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RICE BRAN - A WONDERFUL SOURCE OF MEDICINAL PROPERTIES

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ABSTRACT

Rice bran is the cuticle existing between the rice and the husk of the paddy. It is obtained as a by-product of the rice milling process. Since the milling process has been known to remove much of the vitamins and minerals from the grain, different types of pre-milling treatments of paddy have been devised to improve its milling and nutritional quality. Rice bran is especially rich in bioactive components showing significant biological activities. Rice bran is a source of synbiotic, tocols, γ-oryzanols, polyphenols, nutritive protein and healthy mono and poly-unsaturated oil. The main fractions are proteins, oil and fibers. Since it contains many important constituentslike lipids, proteins, minerals, vitamins, phytin, trypsin inhibitor, lipase, and lectin which can help to maintain the proper body function. Rice bran is highly effective for much disease condition and helps to resist many ailments and diseases including diabetes, hypertension and hyperlipidemia. Rice bran is having more medicinal values compared to other brans. In Kerala there are many rice mills producing rice brans and are used for cattle feeds or other industrial purposes. Being a natural product the issue of side effects will be minimum.

KEYWORDS: Rice bran, rice bran oil, milling, stabilization, γ- Oryzanol.

INTRODUCTION

Rice is one of the most popular and widely used food grains in the world and about fifty per cent of the world population eats rice. The production and consumption of rice are concentrated in Asia, Northern Africa, and Middle East regions.Approximately 90% of world's rice is produced in Asia and global rice production has tripled in the last five decades from 150 million tons in 1960 to 450 million tons in 2011.[1] Developing countries account for 95% of the total production, with China and India alone responsible for nearly half of the world output. The three largest producers of rice in 2009 were China (197 Million tons), India (131 Million tons), and Indonesia (64 Million tons).

Figure 1: Major Rice producing Countries.

The rice farm productivity in India were about 45% of the rice farm productivity in China, and about 60% of the rice farm productivity in Indonesia. It is the most important food crop of India covering about one-fourth of the total cropped area. Asian rice is the seed of the monocot plants *Oryza sativa* and African rice is obtained from *Oryza glaberrima*, belonging to the family Gramineae. It is normally grown as an annual plant. The rice plant can grow to 1–1.8m tall or more depending on the variety and soil fertility. It has long, slender leaves 50–100cm long and 2–2.5cm width. The edible seed is a grain (caryopsis) of 5–12mm long and 2–3mm thick.[2] Rice cultivation is well-suited to countries and regions with low labour costs and high rainfall. It can be grown practically anywhere, even on a steep hill or mountain. It is the grain with the second highest worldwide production, after maize.[3]

Rice cultivation and its scientific studies in Kerala can be traced back to very ancient periods. There are different rice varieties cultivated in Kerala and are unique and should be given a special consideration. The vast diversity of land races, occurrence and characteristics of wild rice leads to the theory that Kerala may be one of the centre of origin of *Oryza sativam*. The sharp fall in the area under paddy cultivation as well as in the quantity of rice produced in the State has had important implications for Kerala's economic, ecological and social development.[4]

Rice Bran

Rice bran is the outer layer of the brown rice grain.[5] It is the cuticle existing between the rice and the husk of the paddy. It consists of embryo (germ) and endosperm of the seeds of *Oryza sativa* (Family- Gramineae). It is obtained as a by-product of the rice milling process. Bran is the hard outer layer of grain and consists of aleurone, pericarp, germ and a part of endosperm (Fig 1.1).Rice bran is the brown coating around the white starchy rice kernel, which is obtained by dehusking paddy and polishing the rice. When bran is removed from grains, the grains lose a portion of their nutritional value. Bran removal amounts to 4% to 9% weight of the paddy milled. White rice holds little nutritional value while the bran that is removed contains 65 percent of the rice kernel's nutrients and having a lot of healthful benefits. It is the most important source of edible oil (fixed oil) at very high percentage (14 to 18 percent). This high percentage of oil shows storage problems due to rancidity. The rancidity is caused by a lipolytic enzyme present in the bran that becomes active during processing, causing the increase in free fatty acid content of the oil. In addition to this high oil content it is also a good source of high fat and proteins, minerals, B-vitamins etc.[6]

