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Brown rice: Nutrition and health claims

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Abstract
Rice is the most important dietary staple cereal crop, especially for people living in Asian subcontinent. Rice consumers eat white rice and consider brown rice as food for the farmers, the poor, and for the animals. White rice is associated with beriberi, a potentially fatal disease due to lack of thiamine (vitamin B1), because this essential vitamin is stripped out of the rice during processing. Today people are going for whole food, like our fore father used to eat. Brown rice is a rice source of minerals and dietary fibre that support the normal functioning of human body. This review covers nutritional composition and various biological activities of brown rice in aspects to human health. Such biological activities which are related to rice and its products are lowering cholesterol, reducing blood pressure and preventing colorectal cancer.

Keywords: staple, thiamine dietary fibre, colorectal cancer

Introduction
In some parts of the world, the word "to eat" means "to eat rice." Rice is the staple food of more than 39 countries which accounts for nearly half of the world's population. All varieties of rice are present throughout the year supplying as much as half of the daily calories to half of the population (Babu *et al.*, 2009). Rice contributes the greatest percentage of calories (22%) and proteins (17%) to populations living mostly in developing countries (Vetha *et al.*, 2013).
Rice is a unique crop due to its soft taste, low sodium levels, easy digestible carbohydrates and hypoallergenic properties (Mir *et al*., 2015) [15]. Rice is consumed, as such in the form of whole grain or is milled to obtain flour. Rice milling involves two steps viz hulling and polishing. During polishing 15% of protein, 85% of the fat, 90% of the calcium, 75% of the phosphorus, 80% of thiamine, 70% of riboflavin and 68% of niacin are removed. By discarding the bran of rice, we are discarding a bag of benefits that helps us to grow (Vetha *et al*., 2013).

Problems associated with consumption of white rice
Low energy and protein intakes are common nutritional problems for people in rice consuming countries. According to UNICEF (1991) [24], incidence of low birth weight, infant mortality, mortality of children under five years of age, and prevalence of underweight children are considerably higher in rice consuming countries than in other countries. An article published in Rice Today (Jan, 2004) [19] reported that micronutrient deficiencies of global public health concern include nutritional anaemia due to iron deficiency, vitamin A deficiency in children, vitamin B1 (thiamine) deficiency and iodine deficiency disorders which are common in many countries where rice is the staple food. (Dipti *et al*., 2012) [8].
Iron deficiency anaemia is a worldwide public health problem, with global prevalence estimated to be 24.8% (Shaw *et al.*, 2011) [22]. The majority of disease burden is shouldered by developing countries with high levels of rice consumption. One reason for iron deficiency in rice consuming population is due to the low concentration of iron in polished rice (Bounphanousay 2007) [6].

Brown Rice
Brown rice is unpolished whole grain produced by removing only the hull or husk using a mortar and pestle or rubber rolls. It may be distinctly brown, reddish or purplish. The embryo may or may not be left intact depending on the hulling process. It becomes milled or white rice when the bran layer is stripped off in the milling or 'whitening' process. It has a mild nutty flavour, is chewier than white rice and becomes rancid more quickly, but is far more nutritious (Anonymous, 2000) [1]. Post-harvest researchers have reported that the milling recovery in brown rice is 10% higher than the polished rice (Garrow *et al.*, 2000).
Brown rice is distinct from other cereal grains in its content of tocotrienols-t ocopherols, γ-oryzanol, and β-sitosterol. These constituents decrease the concentrations of total plasma cholesterol, triglycerides, and low-density lipoproteins and increase the concentrations of high-density lipoproteins. Brown rice also contain soluble dietary fibres (β-glucan, pectin, and gum) and ferulic acid from nonlignified cell walls. (Ryan, 2011) [20]. Recent studies have shown that brown rice has a wide range of biological activities, including antioxidant, anti-carcinogenic, antiallergenic activities, anti-atherosclerosis and amelioration of iron deficiency anaemiain the body (Mir *et al.*, 2015) [15]. In addition to this, brown rice has the ability to fight heart diseases and cancer (Kuhns and Coulter, 2009) [14]. For people living with celiac disease, it is one way that they can consume breads and other bakery goods

due to the absence of gluten forming proteins in brown rice (Morita, 2007) [16].

Thus, consumption of brown rice is a way forward to exploit its nutritive power to the fullest in order to overcome the nutritional disorder suffered by most of the population. Now a day's nutritionist and dieticians are increasingly recommending brown rice as an excellent source of all-round nutrition.

Besides the nutritional benefits of consuming brown rice, there are two economic importance (Vetha *et al.,* 2013):

1. Polishing and whitening reduces the power demand of milling by as much as 65%.
2. With the bran and the nutrient-rich embryo intact, and with fewer broken grains, whole grain milling recovery is as much as 10% higher than white rice.

