all the colored grains studied to date. BR grains contain several subgroups of flavonoids, especially flavones, flavanols, flavanones, and isoflavones, which are usually identified as C-Glycosides, according to (Ito et al., 2019). According to researchers, the chemical makeup of black rice pigment (BRP), which also contains glycosyl and aromatic groups, contains a hydroxyl group. More the twenty different cultivars of the *Oryza* genus are available, having *O. sativa* L and *O. glaberrima* Steudel constituting the most frequent and commonly cultivated in most of the countries (Tai L et al., 2021]. An HPLC tool is utilized to qualitatively assess the anthocyanins found in black rice color, which reveals the existence of flavonoids. Anthocyanin has an absorption peak in the visible spectrum at 520 nm and in the UV spectrum at 270 nm.

### 1.2 Agro-ecological aspects of Black Rice Cultivation.

Parameters	Inference
Height	136-166cm
Seeding month	June - July
Harvesting	October – November
Length of the grain	9 – 9.9mm
Weight of the grain	26.01±2.41mg

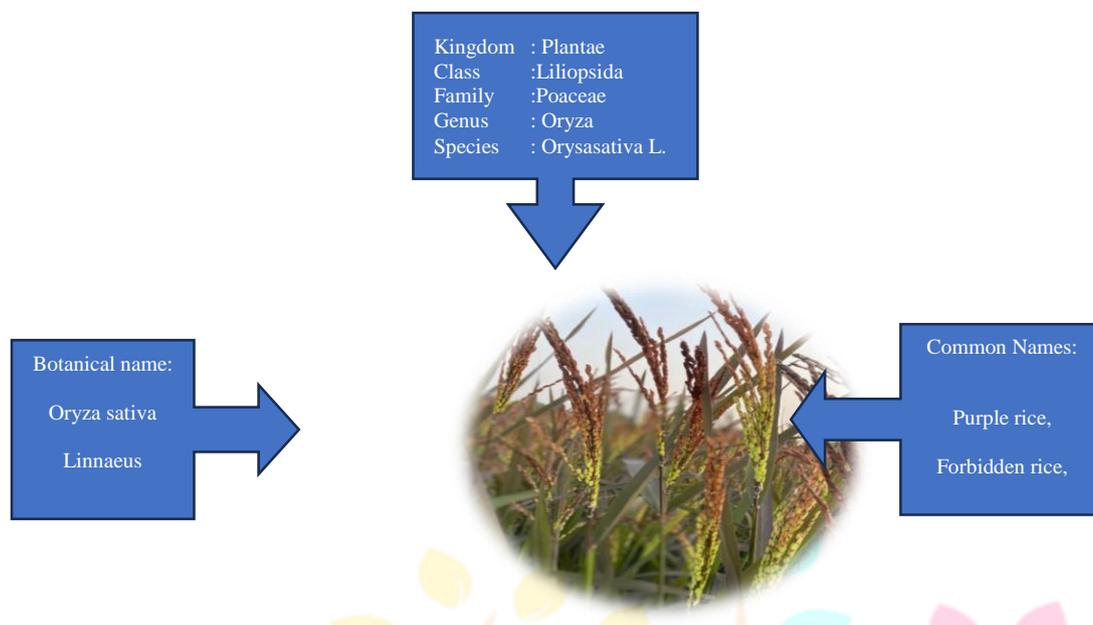
### 1.3 Black Rice Availability in India



As shown in the figure:1.1, cultivation of black rice has drastically increased in India in the past few Years. Initially, it was Manipur, where black rice is used constantly in day-to-day life. It is known in a few states of India, that a dish made up of Black rice is requisite at special occasions and festivals. Time being different varieties of Black rice are grown in South India. Some of them are Kalabhat, Black Burma, and karuppu kavvuni.

Figure:1.1

#### 1.4 Taxonomic details of Black rice



**Figure 1.2**

#### 1.5 Nutritional composition of black rice.

According to Fatchiya, the Approximate composition of black rice contains 72-73.45g of carbohydrates and 9.93 grams of Protein. Combined reports say that one serving of Black rice (1/4 cup or 50g) contains approximately 160 calories, 2g of fiber, and 1-2mg of iron. It also has the highest amount of anthocyanins(327.60mg). among all the studies carried out on colored grains, Black rice has a high concentration of bioactive compounds such as tocopherols, oryzanols, polyphenols, B vitamins, and fiber (Fatchiya et al., 2020).

#### 1.6 History

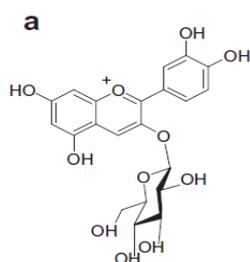
The history of the black rice is vibrant. The black rice was consumed in pre-dynastic China and often referred to as "Emperor's rice" since it was valued for its rarity and its limited availability and served as a tribute dish. As per the belief, initially, black rice was introduced by Meitei king Poireton Khunthokpa during 38-18 BC. Hence the name of the Black rice which is cultivated in Manipur is named as Chakhao Poireton(Ito et al., 2019).