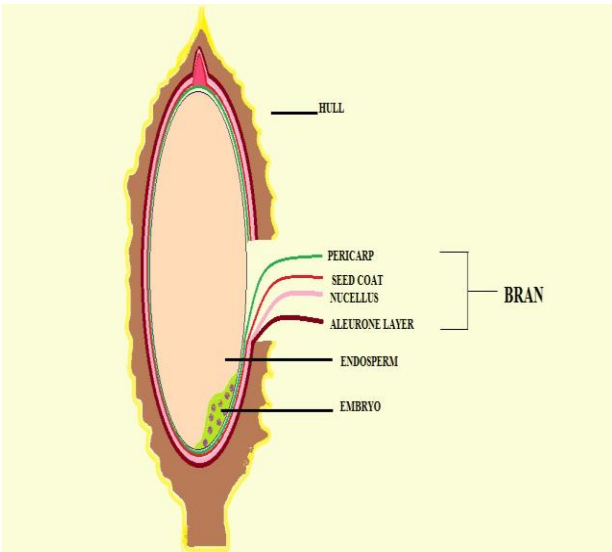


Figure 2: Diagrammatic representation of various layers of rice bran.

Rice Bran Processing

Foreign matter and other impurities have to be removed to protect the processing equipment and improve the final product. The impurities can be divided in to large impurities, small impurities and impurities of the same size of the paddy grain. Large impurities normally consist of rice straw particles, soil, and stones and sometimes iron parts. Small impurities consist of dust, sand, soil particles, weed seeds, insects and small stones. Impurities of the same size of the paddy grains can be empty grains, stones and iron particles. Impurities in lighter weight than paddy can be removed by aspiration or by sieving. Large and small impurities heavier than paddy are removed by sieving whereas particles of the same size but heavier than paddy can be removed by gravity separation. Foreign material about the same weight and size as the paddygrain is difficult to remove and it is disintegrated during the actual milling process. Weed seeds are generally small impurities normally separated through sieves. Iron parts or particles are removed by sieving, by gravity separation or by permanent or electro magnets.[7]

Milling Process

Paddy is a mixture of pericarp, seed coat, and some of the aleurone layer. Rice is obtained from paddy by milling, which removes the hull and bran. After the hull is removed, the brown rice contains bran, germ, and endosperm. The brown rice is further milled to remove the bran and the germ from the endosperm to produce white rice or polished rice. Like most of the crops used, rice bran also has a siliceous hull which must be removed since it is unsuited either for food or feed.[8]

The objective of milling is to get whole grain rice and to preserve most of the rice kernels in their original shape. Both pre- harvest and post- harvest factors cause breakage of rice during milling. Even if the proper precautions are used in post- harvest processing some varieties of paddy produce low head rice yield because of poor milling. Since the milling process is being known to remove much of the vitamins and minerals from the grain, different types of pre- milling treatments of paddy have been introduced to improve its milling, nutritional, cooking, and keeping quality.

Parboiling of paddy is one of the pre-treatment methods used to improve milling process. It is a hydrothermal process that may be defined as the gelatinization of starch with in the rice grain. The rice obtained from milling pretreated paddy is known as parboiled rice whereas, the rice obtained from milling untreated paddy is known as raw rice or white rice.The parboiling process finds extensive application in the Eastern part of Southern India, Eastern Madhya Pradesh, and Uttar Pradesh.

Parboiling of paddy requires three steps namely soaking, steaming and drying.In the soaking process the void spaces in the hul1 and rice kernel are filled with water and the starch granules absorb water and swell. This will cause an increase in the volume of the paddy. During steaming, soaked paddy is exposed to steam heat for a given duration and the starch present in the rice kernel is gelatinized. Subsequently the paddy is dried to 16 percent moisture content, which imparts the hardness that the grains require for milling. The methods of parboiling are of two types- traditional methods and modern methods. The traditional method comprises of both single boiling and double boiling. Some examples of modern methods of parboiling are.

1. CFTRl Method
2. Jadavapur University method

3. Converted process method (American)
4. Malek Process method (American)
5. Avorio process method (Italian)
6. Fernades process method (Surinam).

After the hull is removed from the rice, approximately 6-8% of brown rice kernel is polished yielding white rice and the by-product rice bran. During the milling process, lipase, a highlyactive lipolyticenzyme is released. Within minutes the lipase reacts with oil in the rice bran, resulting in rapid hydrolysis of oil into free fatty acids, making bran unfit for human consumption. After 24 hours of separation, it is not economically feasible to extract oil from the rice bran and after three or four daysit isnot possible to use the rice bran.

