Nutritive Value Of Rice Bran
B.S. Narasinga Rao

Rice is the major food grain of the world and it is the principle cereal consumed in India and other parts of Asia1. Milling of paddy to obtain edible rice grain yields two major by-products of economic and nutritional importance, namely, paddy husk and rice bran. Paddy husk has no food value but has several industrial uses. Rice bran, on the other hand, can serve as an animal feed, as a human food supplement and as a valuable source of edible oil.

India has a vast rice bran potential, occupying the second place in the world, next only to China. Rice bran is a good source of edible oil in which the country is not yet self-sufficient. Rice bran – both full fat and defatted – is a rich source of nutrients and can serve as a source of nutrient supplement. Both the bran and oil from rice bran have a range of bioactive phytochemicals with potential for reducing the risk of chronic degenerative diseases2,3. At present, only about half of the potential source of rice bran is exploited for oil. There is a need to utilise the full potential of the available rice bran in the country, both as a source of healthy edible oil and as a food supplement for promoting our population’s nutrition and health.

Traditional milling of paddy by hand-pounding or by small hullers yields bran heavily contaminated with husk, with a high content of silica (>5 per cent) and crude fibre. It therefore has limited use even as an animal food. As it is low in fat, it cannot be used as an economic source of oil. However, in the modern milling process, the paddy is first dehusked by shellers to obtain husk and brown rice. Brown rice on further milling and polishing yields polished rice and good-quality bran with little contamination with husk and, hence, has a low silica content (<1.0 per cent). The bran obtained by this two step milling process can be used as a health-food as well as a source of edible oil, provided it is stabilised with heat treatment to inactivate the enzyme lipase which gets released after the bran is separated from the grain. Lipase, if not inactivated, results in a rapid increase in the free fatty acid content of the oil. Rice bran produced from parboiled paddy however does not need stabilisation since the paddy itself is treated with steam during parboiling.

Rice bran, produced in modern rice mills, is mixed with rice germ and starch from the endosperm. The yield of husk bran and milled rice from 100 kg paddy are 22.8 kg and 73 kg, respectively. The yield of bran depends upon the degree of milling of the brown rice, it may vary from 5 to 10 per cent. In India, polishing is restricted to 5 per cent by government regulation.

**NUTRITIVE VALUE**

The nutrient composition of rice bran is given in Table 1. Rice bran is a rich source of proteins, fats, minerals and micronutrients, such as B-vitamins and trace elements.

**Proteins:** The protein of rice bran has a higher lysine content and a lower glutamic acid content than rice and wheat and it has a better balance of essential amino acids with an amino acid score of 80 per cent with respect to lysine, and 90 per cent with respect to threonine. It is reported to have a Protein Energy Ratio (PER) value of nearly 2.0.

**Carbohydrates and energy:** The carbohydrate of bran is a mixture of complex carbohydrates and starch. Although starch is absent in true bran, commercial bran obtained on rice milling contains starch derived from the rice kernel, the content of which may range from 10 to 25 per cent depending on the extent of polishing. Rice bran with low levels of available carbohydrate (25 per cent) and high level of fat (20 per cent) can be considered as a good source of energy when used as a supplementary food for diabetics.

Rice bran with 15 to 20 per cent oil can serve as a good source of energy and Essential Fatty Acids (EFA). It is also a commercial source of edible oil.

**Minerals:** Rice bran is a good source of minerals and trace minerals (Table 1) and is much superior to other cereals. There is a need to assess the bioavailability of minerals from rice bran, especially of calcium, iron and zinc, in view of its high phytate content.

The native silica derived from rice grain present in edible grade rice bran may presumably help in bone formation in children and women when rice bran is used as a dietary supplement. Although the significance of silica in bone metabolism and bone formation has been established in animals and in vitro studies4,5, its importance for man has yet to be established. Part of the silica content of edible grade rice bran derived from husk as a contaminant is, however, poorly absorbed and, hence, may not pose any health risk.