#### 1.7 Traditional use of Black rice

Though rice is considered a staple food, there are distinct communities in use black rice as traditional food. There are so many other plants that are used for their medicinal value. Since black rice has adequate nutrition and a good amount of anthocyanin and rich antioxidants, it can be used for traditional use for medicine. Asia stands first for the righteous documentation of medicinal plants. Asia is where most black rice is cultivated and exported. Black rice will elevate overall well-being and promote health. According to research (Priya Sundarajan et al.,2023), all the traditional medicinal plants have abundant phytochemicals. Those are known as "Functional food", they are identified in terms such as "vita food", "Medi foods" or "Pharma foods". Since Black rice possesses a good quantity of phytochemicals, it can be called by the above terminals.

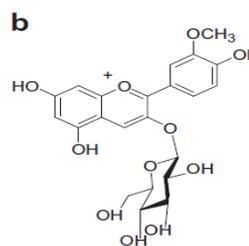
### 1.8 Anthocyanin in Black Rice

Anthocyanins are the best quality indicators of food. They possess great health effects because of their potential antioxidant ability (Kong et., 2003; Macro & Scarmino, 2007). Even though black rice has a good amount of Anthocyanins they are not stable. Studies have shown that they easily get destroyed by many factors like light, intensity, pH, thermal treatment, enzymatic activity, and oxygen supply. The stability of anthocyanin is also affected by some chemicals like ascorbic acid, sulfur dioxide, and metal ions (Gradinaru Biliaderis, Kallithraka, Kefalas, & Garcia-Viguera, 2003; Tiwari, O Donnell, Mutgukumarappan, & Cullen, 2009; Zhang et al., 2008). Anthocyanin is the largest and most important group of water-soluble natural pigments. It also represents one of the most widely distributed classes of flavonoids. Many studies have been carried out for the identification, characterization, and quantification of flavonoids present in black rice. It is an integrated approach consisting of HPLC with a photodiode array (DAD) and HPLC-ESI-MS is also used. The simultaneous analysis of both free glycosylated flavonoids in the black rice bran extract was done preliminarily by reverse phase HPLC-DAD. According to this study, eleven types of flavonoids are tentatively identified in black rice. They are namely quercetin, quercetin-3-O-glucoside, quercetin-3-O-rutinoside, isorhamnetin, isorhamnetin-3-O-glucoside, isorhamnetin-3-O-acetylglucoside, isorhamnetin-7-O-rutinoside, taxifolin-7-O-glucoside, 5,3',4',5'-tetrahydroxyflavanone-7-Oglucoside, 5,6,3',4',5'-pentahydroxyflavone-7-Oglucoside, myricetin-7-O-glucoside.



**a) Cyanidin-3-glucoside**

(Hou, F. et al., Hepatoprotective and antioxidant activity of anthocyanins in black rice bran on carbon tetrachloride-induced liver injury in mice, Journal of Functional Foods (2013), )



**b) Peonidin-3-glucoside**

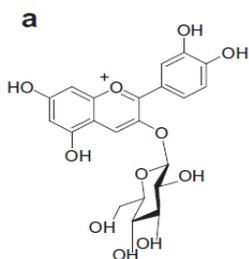
**Chemical structure of Anthocyanins**

**Chemical structure of Anthocyanins**

## 1.9 Pharmacological aspects of black rice

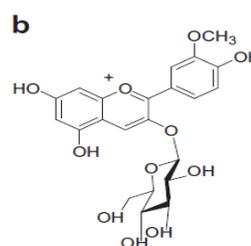
### 1.9.1 Anti- atherosclerotic effect of Black rice

Atherosclerosis is the thickening of an artery caused by a buildup of plaque in an artery. Many researchers have shown that the presence of polyphenols in black rice is beneficial for cardiovascular health. They have also identified the antiatherogenic effect of black rice. There is a notion behind the functional property of black rice that the atherosclerotic property of black rice is because of the dietary fiber and vitamin E component, but clarification is required on this statement. Anthocyanin which is identified in black rice has antioxidative properties and anti-inflammatory. Cyanidin-3-glucoside and peonidin-3-glucoside are found in the aleurone layer of black rice (Xiaodong Xia et al.,2006). Epidemiological research Studies have shown that Anthocyanin consumption may also reduce the risk of diabetes, oxidative stress, and cardiovascular disease. According to reports (Xiaodong Xia et al., 2006)), black rice has anti-atherosclerotic capabilities because of its dietary fiber or vitamin E content. The anti-atherosclerotic action of black rice may be caused by its anthocyanin components, although more research is required. In additional collaborative research, the two primary anthocyanins, cyanidin-3-glucoside and peonidin-3-glucoside, were isolated and identified in black rice. These compounds demonstrated in vitro anti-oxidative and anti-inflammatory effects. According to the study conducted by (Qing wang et all., 2007), they have given supplementation of Black rice to a group of people to observe the changes in the antioxidant status, plasma lipids, and inflammatory biomarkers. For 6 months the results were compared with the consumption of white rice supplementations. This research indicates how well the Black rice pigmentation fraction (BRF) performs compared to White rice pigmentation fraction (WRF) in clinical trials. Since the BRF contains a greater sum of Anthocyanins when compared to WRF. BRF preferably acts as a placebo and is responsible for cardioprotective effects.