McPeak rice bran patented apparatus is one of the improved methods for treating rice bran. It is used for heating the milled rice bran to a high nutrient rice bran product for human consumption. It consists of a hopper for receiving the rice bran, which is mounted above the extruder and includes a rotating stirrer unit driven with a separate DC motor. This stirrer unit agitates the bulk bran and positively prevents the bridging of material within the hopper. A feed conveyor is mounted immediately beneath the hopper, with a feed opening at the inner end of the extruder for controlled feeding of rice bran to the extruder. The flighted core extruder is specially formed with several agitator elements, which is responsible to establish a continuous pressurized state within the extruder to move the powdery bed of rice bran in a forward direction. The compacted rice bran is extruded through the conical discharge cone, where the pressure and heat characteristics are sufficient enough to destroy the lipase activity and thereby stabilizing the rice bran which prevents the formation of free fatty acid. This extruder action doesn't destroy the nutrients and antioxidants within the rice bran. Motor is constructed to operate at 885 rpm and produce 75 horse power.

Today's modern rice mills efficiently separate hulls from paddy rice followed by bran removal. Milling consists of rubber roll de-hullers, paddy separators, abrasive milling (whitening), and possibly friction mills. The bran and polish consist mainly of the outer layers of rice caryopsis. These include the pericarp, seed coat, nucellus, aleurone layer, germ, and part of the sub-aleurone layer of the starchy endosperm. Rice bran makes up 5–8% of rough rice, and the polish may account for an additional 2–3%. Commercial rice bran is a fine, floury material made up of the outer layers of the brown rice plus pulverized germ, some hull fragments, and some endosperm (white rice fragments). The particle size of the bran varies significantly with type of milling and milling condition. The composition of the bran also varies as a function of milling.[9]

Raw rice bran usually contains about 18 percent oil content. Parboiled rice bran produced by cooking of rough rice prior to milling has greater oil content, usually above 20%, than raw rice bran. The final physical and chemical nature of bran depends on the following:

- Rice variety
- Treatment of the grain before milling
- Type of milling system
- Degree of milling
- Fractionation that occurs during milling.

The preferred method for milling of rice that gives hulls, bran, and milled rice is referred to as ''multistage'' or ''multiple break'' where shellers (dehullers), polishers and whiteners are used. The hull is first removed in shellers, and the dehulled brown rice undergoes subsequent whitening operations. The amount of contaminants in the bran affects the total lipid content. Contaminants are broken rice and layers from the endosperm. Addition of calcium carbonate, usually at 0.25% of rough rice as a milling aid during whitening, further reduces the oil content. Other milling aids such as diatomaceous earth and ground limestone have also been used.In developing countries, most rice is milled in a one-stage (huller) mill that removes hull, bran, and germ as a single mixture. It is estimated that less than 25% of rough rice is fractionated into hull and bran fractions.

Steps In Rice Milling

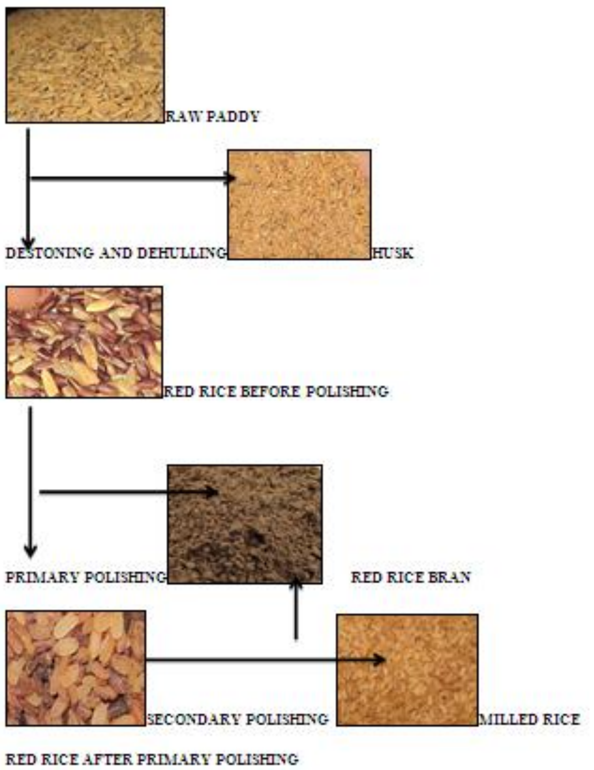


Figure 3: Steps in rice milling.

