



Review on Nutritional Content of Various Types of Rice

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Rice is life for millions of people in the globe. It is deeply embedded in the cultural heritage of the society. In many developing countries rice cultivation is a primary source of livelihood. In countries like Asia and Africa hundred millions of families are reliant on rice cultivation only. It is rich in genetic diversity having numerous varieties grown throughout the world. Every region have their own variety of rice cultivated having their own nutritional and health properties. In this article we have discussed about different types of rice varieties such as white rice, black rice, brown rice, basmati rice, jasmine rice, wild rice and golden rice and their differences on the basis of their nutritional content, cholesterol level, fats, vitamins and minerals content etc. we have also discussed about the value added products obtained by the different rice varieties and their medicinal properties also. Every rice variety have its own benefits of consumption and many nutritional properties such as white rice is rich in carbohydrates, brown rice is high on fibre and low in calories, black rice is rich in anthocyanin, basmati rice is rich in aroma content, jasmine rice is rich in quality and aroma, wild rice is high in antioxidant properties and golden rice is rich in vitamin A. Along with the major properties they are having many other properties that makes these rice varieties unique and important in their own way.

Keywords: Rice; antioxidants; nutrition; origin; health; cholesterol and aroma.

1. INTRODUCTION

Rice (*Oryza sativa*) is a foremost vital staple nourishment for the millions of the individuals all over the world. It has a place to family Poaceae, and having chromosome number $2n=24$. Rice is begun from Africa and Tropical and Sub-Tropical South Eastern Asia [1-3]. Rice almost covers world's largest area i.e. approximately 28%. It covers 42.3 million hectares with 80 million tones of production annually. About 4/5 of the world's largest production is done by the small scale farmers across the world and is consumed locally in every region [4-7].

It is evaluated that the demand of rice will be expanded by 487 million tones by 2020 [8,9]. There are numerous dietary and wellbeing benefits of different sorts of rice. White rice is commonly consumed all over. Brown rice is becoming popular because of its health benefits [8-12]. From rice various value added products can be made such as rice flour, rice bran oil, rice milk, rice syrup, etc. China and India are the world largest rice producing countries followed by Indonesia, Bangladesh, Vietnam, Myanmar, and Thailand. In India, Chattisgarh is the largest rice producing state and is known as the "Rice Bowl of India."

1.1 History

Rice is known to be the first ever crop to be cultivated in Asia. Around 3000 BC, the preserved rice grains were found in China. Rice was presented to India before the time of the Greeks [13-16]. It is believed that in china rice

has been developed since the Antiquated times around 10,000 a long time ago. D. Chatterjee in 1948 illustrated the 23 species of genus *oryzae* out of which 21 were the wild species and only 2 species were cultivated of rice. The two species are *Oryza sativa* and *Oryza glaberrima* cultivated [17,19]. The evidence of farming of rice came from an archaeological site that was 7000 year old situated near the Hemudu, a river village near lower Yangtze in Zhejiang in China. There were the rice grains earthened up. Once they unearthed, they were white at a time but with the exposure to air and environment they turn black after sometime [19-23]. Now those grains can be seen at a Museum in Hemudu. It is still not confirmed whether the rice was collected simply or was cultivated. A team from Chungbuk National University from South Korea announced that they have found the rice grains remains in the Paleolithic site of Sorori in around 12000BC.

2. BRIEF REVIEW ON DIFFERENT TYPES OF RICE

2.1 White Rice

White rice is one of the foremost consumed sort of rice. It is processed rice whose bran, germ and husk is expelled, i.e, it is cleaned rice with shiny appearance. White rice is a fabulous source of carbohydrates [24,25]. White rice is enhanced with vitamins and minerals. It could be a great source of B vitamins, thiamin, niacin, riboflavin, filaments, press, manganese and magnesium.

