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## Nutritional composition of rice bran and its potentials in the development of nutraceuticals rich products

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**Abstract**

Rice bran contains 11-17% of protein, 12-22% of oil, 10-15% of moisture, 6-14% of fiber and 8-17% of ash. Rice bran is rich in vitamins and minerals, such as calcium, aluminium, iron, chlorine, manganese, magnesium, zinc and phosphorus, niacin, vitamin E and thiamine. Rice bran also contains a significant amount of nutraceutical compounds and approximately 4% unsaponifiables, consisting primarily of natural antioxidants (approximately 100) such as oryzanol, tocopherols and tocotrienol. Rice bran contains a highly digestible protein that is rich in essential amino acids, particularly lysine, so it can be used as an ingredient in the preparation of different food recipes. Due to its antioxidant properties, it also has the potential to be used as an additive to increase storage stability in food, therefore rice bran fiber can be used as both a functional and nutritious ingredient. Rice bran can be used in the preparation of bakery items with high fiber and low fat. Rice bran is also used industrially in batter blends and meat emulsions. Taking into account the potential of rice bran, this review aims to concentrate on rice bran nutraceuticals, its nutritional composition and application in the food industry.

**Keywords:** Nutraceuticals, oryzanol, rice bran, tocotrienols

**Introduction**

Rice is the world's major cereal and is the main food grain that is eaten in India and other parts of Asia. Paddy milling to produce edible rice grain yields two major economic and nutritionally important items, namely paddy husk and rice bran (Wang *et al.*, 1999) [41]. Paddy husk does not have any value for food, but it has many industrial applications. However, rice bran can serve as a food supplement for humans, as a valuable source of edible oil and as animal feed (Chen *et al.*, 2013) [7].

India's paddy production accounts for around 80 million tons annually. It can yield approximately 5 million tonnes of rice bran that is not completely exploited. India has a huge potential for rice bran, ranking second in the world, with approximately 9.48 million tons in 2013-2014, led only by China. The production of rice bran per annum in India is around 165 lakh tons (Kamali *et al.*, 2010) [22].

Rice bran is the brown coating accomplished by dehusking paddy and polishing the rice in the white starchy rice kernels. Though white rice has no nutritional value, the bran that is extracted contains 65% of the nutrients of the rice kernel and has a multitude of health benefits. Rice bran is a good source of edible oil that the nation is not yet self-sufficient in. Both full fat and defatted rice bran is a rich source of nutrients and it can act as a supplementary source of nutrients. Rice bran contains 11-17% of protein, 12-22% of oil, 10-15% of moisture, 6-14% of fiber and 8-17% of ash. It is rich in minerals and vitamins such as aluminum, calcium, chlorine, iron, magnesium, manganese, phosphorus, potassium, sodium and zinc and vitamin E, thiamine and niacin. Rice bran often contains a decent amount of nutraceutical compounds and approximately 4% unsaponifiables, most of which are natural antioxidants (approximately 100) such as oryzanol, tocotrienols and tocopherols (Ju and Vali, 2005) [20]. There is a number of bioactive phytochemicals present in both bran and rice bran oil with the ability to minimize the risk of chronic degenerative diseases (Fabian and Ju, 2011) [10].

As well as being hypoallergenic, rice bran proteins have high nutritional value (Kennedy and Burlingame, 2003) [23] (Tsuji *et al.*, 2001) [38].

The nutritional value of the protein concentrated in the rice bran is exceptional and somewhat similar to that of any other cereal and legume endosperm protein. Rice bran proteins are highly digestible and rich in essential amino acids, especially lysine, so they can be used to enrich food recipes as ingredients. Due to its antioxidant properties, rice bran also has the potential to be used as an additive to increase storage stability in a variety of foods. It is possible to use rice bran fiber as both a dietary and a functional component.

For baked items, such as cookies, breads, muffins, crackers, pastries and pancakes, the functional and nutritional properties of rice bran are sufficient (Sharif *et al.*, 2009) [36]. To increase the protein, lysine and dietary fiber content in bread and cookies, the addition of rice bran to wheat flour has been documented.

### Nutritional content of rice bran

#### Proximate composition

A good source of multiple nutrients is rice bran, a by-product of rice milling. It contains around 10-15% moisture, 12-22% fat, 11-17% protein, 6-14% fiber, and 8-17% ash (Ju and Vali, 2005) [20]. Narasinga (2000) [29] stated that rice bran protein had a higher content of lysine and a lower level of glutamic acid than rice and wheat. Rice bran proteins (Kennedy and Burlingame, 2003) [23] are also of high nutritional value and are hypoallergenic (Tsuji *et al.* 2001) [38]. The defatted bran residues contained 15.4% protein (Hamada, 2000) [13]. Hernandez *et al.* (2000) [16], Jiang (2005) [19] and Hu (1996) [17] have stated that 20% oil and 15% protein and 50% carbohydrates (mainly starch) and dietary fiber such as beta-glucan, pectin and gum are found in rice bran. In defatted rice bran, Kahlon *et al.* (1999) [21] recorded 18.16, 0.54, 11.6 to 17 and 9.51 percent protein, crude fat, crude fiber and ash, respectively. The rice bran BRRI-28 variety contained 6.54 to 9.48 per cent moisture, 7.24 to 10.63 per cent ash, 12.26 to 14.01 per cent protein, 23.5 to 27.8 per cent fat, 2.5 to 10.1 per cent crude fiber and 42.2 to 45.7 per cent carbohydrate (Mohammed *et al.* 2014) [26].