General Stabilization Of Rice Bran[10]

The instability of rice bran has long been associated with lipase activity. As long as the kernel is intact, lipase is physically isolated from the lipids. Even dehulling disturbs the surface structure allowing lipase and oil to mix. Oil in intact bran contains 2–4% free fatty acids. Once bran is milled from the kernel, a rapid increase in the FFA occurs. In high humidity storage, the rate of hydrolysis is 5–10% per day and about 70% in a month.

The objectives of rice bran stabilization are as follows:
- Arrest lipase and lipoxygenase activity.
- Improve oil extraction efficiency.
- Reduce fines in crude oil.
- Sterilize the bran.
- Reduce color development.

Methods for stabilization of rice bran includes dry heating, wet heating, extrusion. The most practical method has been the use of extrusion or expansion methods.In retained heating methods (dry heat), a simple hot air drying reduces the moisture content to 3–4%. The bran must be kept dry in moisture-proof containers, or the rehydrated bran will regain its lipase activity. If the bran is heated in the presence of moisture, the lipase is permanently denatured. Expanders or expellers are also used to permit addition of moisture (wet heating) through steam and the formulation of colletts or pellets from the bran. The colletts aid handling and oil extraction.Extrusion (dry heat) cookers have been ideal for stabilization because excess moisture is not added, eliminating the need for drying. The heating of the bran occurs through conversion of mechanical energy of the screw drive to heat the bran.[11]

Temperature used for stabilization varies from 100^0 to 140^0C. The bran is kept hot for 3–5 minutes after extrusion to ensure lipase inactivation. The hot bran is then cooled using ambient air. Dry extrusion was found more suitable for stabilizing bran to be used as a food ingredient. Stabilization within 1 hour after milling is considered ideal for bran quality. Wet heating is more effective for bran stabilization for oil extraction than in dry heating. Lipase is inactivated in 3 minutes at 100^0C. The equipment that can be used includes steam cookers, blanchers, autoclaves, and screw extruders with injected steam and water. Extrusion with steam injection and up to 10% added water reduces the temperature required for lipase inactivation. Temperatures are reduced to 100–120^0C. Product may be held at 100^0C for 1.5–3.0 minutes before drying to stable moisture content.[12]

Other stabilization methods that have been investigated are as follows:
- Refrigeration to reduce the rate of hydrolysis.
- Lowing pH to reduce lipase activity.
- Chemical additions such as sodium metabisulfite.

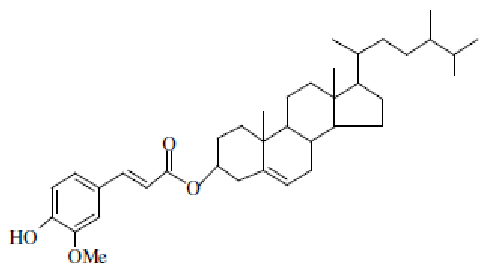
Composition And Constituents Of Rice Bran [13,14]

Fig. 4: Rice bran.

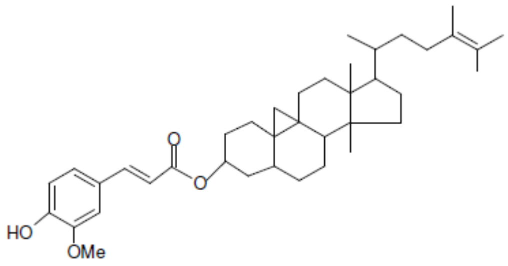
Organoleptic characterstics
- **Colour:** Redish brown
- **Odour:** Pleasant
- **Taste:** Bitter
- **Solubility:** insoluble in water

It was found that rice bran contained high levels of both tocopherols and tocotrienols, which compromise vitamin E and act as antioxidants in the body. Also, high levels of a mixture of compounds referred to collectively as oryzanol were identified within rice bran. A component of rice bran oil that has promise as a nutraceutical compound is γ-oryzanol. Oryzanol components are complex compounds that can act as an antioxidant, improving solubility in cell membranes and potentially lowering cholesterol by competitive inhibition of absorption and synthesis. The individual components of the oryzanol can be separated, leading to the identification of 3 major fractions of oryzanol.[15]