Table 1. Nutritional content of white rice

Nutrition Facts	Amount
Calories	130
Water	69%
Protein	2.4g
Carbs	28.7g
Sugar	~
Fiber	~
Fat	0.2g
Saturated	0.05g
Monounsaturated	0.06g
Polyunsaturated	0.05g
Omega-3	0.01g
Omega-6	0.04g
Trans fat	~

Source : [medicalnewstoday.com/articles/318699.php#1]

2.2 Brown Rice

It is a great source of magnesium, phosphorous, thiamin, niacin, vitamin B6, manganese, and selenium. Brown rice contains Folate (folic acid), which makes a difference to create new cells. Selenium (Se) display in brown rice makes a difference in controlling the thyroid organ. Brown rice is low in calories, high in fiber, gluten free and can be utilized to plan numerous dishes. It contains no trans-fat or cholesterol. It has only little traces of fat and sodium. Fibers display in brown rice makes a difference in bringing down cholesterol levels and decreases the chance of heart illnesses. It makes a difference in anticipating the arrangement of blood clots. Brown rice has low glycemic index (GI).

2.3 Black Rice

Black rice is developed in a really restricted number of nations within the world and commonly referred as "Forbidden Rice". This title comes from the reality that as it were royalty was permitted to eat it. Black rice is a vital social component for thousands of a long time and crop that's developed in or maybe restricted supply. Black rice contains 10g of protein per crop. It has high concentration of iron, zinc and phosphorous. It has strong sum of

fibers. Black rice has more cancer prevention agents than any assortment of rice. The presence of black color of rice is due to the anthocyanin.

The foremost vital health benefits are effects on heart health, assimilation, diabetes, weight loss, persistent infections, among others. Dark rice is rich in cancer prevention agents, which is anthocyanin, which have the capacity to diminish oxidative push all through the body and avoid the negative impacts of free radicals.

Black Rice contain more of the fiber substance and fat substance is nearly insignificant, both of them are great for wellbeing. Fiber helps to rub abundance of cholesterol and lower blood weight. It helps in making a difference in controlling diabetes. Amazing level of dietary fiber found in this sort of extraordinarily rice can too help to direct diabetic indications, fiber is able to control the discharge of insulin and glucose into the circulation system, which can cut down on the spikes and drops in blood sugar that diabetic understanding must avoid. Research has associated the presence of anthocyanins in black rice to a decrease of poisons all through the body, this will too help to improve liver and kidney work and put less push on these organ systems.



Fig.1. Brown Rice

Source : [<https://www.livescience.com/50461-brown-rice-health-benefits-nutrition-facts.html>]



Fig. 2 Black Rice

Source: [<https://www.mugasilk.in/>]

Table 2. Nutritional content of brown rice

Content	Brown Rice (one cup)
Calories	232
Protein	4.88g
Carbohydrate	49.7g
Fat	1.17g
Dietary Fiber	3.32g
Thiamin(B1)	0.176g
Riboflavin(B2)	0.039g
Niacin(B3)	2.730mg
Vitamin B6	0.294mg
Folacin	10
Vitamin E	1.4mg
Magnesium	72.2mg
Phosphorous	142mg
Potassium	137mg
Selenium	26mg
Zinc	1.05mg

Source: [<https://www.vegkitche.com/brown-rice-vs-white-rice/>]

2.4 Basmati Rice

Basmati derived from the Sanskrit implies fragrant. It was accepted that basmati has been developed in Indian subcontinent for centuries. Basmati was presented to the middle East and by Hindu traders. The flavor of basmati rice is developing by the aroma compound 2-acetyl-1-pyrroline. The grains of basmati rice contains about 0.009ppm of aroma compounds actually that's 12 times more than the non- basmati rice varieties.

A new variety of basmati rice was presented by Indian Agricultural Research Institute which is called as Pusa Basmati -1(PB 1); and is additionally called as Todal since the blossoms has awns. This variety of basmati rice was

delivered through conventional plant breeding and it may be a semi dwarf plant which has all the great highlights of conventional basmati rice. The yield of this basmati rice is much more than the typical basmati rice.