Another interesting feature of mineral content of rice bran is its low sodium and high potassium content, the potassium/sodium ratio being nearly 100. With this kind of low sodium and high potassium content, rice bran can perhaps be a useful supplement in diets for hypertensives.

**Vitamins:** Rice bran is also a rich source of B-complex vitamins (Table 1), particularly thiamine and nicotinic acid and some other minor B-vitamins. Riboflavin and vitamin B_6 content however appear to be on a lower side. In Table 2, the nutrient content of rice bran is compared with RDA for a sedentary man (consumption unit)6 and also with rice and wheat. A 100 g of edible grade rice bran can meet 20 to 27 per cent of the daily needs of nutrients of a sedentary man.

**Phytochemicals:** Full fat rice bran is a rich source of a number of bioactive phytochemicals (Table 3). They include dietary fibre, phytosterols, gamma oryzanol, tocopherol and tocochromans, ferulic acid and other phenolic compounds. The other bioactive compounds present as minor constituents are lipoic acid, coenzyme Q, etc. Except for dietary fibre, most of the other phytochemicals are present in the non-glycérified (unsaponifiable fraction) of the oil present in rice bran.

**Dietary fibre:** Rice bran contains 25.3 g of dietary fibre per 100 g which can meet the recommended dietary fibre intake of an adult which is about 27 g a day7. Dietary fibre in rice bran includes cellulose, hemicellulose (13 per cent) and pentosans.
(6.5 per cent) which are all insoluble fibres. It also contains in addition about 2 per cent soluble dietary fibre. The role of dietary fibre in offering protection against diabetes and heart disease is well established.

There are only limited studies to demonstrate the antidiabetic and hypocholesterolemic effects of dietary fibre of rice bran in man, although this aspect has been studied in rats and hamsters. In a study in human subjects, it was shown that 100 g of rice bran a day can lower plasma cholesterol levels and in this respect it is as good as oat bran. An intake of 30 g of rice bran however did not have any effect.

Both full fat rice bran and defatted rice bran are good sources of dietary fibre, the latter having a higher content (30 per cent). The reported hypocholesterolemic effect of full fat rice bran may be partly due to its oryzanol and phytosterols content.

Rice bran obtained from the modern two stage milling process has been further processed to obtain edible grade rice bran and other edible fractions. One of the problems with rice bran is the high level of roughage (crude fibre) content. Rice has been further processed to reduce this roughage and prepare other functional foods. Rice bran can be steam cooked and converted into flakes for ready consumption. It can also be ground, sieved and separated to reduce the roughage. The resulting product would be a very fine powder which can be converted into granules, rendering it more convenient to use as a food supplement.

Rice bran has also been fractionated by a wet process (a) high fibre (b) low fibre (3 to 4 per cent) and (c) water soluble fractions, all of which can be used as food supplements. Although all three fractions can be used as functional food supplements, the latter two – the low fibre and soluble fractions – can be conveniently incorporated into food formulations for infants and young children.

Defatted rice bran has also been exploited for obtaining value added products. It has been used to isolate protein after alkali extraction and also for isolating phytic acid, of which rice bran is rich source, and inositol after acid extraction (pH 4.0).

**Food uses:** Edible grade rice bran (stabilised), defatted rice bran and their fractions have great potential of being used in various foods to upgrade their nutritional and health promoting potential (hypoglycemic, hypocholesterolemic). Food uses of rice bran have been explored in other countries in which both full fat and defatted rice bran have been used in baby foods, breads, muffins, pancakes, cookies, cakes, pies, coatings and crests for finger foods, confectioneries, deep fried preparations, extruded snacks, soups, breakfast cereals and as spice carriers, etc. Processed bran preparations are recently being marketed for use as additives and as a source of fibre in various foods at home. Rice bran has been used with milk to prepare rice bran milk, a nutritional high protein drink.