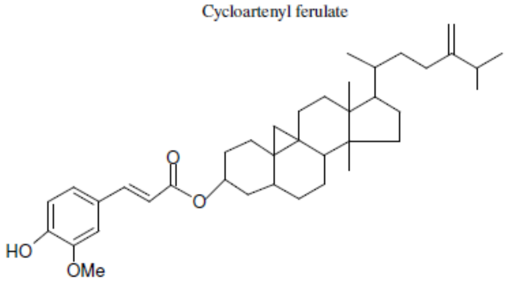
- Cycloartenylferulate
- 24-methylene cycloartanylferulate
- Campesterylferulate.



Campesteryl ferulate



Cycloartenyl ferulate

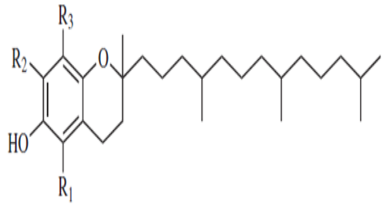


24 methylene Cycloartanyl ferulate

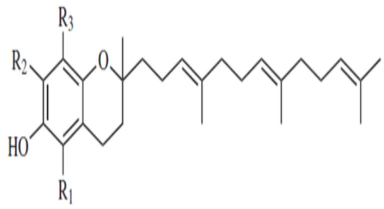
Fig. 5: Major ferulates in oryzanol.

γ-Oryzanol was first isolated from soapstock from rice oilrefining. Although originally thought to be a single compound, it is now known to be a mixture of steryl and other triterpenyl esters of ferulic acids (cycloartenylferulate, 24 methylenecycloartenylferulate, and β sitosterol ferulate and campesterylferulate). It is present at 1.5–2.9% of rice bran oil with am.p. of 138.5°C. The oryzanol content is dependent on rice grain variety with long grain rice at 6.42 mg/g and medium grain rice at 5.17 mg/g.

Tocopherols and Tocotrienols (tocols) are present in rice oil.[16] Crude rice bran oil was found to contain, per 100 g of oil, 19–46 mg of α-tocopherol, 1–3 mg of β-tocopherol, 1–10 mg of γ-tocopherol, and 0.4–0.9 mg of d-tocopherol, 14–33 mg of α-tocotrienol, and 9-69 mg of γ-tocotrienol. The mean tocol content was 93 mg/100 g for crude oil and 50 mg/100 g for refined oil. Close to 370 mg/100 g has been reported. Rice bran stabilization and storage and method of extraction affects the concentration of tocols in the oil. γ-Tocotrienol is more stable and persists to a greater extent during storage than other tocols. Other factor influencing tocol content are milling and variety. Long-grain varieties have higher levels of tocotrienols than medium grain rice.



Tocopherols (T)



Tocotrienols (T3)

	R_1	R_2	R_3
α-T(3)	CH_3	CH_3	CH_3
β-T(3)	H_3	H	CH_3
γ-T(3)	H	CH_3	CH_3
δ-T(3)	H	H	CH_3

Fig. 6: Tocopherols.

Major Alcohols

Straight-chain alkanes, alkenes, and branched-chain alkenes (squalene) are detected in the hydrocarbon fraction. The squalene content is 120 mg/100 g. Hard and soft waxes are recovered from crude rice bran oil with m.p. of 79.5°C and 74°C. The hard wax consists of 64.5% fatty alcohols, 33.5% fatty acids, and 2% hydrocarbons. Soft wax includes 51.8% fatty alcohols, 46.2% fatty acids, and 2% hydrocarbons.

Rice bran is rich in lipids, proteins, minerals, vitamins, phytin, trypsin inhibitor, lipase, and lectin (hemeagglutinins). Compared with other cereal beans, rice bran with germ is a little higher in fat content but comparable in protein, fiber and ash. (The high phosphorous content is among the highest of the cereal grains) Rice bran is also high in silica probably because of the presence of rice hull fragments. Bran is high in B vitamins and tocopherol, but it contains only a little Vitamin A and C. Rice bran and germ are used in animal feeds as a low-cost source of protein and oil. Lipids are present as spherosomes or lipid droplets less than 1.5 mm in diameter in the aleurone layer, less than 1.0 mm in the subaleurone layer, and less than 0.7 mm in the embryo of the rice grain. Most of the lipids in the endosperm are associated with protein bodies and the starch granules as bound lipids. The lipids are broadly classified as non-starch and starch lipids. The majority of the lipids are the non-starch lipids.[12]Comparison of various bransare given below.