India accounts over 70% of worlds rice production. A little portion of that is developed naturally. The region of Basmati rice production in India are the leading states of Punjab, Haryana, Delhi, Utrakhand and Uttar Pradesh. Traditional Indian type include basmati 370, basmati 385 and basmati Ranbir singh pura (R.S. Pura), Muradbadi 6465 for additional long grains. Pakistani varieties of basmati rice are PK 385, Super Kernal Basmati Rice and D-98. Talking almost its glycemic index, it is medium, that ranges from 52-68.



Fig. 3. Basmati Rice

Source: [<https://www.soscuisine.com/recipe/steamed-basmati-rice/>]

Table 3. Nutritional Comparison between Brown Basmati and White Basmati Rice

Brown Basmati Rice		White Basmati Rice	
Calories	150kJ	Calories	160 kJ
Total Fat	1.5 g	Total Fat	0.5 g
Cholesterol	0mg	Cholesterol	0mg
Sodium	0mg	Sodium	0mg
Total Carbohydrates	33g	Total Carbohydrates	34g
Protein	4g	Protein	3g
Iron	4%	Iron	2%

Source: [<https://nirogam.com/brown-rice-for-weight-loss/>]

2.5 Jasmine Rice

Jasmine rice is the most well known aromatic rice variety developed in Thailand. According to Thai Rice Exporters Association, the whole yield of the thai rice is anticipated to extend to around 4 million tons from 6.1 million tonnes. The grain is characterized by its special appearance, cooking quality and smell. It could be a long grain variety of fragrant rice. Moreover called as fragrant rice. Its fragrance, reminiscent of pandan (Pandas and popcorn, comes about from rice plant's common generation of aroma compounds of which -2-acetyl-1-pyrroline. The

rice variety having 1 grams of fiber and insignificant sum of vitamins A, C, and D as well as iron. The Jasmine rice is incapable to supply additional health benefits on consumption.

The Jasmine rice are of two types one is white Jasmine rice and the other one is brown Jasmine rice. Brown Jasmine rice has numerous benefits such as they give small bit additional nourishment to your diet than the white one variety and is the superior source of magnesium. Glycemic esteem in jasmine rice is about 60 to 80.



Fig. 4 Jasmine Rice

Source : [<https://www.ebay.com.au/itm/Coles-Jasmine-Rice-1kg-/173854750601>]

Table 4. Comparison of nutritional content of jasmine rice with long grain white rice

Content	Long Grain White Rice	Jasmine Rice
CALORIES	160g	81g
PROTEINS	4g	4g
FATS	0g	1g
CARBOHYDRATES	36g	39g
FIBER	1g	1g
CALCIUM	2% of daily value	2% of daily value
IRON	0% of daily value	2% of daily value

2.6 Wild Rice

Wild rice could be a seed of aquatic grass that's comparable to rice in appearance but isn't specifically related to it. The grass develops together with the streams and lake shores or close the shallow freshwater swamps naturally. Early English pioneers called this aquatic plant indian rice or wild rice, whereas the French saw a likeness to oats within the plant and thus called it folleavoine. Wild rice is additionally known as Indian rice, water oats and Canadian rice. Generally the grains were as it were accumulated and eaten within the districts of North America and China as it were. In china it is consumed as a vegetable more than the seeds.

The University of Minnesota in 1994 guaranteed that in comparison to the other whole grains, the wild rice is greatly high in cancer prevention agents(antioxidants). They moreover found that by analyzing eleven diverse tests of wild rice it came to know that the antioxidant property within

the wild rice was 30 times more than the white rice. The grains are marginally higher in protein substance. It is additionally a great source of magnesium, manganese, vitamin B6, phosphorus, niacin and zinc. The researches have not appeared numerous health benefits of the wild rice. The researchers of China in 2009 too found that the wild rice plays an crucial role in bringing down the lipids and cholesterol level within the body.