Brown rice is superior to polished rice

Our food ranking system identifies brown rice as an excellent source of manganese and agood source of the minerals like selenium and magnesium (Pankaj, 2008) [17]. Brown rice has protein content twice that of white rice. Brown rice is also high in silica (6 mg/g), probably because of the presence of rice hull fragments (Seki *et al*., 2005) [21].

Rice bran fraction (a part of brown rice) produces two major components, namely rice bran oil and defatted rice bran. A breakdown component from rice bran oil consists a number of fatty acids and flavonoid content. Brown rice oil contains 20% unsaturated fatty acids in the form of oleic, and lino lenic fatty acids. Meanwhile, defatted rice bran component consist of a number of polysaccharides and dietary fibre that support cancer and cardiovascular diet therapy (Henderson *et al*., 2012) [10].

Table 1: Comparison of calorific value and nutrient content of brown rice and white rice

Parameters	Brown Rice	White Rice
Calories	232kcal	232kcal
Protein	4.88 g	4.10 g
Carbohydrate	49.7 g	49.6 g
Fat	1.17 g	0.205 g
Dietary Fibre	3.32 g	0.74 g
Thiamine (B1)	0.223 mg	0.176 mg
Riboflavin (B2)	0.039 mg	0.021 mg
Niacin (B3)	2.730 mg	2.050 mg
Vitamin B6	0.294 mg	0.103 mg
Folacin	10 mcg	4.1 mcg
Vitamin E	1.4 mg	0.462 mg
Magnesium	72.2 mg	22.6 mg
Phosphorus	142 mg	57.4 mg
Potassium	137 mg	57.4 mg
Selenium	26 mg	19 mg
Zinc	1.05 mg	0.841 mg

***Source*:** Vetha *et al.,* 2013

Difficulties of brown rice

After the bran layer is removed from the endosperm during milling, the individual cells are disrupted, and the rice bran lipids come into contact with a highly reactive enzyme (lipase). The bran contains oil composed of glycerides, about 2-3% of unsaturated Fatty Acids (UFA) and 1.6% phospholipids. Double bonds of unsaturated Fatty Acids are susceptible to oxidation, forming oxides and peroxides causing rancidity (Vetha *et al*., 2013).

Freshly milled rice bran has a short shelf life because of decomposition of lipids into free fatty acids (FFA) (hydrolytic rancidity), making it unsuitable for human consumption and the economical extraction of edible rice oil. In rice bran, the hydrolysis is catalysed by endogenous enzyme activity (lipases) and, to some extent, by microbial enzymes if the material is of poor quality (Barnesand Galliard, 1991).The hydrolysis of lipids in rice bran becomes apparent in several ways: off-flavour such as a soapy taste, increased acidity, reduced pH, changes in functional properties, and increased susceptibility of fatty acids to oxidation.

Health benefits of brown rice

Numerous studies have been conducted, which correlates, bioactive compounds in brown rice such as γ-oryzanol, tocopherols, tocotrienols, polyphenols, phytosterols, and carotenoids, found with health benefit effects. It also contains essential amino acids and micronutrients that work together for health promotion. Selected compounds from brown rice have been investigated for the prevention and control of chronic disease through multiple mechanisms. Brown rice and its oil have reported cardiovascular health benefits (Cara *et al.*, 1992) [7].

Brown rice helps in lowering of cholestrol

Brown rice includephytosterols, triterpene alcohols, tocopherols, and tocotrienols, as possible hypocholesterolemic agents. The cholesterol-lowering properties ofbrown riceis a result ofunsaponifiable component present in rice bran oil (Wilson *et al*., 2000) [27]. Replacing the usual cooking oils with rice bran oil decreases the blood cholesterol's level in hyper cholesterol patients (Raghuram *et al*., 1989).

Brown rice helps prevent cancer

Brown rice can substantially reduce the risk of colon cancer, as it is a very good source of selenium, a trace mineral which induces DNA repair and synthesis in damaged cells and inhibits the proliferation of cancer cells. Selenium is an antioxidant and is essential for thyroid hormone metabolism and immune function (Anonymous, 2004) [1]. Selenium plays an important role in cancer prevention as a cofactor of glutathione peroxidase, which is one of the body's most important anti-oxidant enzyme and is used in liver to detoxify a wide range of potentially harmful molecules (Vogt *et al.*, 2003) [26].

Inositol hex phosphate, a naturally occurring molecule found in high-fibre foods such as brown rice, is a compound that has shown to demonstrate cancer prevention properties. Inositol hex phosphate holds great promise in strategies for the prevention and treatment of cancer (Anonymous, 1998) [3].