**a) Cyanidin-3-glucoside**

(Hou, F. et al., Hepatoprotective and antioxidant activity of anthocyanins in black rice bran on carbon tetrachloride-induced liver injury in mice, Journal of Functional Foods (2013), )



**b) Peonidin-3-glucoside**

### 1.9.2 Anti hyperlipidaemic effect

An interesting finding from several studies shows that anthocyanins may help explain why black rice has inhibitory effects on cholesterol absorption. This information may be used to treat and prevent hypercholesterolemia. A category of metabolic illnesses known as hypercholesterolemia is characterized by high amounts of cholesterol in the blood. Multiple therapeutic targets are provided by cholesterol absorption, an efficient method of decreasing cholesterol levels, in the treatment of hypercholesterolemia. Phytochemical-rich and antioxidant-rich plants will distinctly possess lipid-lowering capacity. Increased risk of atherosclerosis and occlusive-related vascular disease caused by Hypercholesterolemia (Alam et al., 2023). The oxidative stress can be triggered by hypercholesterolemia, which leads to the formation of reactive oxygen species (ROS). An increase in ROS will encourage the progression of coronary artery disease and atherosclerosis. This can be treated by Black rice as well because it is nutrient-dense and rich in antioxidants, flavonoids, and phytochemical classes.

### 1.9.3 Anti-cancer Properties of Black rice

According to the investigation of researchers (Chang Hui et al.,2010) stated that tumor growth can be suppressed by oral administration of anthocyanin-rich extract of black rice(AEBR). That can also slow down the Angiogenesis process. Earlier studies revealed that the black rice extract has anti-cancer properties. AEBR reduces the viability of breast cancer cells. There is a respectful cytotoxic effect of AEBR. Evaluation of anti-tumor properties of AEBR is done in vivo using Athymic mice xenografted with human tumor models. Finally investigated that oral administration of AEBR with 100mg/kg/day will significantly suppress tumor growth and angiogenesis. Therefore, consuming black rice on a regular daily basis can inhibit the proliferation of cancer cells.

### 1.9.4 Black rice extract as a phytosome dosage to treat cancer

Black rice possesses mighty phytochemicals. The natural photothermal properties are owned by Black rice, which can be used for PTT(photothermal therapy) to treat Cancer(Sundarrajan et al.,2023). PTT treatment can be performed at a low cost and in the absence of synthetic anti-cancer drugs. During this treatment, black rice can be orally administered to increase active absorption and systemic absorption. Since phytosomes have low lipid solubility will have improved bioavailability. Correspondingly this leads to a distinct increase in therapeutic effect (Maheshwari et al.,2022).

### 1.9.5 Hepatoprotective activity of Black rice

CCl<sub>4</sub>-injected cells are more prone to reduced cell viability and increased aminotransferase activity. When CCl<sub>4</sub> attacks the cells then there will be elevated TBARS production and significantly diminished GSH content and decreased SOD activity was observed. The damage to the liver and destruction of hepatic cell membranes are caused by CCl<sub>4</sub> metabolites which react with polyunsaturated fatty acids and assist in propagating a chain reaction that leads to lipid peroxidation (Slater 1987). On comparing virus and alcohol, there is a higher chance of liver injury by CCl<sub>4</sub>. Jaundice, abdominal pain, fatigue, and fluid accumulation are some of the co-occurring conditions of liver disease (Reddy P V et al.,2018). Research gives detailed information about how the supplementation of ABRE has a reversing effect on liver injury made by ccl<sub>4</sub>. Black rice supplementation given to the mice enhances the activities of SOD and GSH-

Px. When the liver is damaged by CCl<sub>4</sub>, ARBE supplement will help in restoring and maintaining the activity of antioxidant enzymes (Hou F et al, 2013).

## CONCLUSION

Upon examination of the available data and literature, it can be inferred that black rice is rich in vitamins and minerals and also secondary metabolites. Black rice retains a nutraceutical property since it has a good amount of phytochemicals and flavonoids. Anthocyanin which is a flavonoid densely present in black rice takes control of reducing inflammation. Black rice possesses anti-diabetic, anticancer, antimicrobial, and anti-obesity effects. They also play a major role in preventing cardiovascular diseases (CVDs). Therefore, anthocyanins extracted from edible plants are considered a potential pharmaceutical ingredient.

## Conflict of interest

The authors declare no conflicts of interest relevant to this article.

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