2.7 Golden Rice

Golden rice is a rich source of Vitamin A, and a very good alternative for the people who are going through a major public health issue i.e VAD (Vitamin A deficiency. The biofortification of rice with Vitamin A increases the nutritional value of rice. Vitamin A is important for our vision, growth, cellular differentiation and proliferation. Golden rice is rich in beta-carotene thus giving the yellow (golden) color. Beta- carotene is transformed into Vitamin A when metabolized by the human body.



Fig.5. Wild Rice

Source: [https://www.alibaba.com/product-detail/HIGH-QUALITY-New-Fresh-Canadian-Certified_50034936497.html]

Table 5. Nutritional content of wild rice

Content	Amount per serving	%DV (Daily Value)
Total fat	0.5g	1%
Cholesterol	0mg	0%
Total carbohydrates	35g	13%
Dietary Fiber	3g	11%
Protein	6g	12%



Fig. 6. Golden Rice

Source : [<http://www.goldenrice.org/Content2-How/how.php>]

Golden rice is a genetically modified crop which is biofortified with beta-carotene for people suffering from VAD (Vitamin A deficiency) especially in developing countries. Golden Rice Project was firstly introduced by Peter Beyer and Ingo Potrykus in 1999 in order to provide a sustainable biofortification approach to combat VAD in developing countries. The biofortification of rice with beta- carotene helps in increasing the nutritional value of rice. Beta-carotene is not produced normally in rice, due to which rice lacks Vitamin A. VAD is prevalent in developing countries like Africa, South Asia, Southeast Asia where rice is the main part of their diets or the food which do not contain Vitamin A. Vitamin A is necessary for healthy immune system, good vision, and healthy skin. According to the survey of the World Health Organization it is estimated that nearly 250 million children of young age are highly affected by vitamin A deficiency and near about 2.7 million children have died because of vitamin A deficiency. So golden rice is modified in a way that they can overcome the vitamin A deficiency in children as well as in adults also. And also can help to prevent the major diseases caused by the deficiency such as night blindness etc. in the developing countries.

2.8 Comparison of White Rice Vs Brown Rice

White rice is polished and refined rice (seed coat and bran is expelled). On the other hand brown rice is a whole grain in which seed coat and germ(embryo) is intact. For this reason brown rice is rich in fibres, vitamins, and antioxidants. White rice is commonly consumed all over but brown rice could be a common more beneficial

alternative. Brown rice is a great source of phosphorus, selenium, magnesium, thiamine, niacin, vitamin B6, and manganese.

White rice has adverse impact on blood sugar balance and diabetic patients ought to maintain a strategic distance from eating white rice. While brown rice has low glycemic index and have useful impacts on blood sugar control. Brown rice makes a difference in preventing heart illnesses because it may be a great source of antioxidants. On the other hand high utilization of white rice leads to expanded hazard of sort 2 diabetes. The brown rice has lower glycemic list than the white one variety. Lower glycemic value in a product can give more energy and act better in controlling hunger. Diabetic patients prefer to consume food having the glycemic index of 70 or lower as it slow down the absorption rate and thus prevent large spikes after the consumption in blood sugar.

2.9 Value added Products of Rice

Value addition enhances the quality and profitability of product. There is a wide range of value added of rice which can be processed and canned. The important advantage of value addition in rice is fortification of rice with vitamins and minerals. The one of a kind characteristics of rice like hypo-allergenicity and flat taste make it valuable for variety of nourishment items. Approximately 10% of rice production is utilized for the generation of rice based products. There are numerous by-products of rice: Rice Bran, Rice Flour, Rice Husks, Broken Rice. The rice flour can be used for the preparation of various food products like puttu, noddles, murrukku, idiyappam, poha, etc.