Table 1: Bran comparison chart.

Nutrient (Values/100g)	Stabilized Rice Bran	Corn Bran	Oat Bran	Wheat Bran
Calories (kCal)	330	224	246	216
Moisture (g)	6	4.7	6.6	10
Protein (g)	14.5	8.4	17.3	15.6
Soluble Fiber (g)	2			
Total Ash (g)	8.5	0.4	2.9	5.8
Total Carbohydrates (g)	51	85.6	66.2	64.5
Total Dietary Fiber (g)	29	79	15.4	42.8
Vitamin E				
Tocopherols	12	0.4	1	1.5
Tocotrienols	13.6			
Vitamin B Complex				
B1 (mg)	2.8	0.01	1.2	0.5
B2 (mg)	0.3	0.1	0.2	0.6
B3 (mg)	46.9	2.7	1	13.6
B5 (mg)	4.2	0.6	1.5	2.2
B6 (mg)	3.2	0.2	0.2	1.3
Calcium (mg)	40	42	58	73
Choline (mg)	104.8			
Gamma Oryzanol	300			
Inositol (mg)	1496			
Iron (mg)	7.7	2.8	5.4	10.6
Magnesium (mg)	727	64	235	611
Manganese (mg)	25.6	0.1	5.6	11.5
Phosphorous (mg)	1591	72	734	1013
Phytosterols (mg)	341.1			
Potassium (mg)	1573	44	566	1182
Sodium (mg)	8	7	4	2
Total Carotenoids	129.3			
Total Sugars (g)	8	0	1.5	0.4
Zinc (mg)	5.5		3.1	7.3

Starch lipids consist primarily of lysophospholipids, triacylglycerols, and free fatty acids. Major phospholipid species are lysophophatidylethanolamine and lysophosphatidylcholine. The major fatty acids are palmitic and linoleic acids along with oleic acid. Minor amounts of monoacylglycerols, diacylglycerols, and sterols are also found (Table 1). Glycolipids found are diglycosylmonoacylglycerols and monoglycosylmonoacylglycerols. The component sugars are galactose and glucose. The non-starch lipids in the aleurone, subaleurone, and germ layers were 86–91% neutral lipids, 2–5% glycolipids, and 7–9% phospholipids, although these are variable because of different milling degrees.[13] The fatty acid composition of non-starch lipids showed 22–25% palmitic, 37–41% oleic acid, and 37–41% linoleic acid. The brown rice non-starch lipids were 14–18% in germ, 39–41% in bran, 15–21% in polish, and 25–33% in milled rice. The composition was 83–87% triacylglycerol together with 7–9% free fatty acids, diacylglycerols, sterols together with sterol esters, hydrocarbons, and wax.[17]

Table 2: Lipid Composition of Rice and its Fractions.

Property	Nonstarch Lipids In Rice Fractions						Nonwaxy Starch Lipid Inrice Fractions	
	Hull	Brown	Milled	Bran	Germ	Polish	Brown Rice	Milled Rice
Iodine Number	69	94	100	99	101			
Lipid content	0.4	2.7	0.8	18.3	30.2	10.8	0.6	0.05
Saponification number	145	181	190	184	189			
Unsaponifiable matter	26	9	6	6	34			
Fatty acid composition Wt % of total								
Linoleic	28	38	40	36	37	38	38	40
Oleic	42	35	21	37	36	35	12	11
Palmitic	18	23	33	23	24	23	46	45
Others	12	4	6	4	3	4	4	4

Neutral Lipids, % of Total Lipids	64	86	82	89	91	87	28	26
Triglyceride		71	58	76	79	72	4	2
Free Fatty Acids		7	15	4	4	5	20	21
Glycolipids, % of Total Lipids	25	5	8	4	2	5	19	16
Phospholipids, % Total Lipids	11	9	10	7	7	8	53	58
Lysophosphatidylcholine		<1	2	<1	<1	<1	21	23
Lysophosphatidylethanolamine			1				22	25
Phosphotidylcholine		4	9	3	3	3	4	4
Phosphotidylethanolamine		4	4	3	3	3	5	5