Evidence suggests that dietary rice bran may exert beneficial effects against breast, lung, liver, and colorectal cancer (Henderson *et al*., 2012) [10]. The potential chemopreventive agents in the bran are ferulic acid, tricin, β-sitosterol, γ-oryzanol, tocotrienols/ tocopherols, and phytic acid (Barnes *et al*., 1991) [5]. The anticancer effects of the rice bran are mediated through the ability of these agents to induce apoptosis, inhibit cell proliferation, and alter cell cycle

progression in malignant cells. These protect against tissue damage through the scavenging of free radicals and the blocking of chronic inflammatory responses. These have also been shown to activate anticancer immune responses as well as affecting the colonic tumour microenvironment making it favourable for global dietary chemoprevention. Therefore, the establishment of dietary rice bran as a practical food has potential to have a significant impact on cancer prevention for the global population (Kannan *et al*., 2008) [13].

Lignans protect against heart disease

One type of phytonutrient especially abundant in brown rice are plant Lignans, which are converted by friendly flora in our intestines into mammalian Lignans, including one called enterolactonethat is thought to protect against breast and other hormone-dependent cancers as well as heart disease (James *et al.,* 1999) [11].

Helps increase energy levels

Brown rice is an excellent source of manganese and magnesium. Just one cup of brown rice will provide 88% of the daily value for manganese. This trace mineral helps produce energy from protein and carbohydrates and is involved in the synthesis of essential fatty acids. Manganese is also a critical component of a very important antioxidant enzyme called superoxide dismutase that is found inside the body's mitochondria where it protects against damage from the free radicals produced during energy production (Kannan *et al*., 2008) [13].

Tune down and bone up on brown rice

Magnesium, found in good amount in brown rice, has proven to be helpful in reducing the severity of asthma, lowering high blood pressure, reducing the frequency of migraine headaches and reducing the risk of heart attack and stroke. Magnesium helps regulate nerve and muscle tone by balancing the action of calcium. In many nerve cells, magnesium serves as nature's own calcium channel blocker, preventing calcium from rushing into the nerve cell and activating the nerve. By blocking calcium's entry, magnesium keep our nerves (and the blood vessels and muscles they enervate) relaxed. A cup of brown rice provides 21% of the daily value for magnesium (Jiamyangyuen and Buncha, 2008) [12].

Helps prevent atherosclerosis

Atherosclerosis is a condition where the arteries become narrowed and hardened due to build-up of plaque around the artery wall. The disease disrupts the flow of blood around the body, posing the risk of serious complications. Brown rice helps raise blood levels due to nitric oxide, a small molecule known to improve blood vessel dilation and prevent development of atherosclerotic plaques (Panlasiguiand Thompson, 2006).

Weight Loss

Brown rice is concentrated source of fibre andis ideal for losing weight as it stays in our stomach for a longer time as compared to other foods. This allows slower digestion, thus making us feel full for longer period of time. So instead of consuming two bowls of white rice, eating one bowl of brown rice helps to attain satiety. Fibre also moves fat through our digestive system faster so that less of it is absorbed. It also controls blood sugar level (James *et al.,* 1999) [11].

Some researchers have indicated that whole grain including rice bran is linked to reduced risk of obesity and weight gain. Whole grain intake was inversely related to body mass index (Slavin, 2005) [23].

Table 2: Selected bioactive compounds in rice bran evaluated for their properties with regard to prevention of chronic disease

Rice bran compound	Disease prevention activity
Ferulic acid	Antioxidant, chemopreventive, anti-inflammatory, and lipid-lowering effects
γ-Oryzanol	Antioxidant, chemopreventive, anti-inflammatory, and lipid-lowering effects
Inositol hexaphosphate	Blocks cancer growth and signaling
Campesterol	Antiangiogenic
β-Sitosterol	Blocks cholesterol
Linoleic acid	Anti-inflammatory
α-Tocopherol	Inhibits lipid peroxidation and intracellular signaling
Tocotrienol	Inhibits lipid peroxidation and intracellular signaling
Salicylic acid	Anti-inflammatory
Caffeic acid	Gastrointestinal microbe interactions
Coumaric acid	Antimutagenic, inhibits the cell cycle, antioxidant, and chemopreventive
Tricin	Antimutagenic, inhibits the cell cycle, antioxidant, and chemopreventive

***Source*:** Ryan, 2011

Conclusion

Whole foods contain thousands of phytonutrients that have health-promoting properties, as well as vitamins, minerals and macronutrients like fibre and beneficial fats. Wholefoods are easily assimilated and absorbed readily by the body. But processing leads to reduction in many of these compounds. The current existence of milled rice on the market reduces the rice's nutritional value and essentially turns it into a simple carbohydrate food. Therefore, in addition to developing more nutritious varieties, awareness of the benefits of eating brown rice should be raised among rice consumers. Brown rice is a wealth of nutrients that are contained in the bran layer. This lost health food is now being revived and taken back into the regular diet of consumers. Such an approach would ultimately result in a sustainable enhancement of the essential nutrient supply in rice-based diets.

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