#### Dietary fiber

Rice bran contained 25.30 gm of dietary fiber per 100 gm (Narasinga, 1988) [28] which can meet the recommended dietary fiber intake of an adult which is around 27.00 gm a day. Cellulose, hemicelluloses (13 percent) and pentosans (6.5 percent), which are all insoluble fibers, were dietary fibers in rice bran. It also included around 2 per cent soluble dietary fiber in addition. Soluble dietary fibers derived using alkali solution from defatted rice bran are primarily composed of hemicelluloses (Aoe *et al.*, 1993) [3]. The role of dietary fiber is well known in offering protection against diabetes and heart disease. Depending on the commodity, the total dietary fiber content in stabilized rice bran varied from 25 to 40 percent (Carroll, 1990) [6]. The fiber of the rice bran consisted of a comparatively bit of soluble fiber (7-13 percent) and therefore the remainder was insoluble fiber (Anderson *et al.* 1990) [2]. Another good source of 20 to 51 percent of both soluble and insoluble dietary fiber is stabilized rice bran (Saunders, 1990) [34], which is almost twice that of oat bran. The proportion of

dietary fibre and crude fibre content of rice bran is substantially increased by defatting (Moldenhauer *et al.* 2003) [27]. Compositional analysis revealed that almost 27% of dietary fiber consisted of rice bran have positive effects, such as laxative and cholesterol-lowering capacity, (Azizah *et al.* 2000) [4]. A water-binding capacity, higher fat binding and emulsifying capacity were included in the dietary fiber of defatted rice bran compared to the commercial sugar beet fiber (Hamid- abdul and luan, 2009) [14].

#### Minerals

Rice bran has a phosphorus, potassium and calcium content of 2.1, 1.9 and 80 mg per 100g, respectively (Narasinga, 2000) [29]. The nutrient structure of bran from the new varieties of rice, i.e. In these types, potassium levels were relatively higher in GK88, ITA, WAR 100 and IR 72, compared to phosphorus and calcium. The GK88 variety had the lowest potassium (44 mg/100 g) and calcium (5.55 mg/100 g) levels, with ITA 402 having the maximum potassium (76 mg/100 g) concentration. WAR 100 having the lowest (26.3 mg/100 g), ITA 406 had the highest phosphorus level (51.0 mg/100 g). The maximum calcium level (9.53 mg/100 g) was in IR 72 (Ellis *et al.* 2002) [9].

#### Nutraceuticals properties of rice bran

Rice bran also contains a significant amount of antioxidants, i.e. vitamin E, oryzanol and cholesterol-lowering waxes, as well as anti-tumor components, and has the potential to inhibit or decrease the levels of free radicals that damage reactive cells (Schramm *et al.*, 2007) [35]. Alpha-tocopherol, which is an antioxidant and can minimize the risk of cancer formation and coronary heart disease, is the main element of vitamin E in rice bran. Rice bran has also found to prevent Alzheimer disease and allergies (Imasanguan *et al.*, 2008) [18].

Several phenolic compounds have been reported in rice bran ethyl acetate extracts. It has been documented that some of these phenolic compounds inhibit the growth of human breast and colon cancer cells. (Verschoyle and others, 2007) [40]. In the prevention of numerous illnesses, such as cancer, hyperlipidemia, fatty liver, hypercalciuria, kidney stones, and heart disease, rice bran has demonstrated promising health-related benefits (Parrado *et al.*, 2006) [31]. There is high phytic acid in rice bran, which is also a part of most cereals, nuts, oilseeds and legumes. It has been shown that this antinutrient decreases the occurrence of large bowel cancer caused by carcinogenes, inhibits the growth of transplanted tumors and also inhibits the growth of hepatocellular cell lines (Norazalina *et al.*, 2010) [30].