In the past, human consumption of rice bran has been limited, primarily because rice bran spoils quickly, but methods to preserve rice bran have been developed. Additionally, methods for extracting rice oils were developed. Interest in rice bran grew when studies showed that the inclusion of oat bran in the diet lowers serum cholesterol. The antioxidant activities of four of the vitamin E and three oryzanol components purified from rice bran were investigated in a chemical model of cholesterol oxidation. All components exhibited significant antioxidant capacity and inhibited cholesterol oxidation. All three oryzanol components had higher antioxidant capability than any of the four vitamin E components.[18]

General Uses of Rice Bran

Food ingredient

As a food ingredient, rice bran and its derivatives are easy to integrate, tastes light and slightly toasted, and offers an excellent texture. As an alternative to wheat, corn or oat bran, rice bran is hypoallergenic, gluten free, genetical modifier (GMO) free and transfat free. As a gluten free food ingredient stabilized rice bran is easy to integrate into finished foods.[19]

- Meat Inclusion (Rice bran meat emulsion)
- Meat enhancement
- Meat Analogue
- Emulsified
- Coarse Ground
- Rice bran provides an increase cook yield, improves texture, reduces purge and provides freeze-thaw stability in meat products
- Rice bran can replace other ingredients such as soy protein or mustard while providing significant cost savings
- Beef hot dogs
- Meat replacement

Replacement of 3% beef 90's and beef 50's with 3% Rice Bran.

- **Mustard replacement**

Replacement of 1.5% mustard with 3% Rice Bran.

- **Edible grade oil**

Rice bran oil contains fatty acid composition and high levels of antioxidants like vitamin E, and high content of tocopherols, tocotrienols and phytosterols. Along with oleic and linoleic fatty acids, these composed of very small levels of linolenic acid, therefore its having greater advantage over vegetable oils. Also, high levels of a mixture of compounds referred to collectively as oryzanol were identified within rice bran. Different grades of bran oil such as cooking oil, salad oil could be produced by hydrogenation and refining.

- **Soap manufacture**

Rice bran oil with high free fatty acid can be suitably used for the manufacture of soft soap and liquid soap. In addition to this other soaps like aluminum, barium calcium can be manufactured as components of lubricants.

- **Free fatty acid manufacture**

It can be used in manufacture of stearic acid and oleic acid.

- **Protective coatings**

It can be used to manufacture surface coatings like alkyl and resin based paints, enamels, varnishes and lacquers.

- **Plasticizers**

It is used to manufacture plasticizers for use in rubber and plastic industries.

- **Tocopherols**

It contains 2-4% of tocopherols with nutritional and antacid effects.

- **Rice bran wax**

It can be used as substitute for carnauba wax and also be used in the production of stencils,candles,carbon paper base etc.

- **Animal Nutrition**

A very successful track record in high-end feed ingredient for equine athletes and pet food.RiceBran Technologies has a very successful track record in high-end feed for equine athletes. We are leveraging that success for high-end pet food.

- **Nutraceuticals[20]**

The nutritional value of rice bran makes for a great base upon which to build nutrition-based products. For breads, pastries, pastas, tortillas and many other food applications, stabilized rice bran offers a great source of nutrition, fiber, an excellent texture and lightly toasted flavor.

Medicinal Uses

Used in Cholesterol Oxidation[21]

High cholesterol, when added to a reduced-fat diet. Following a low-fat diet and taking 85 grams of full-fat rice bran per day seems to lower total cholesterol by 8% and "bad" low-density lipoprotein (LDL) cholesterol by 14%. Rice bran does not seem to affect other blood fats such as triglycerides or "good" high-density lipoprotein (HDL) cholesterol. Taking 11.8 grams of rice bran in a reduced-fat form doesn't work as well. Both full-fat and reduced-fat rice bran work about as well as oat bran for reducing high cholesterol. The antioxidant activities of four of the vitamin E and three oryzanol components purified from rice bran were investigated in a chemical model of cholesterol oxidation. All components exhibited significant antioxidant capacity and inhibited cholesterol oxidation. All three oryzanol components had higher antioxidant capability than any of the four vitamin E components. They are linked to lower the cholesterol levels. Rice bran consumption has shown to be successful in reducing cholesterol levels in pigs, hamsters, rats, humans, and non-human primates.