Fig. 7 Comparison of White rice Vs Brown rice

Source : [<https://www.stylecraze.com/articles/brown-rice-vs-white-rice/#gref>]

Table 6. Comparison between Black rice and White rice

Content	Brown Rice (one cup)	White Rice (one cup)
Calories	232	223
Protein	4.88g	4.10g
Carbohydrate	49.7g	49.6g
Fat	1.17g	0.205g
Dietary Fiber	3.32g	0.74g
Thiamin(B1)	0.176g	0.223g
Riboflavin(B2)	0.039g	0.021mg
Niacin(B3)	2.730mg	2.050mg
Vitamin B6	0.294mg	0.103mg
Folacin	10µg	4.1µg
Vitamin E	1.4mg	0.462mg
Magnesium	72.2mg	22.6mg
Phosphorous	142mg	57.4mg
Potassium	137mg	57.4mg
Selenium	26mg	19mg
Zinc	1.05mg	0.841mg



Fig. 8. Value added products of rice

Source: [http://agritech.tnau.ac.in/horticulture/horti_vegetables_tapioca.html]

Some fermented products of rice: **Idli** is a small, whitish, spongy and steamed cake that is made by bacterial fermentation of 12 to 18 hours. Idlis are soft, moist and spongy having a sour flavor. **Dosa** is another fermented product that is made by the batter of dal and rice. It is very thin and is baked on the hot pan. **Dhokla** is a fermented food product of Bengal gram and rice. Dhokla is most popular dish of West India specially in Gujarat. There are many other products also Ambali, Ganji etc. made by fermentation of rice. There are numerous nations like United States, China and Japan which is fruitful in creating variety of commercial rice based items like

expelled products, noodles, pre-cooked rice, and canned items. In India, value added items such as instant rice noodles, rice bread, fast cooking rice, cocoa powder coated rice drops, are prevalent in Kerela.

2.10 Medicinal Uses of Rice

India is favored with a variety of therapeutic plants out of which most of the plants are traditionally utilized in unani frameworks of solutions, Ayurveda, and by numerous of tribal healers form old times. Within the old writing of India, it is clearly said that in this earth each plant

show is similarly vital for creatures, human creatures as well as for plants moreover. In Ayurveda numerous of the therapeutic values of rice are depicted. Rice is having numerous of the medicinal properties but it isn't experimentally demonstrated as viable in medicinal point of view, but is accepted and utilized in numerous of the nations for the medicinal purpose.

2.11 Skin Treatment

Rice are also used to treat the various skin problems. The one way to treat skin is to boil rice then drain the water and the rice ball is allowed to cool at room temperature and then mashed. Then the paste is applied to various skin diseases such as sores, boils, skin blemishes and skin swelling. It can work effectively.

Stomach problems- Rice is also helpful in treating diarrhoea, indigestion, nausea, stomach upsets etc. cancer treatment- the by-product of brown rice is also used to treat breast cancer, stomach cancer and warts. Eye inflammation- the "greens" of the boiled rice is used as eye lotion. It can also use to cure inflammation near eyes and inner tissues of body. Dysantry- in Cambolia, the mature hull of rice is taken from 3 to 4 month old plant and is used to treat dysantry.

3. CONCLUSION

It is concluded that rice is the major cultivated crop essentially developed around the world. In most of the nations rice is utilized a staple nourishment and is the foremost important cereal crop. More than half of the overall world's population is subordinate on rice only. There are various types and varieties of rice developed totally different districts of the world having numerous health benefits such because it may be a great source of carbohydrates, amazing vitality source, low in fats, salts and having no cholesterol, good source of vitamins and minerals etc. conjointly they have many medicinal values to treat stomach issues, acid reflux, skin issues etc. There are numerous benefits of consuming rice because it gives instant vitality, it stabilizes the blood sugar, conjointly may be a great source of vitamin B1. Rice can be developed in adverse conditions moreover within the wide geological range. The slogan 'Rice Is Life' is much more important for India as this edit plays an effective part in providing the pay to millions families of rural

regions and also it provides food for more than half of the world's population worldwide.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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