**Table 1:** Accessible bioactive compounds in rice bran. (Adapted from Friedman, 2013) [11]

Phenolic and cinnamic acid	Polymeric carbohydrates	Anthocyanins and flavonoids	Steroidal compounds
Catechins	Hemicellulose	epicatechins	$\gamma$ -oryzanol
coumaric acid	Glucans	cyanidin glucoside	$\beta$ -sitosterol ferulate
gallic acid	Arabinoxylan	hermetins	tocopherols
vanillic acid		peonidin glucoside	Tocotrienol
methoxycinnamic acid		anthocyanin monomers, dimers, and polymers	acylated steryl glucosides
hydroxybenzoic acid		Eriodytol	Campesterol ferulate
sinapic acid		Luteolin	

Rice bran is the best source of 20-51 per cent of both soluble and insoluble dietary fiber, which is almost twice as much as oat bran (Saunders *et al.*, 1990) [34]. In order to minimize cholesterol absorption, soluble fiber in bran binds to cholesterol and bile acids in the gastrointestinal tract (Kim *et*

*al.*, 2010) [25]. Lignin, hemicelluloses, cellulose, and hydrated silica are primarily the fibers found in rice bran (Salanti *et al.*, 2010) [33]. These components are similar to those derived from defatted concentrated rice bran in ground rice bran. Human pancreatic or brush boundary enzymes are not digested, and

therefore are not supposed to be completely consumed. The proportion of dietary fiber and crude fiber content of rice bran is increased significantly by defatting (Godber *et al.*, 2002)<sup>[12]</sup>. Increased fecal bulk and decreased blood cholesterol are also potential health benefits of rice bran intake (Abdul *et al.*, 2000)<sup>[11]</sup>. Rice bran also contains very high amounts of vitamins that are B-complex. B-complex vitamins are important for the health of the whole body, but especially for the health of the brain and nervous system.

### Uses of rice bran for development of nutraceuticals rich food products

As one of the cheapest cereal by-products, rice bran offers strong potential in Indian diets to complement the expensive sources of fiber and protein such as oat bran, wheat flour, and wheat bran (Sairam *et al.* 2011)<sup>[32]</sup>. The supplementation of rice bran with wheat flour as such or its defatted component has the ability to improve the nutritional profile of food products based on cereals with a special reference to the quality of protein, lysine and dietary fibre. In our region, there is a great deal of scope for integrating rice bran into cereal-based bakery items.

In the bakery products, biscuits are widely popular among people of all ages in India in both rural and urban areas. India, with an annual production of 20.50 lakh metric tonnes during 2012-2013, is known as the second largest producer of biscuits next to the United States of America. Excellent shelf life in environmental conditions, simplicity and ease of handling during use and transport, and accessibility for diverse consumers at affordable prices make the biscuits popular even in traditional Indian food cultures. Because of their popularity and pervasive presence in Indian markets, biscuits are important nutrient-providing elements of one's diet. If suitably modified, biscuits are probably the best nutrient-carrying vehicles to meet the nutritional demands of common consumers.

Therefore, biscuits made using refined wheat flour are usually devoid of fiber, and adding rice bran to them will greatly improve their nutritional quality. Biscuits have many desirable characteristics, including a broader base of consumption, relatively long shelf-life and decent standard of eating. The long shelf-life of biscuits makes it possible to manufacture and sell large-scale goods (Blanco Canalis *et al.* 2016)<sup>[5]</sup>. Better food quality makes biscuits desirable for protein fortifications and other nutritional advances, especially for the elderly, children's nutrition initiatives and low-income groups.

Rice bran may be used to develop high fiber and low fat bakery products (Keneddy *et al.* 1996)<sup>[24]</sup>. Rice bran can also be used in the preparation of meat emulsions and batter mixes (Tuncel *et al.* 2014)<sup>[39]</sup>. Moreover to the physiological benefits furnished by rice bran, as a fiber rich food may provide gelling, texture, thickening, stabilizing and emulsifying properties to various food products (Dreher, 1987; Sharma, 1981)<sup>[8, 37]</sup>. The food products coated by stabilized rice bran absorb little fat during frying and other cooking methods while the few amount of fat can be seen naturally in rice bran which might work as a carrier for flavors (Hammond, 1994)<sup>[15]</sup>. A protein formulation made with rice bran might be helpful to overcome certain protein related disorders. Rice bran protein is superior than other cereal proteins because of its anticancer and distinctive hypoallergenic properties (Fabian & Ju, 2011)<sup>[10]</sup>. On the other hand, the expansion of rice bran as a dietary supplement or medicinal food is still at an early stage.

### Conclusion

Rice bran is a rich source of fiber, proteins, fatty acids, minerals,  $\gamma$ -oryzanol, tocopherols and tocotrienols. It may serve as an important raw material for the production of nutraceuticals and functional foods, including noodles, ice cream, pasta, corn flakes, bread and zero-trans-fat shortening, provided the significance of rice bran. However, comprehensive in vivo studies are recommended to build a clear database of health benefits associated with rice bran consumption. Rice bran must be included in research studies on functional foods and nutraceuticals as a major source of bioactive components for the development of designer foods.

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