Used in Osteoporosis

Ovary ectomized rats were used as a model for postmenopausal osteoporosis. It was found that the addition of a 7% oryzanol rice bran oil (RBO) concentrate to the diets of ovary ectomized rats resulted in less bone loss at several bone sites than control rats. Currently it is not known what the active elements in rice bran oil are that are beneficial in reducing bone loss. The mode of action is unknown. RBO concentrate primarily acts in preserving the cortical bone in the long bones, which is replaced very slowly. Other functional foods, such as soy protein, act on the trabecular bone in the vertebrae, which is replaced rapidly. The possibility of using soy protein with RBO is currently under investigation.

Used in Cancer[22]

Stabilized rice bran derivatives are richest source of phytosterols, the most common phytosterol are beta sitosterol, campestrerol and stigma sterol. Phytosterol offer protection to the most common cancer especially colon, breast and prostate cancers The review summarizes the possible mechanism by which phytosterols functions on membrane structure, function of tumour and host tissue, signal transduction pathway that regulate tumour growth and apoptosis and immune function and other mechanism involving tumour growth and chemo prevention. The consumption of stabilized rice bran may be advantageous for cancer prevention Tocopherols and tocotrienols had much greater in vitro antioxidant activities and greater suppression of B16 melanoma cell proliferation than alpha-tocopherol and known tocotrienols. Results indicated that the number and position of methyl substituents in tocotrienols affect their hypocholesterolemic, antioxidant, and antitumor properties Isolation and identification of novel tocotrienols from rice bran with hypocholesterolemic, antioxidant, and antitumor properties.[20] A striking anti-cancer action of IP6 has been demonstrated both in vivo and in vitro, which is based on the hypotheses that exogenously administered IP6 may be internalized, dephosphorylated to IP (1-5), and inhibit cell growth. There is additional evidence that Inositol alone may further enhance the anti-cancer effect of IP6.

Used in Heart disease[23]

Rice bran and its main components: potential role in the Management of coronary risk factors.The human study confirms that rice bran and rice bran oil can mimic the effect of dietary cholesterol in decreasing the activity of the key regulatory enzyme for cholesterol synthesis. The reductase lasted about 4 hrs suggesting a need for the presence of rice bran or oil in each meal daily. Further studies on feeding rice bran oil or its unsaponifiable fraction to experimental animals on atherogenic diet indicate that the unsapanifiable fraction of rice bran oil plays a major role in reducing the level of circulating lipids. Thus dietary rice bran oil may be useful in hypercholesterolemic effects to minimize the risk of choronary heart disease.

- Hypoallergenic
- Gluten Free
- Non-dairy
- Non-GMO(Genetically modified)
- No Anti-nutritional Factors
- Hypolipidemic
- Treatment of stomach cancer
- Atopic dermatitis/ Allergic skin rash
- Reducing kidney stones

Special Precautions & Warnings[24]

- Pregnancy and breast-feeding: Rice bran is safe in amounts found in food, but there's not enough information to know if it's safe in the larger amounts that are used as medicine.
- Gastrointestinal (GI) conditions: Don't use rice bran if patient have a digestive tract problem such as intestinal ulcers, adhesions, conditions that cause narrowing or blockage of the digestive tract, slow digestion, or other stomach or intestinal disorders. The fiber in rice brain could block the digestive tract.
- Swallowing: Use rice bran with caution if have trouble in swallowing. The fiber it contains might cause choking.

Table 3: Selected bioactive compounds in rice bran evaluated for their properties with regard to prevention of chronic disease.[25]

Rice bran compound	Disease prevention activity
Ferullic acid	Antioxidant,chemopreventive,anti-inflammatory, lipid lowering effects
γ- Oryzanol	Antioxidant, chemoprotective, anti-inflammatory, lipid lowering effects
Inositol hexophosphate	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	Gastro intestinal microbial interactions
Coumaric acid and Tricin	Anti mutagenic, inhibits the cell cycle, anti-oxidant and chemoprotective

CONCLUSION

Rice bran was considered as a waste product with little value because of lipid instability. However, the introduction of innovative lipid stabilization technology has allowed rice bran to move up into a higher level of the food chain. Patented technology and engineering breakthrough now has allowed the inactivation of lipase enzyme by heating the rice bran at about 130-140°C for a short period of time which brings out the stabilized rice bran without any earlier problems.Currently the rice bran is not processed for human use on industrial or commercial basis even though its medicinal and nutritional values are proved. In the case of rice bran the potential application is very high.

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