**RICE BRAN OIL**

Rice bran which has been heat stabilised to inactivate the lipase or the freshly prepared rice bran is a good source of edible oil with nutritional and health promoting potential. Rice bran obtained by the two stage milling of raw rice has nearly 18 to 20 per cent oil. However, a higher level of oil is present in bran obtained from parboiled paddy which does not require any stabilisation. Oil can be obtained from rice bran by the traditional method of processing (pressing), but the yield would be low. The modern methods of solvent extraction of bran can, however, recover all the oil present in the bran. The crude oil obtained from solvent extraction has to be further purified by degumming, dewaxing, deodorisation and decolouration to obtain edible grade rice bran oil.

Rice bran oil (RBO) has a desirable fatty acid profile with 35 per cent linoleic acid and 2 per cent linolenic acid and it is almost comparable to groundnut oil.
TABLE 2
Nutrient Content of Rice Bran Compared with that of Rice, Wheat and RDA

<table>
<thead>
<tr>
<th>Nutrients</th>
<th>Content per 1000 kcal</th>
<th>Nutrient content per 100 g of rice bran as % of RDA</th>
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<tbody>
<tr>
<td></td>
<td>Rice Bran</td>
<td>RDA</td>
</tr>
<tr>
<td>Energy (kcal)</td>
<td>1000</td>
<td>1000</td>
</tr>
<tr>
<td>Protein (g)</td>
<td>46.0</td>
<td>24.7</td>
</tr>
<tr>
<td>Protein (kcal)</td>
<td>184.0</td>
<td>99.0</td>
</tr>
<tr>
<td>Fat (g)</td>
<td>59.3</td>
<td>8.3</td>
</tr>
<tr>
<td>Fat (kcal)</td>
<td>634.0</td>
<td>74.2</td>
</tr>
<tr>
<td>Calcium (mg)</td>
<td>222.8</td>
<td>165.0</td>
</tr>
<tr>
<td>Iron (mg)</td>
<td>30.6</td>
<td>11.6</td>
</tr>
<tr>
<td>Zinc (mg)</td>
<td>17.8</td>
<td>6.4</td>
</tr>
<tr>
<td>Iodine (µg)</td>
<td>186.6</td>
<td>61.9</td>
</tr>
<tr>
<td>Thiamine</td>
<td>8.4</td>
<td>0.5</td>
</tr>
<tr>
<td>Riboflavin (mg)</td>
<td>1.1</td>
<td>0.6</td>
</tr>
<tr>
<td>Niacin (mg)</td>
<td>119.8</td>
<td>6.6</td>
</tr>
<tr>
<td>Pyridoxine</td>
<td>1.4</td>
<td>0.8</td>
</tr>
<tr>
<td>Folic acid (µg)</td>
<td>231.2</td>
<td>41.2</td>
</tr>
</tbody>
</table>

Source: Ref 1 and Nutritive Value of Indian foods, ICMR, 1991.

Unsaponifiable matter: The peculiar feature of RBO, as compared to other common vegetable oils, is its high content (4-5 per cent) of unsaponifiable matter as compared to one or less than 1 per cent in other common edible oils. The unsaponifiable matter content of RBO is much above the maximum standard fixed for edible oils by PFA. The high level of unsaponifiable matter in RBO is quite safe as demonstrated by standard toxicological studies at NIN.12 The high unsaponifiable matter in RBO is not only safe for human consumption but it contains valuable phytochemicals with potential for reducing blood cholesterol and against the risk of heat diseases. This potential of rice bran oil in protecting against high blood cholesterol has been studied and exploited only during the past two decades.2,3,12,13 Rice bran oil, its unsaponifiable matter and its components, phytosterols, oryzanol and tocotrienols, have been shown to reduce blood cholesterol as compared to other oils with comparable linoleic acid content (that is, groundnut oil) both in experimental animals and human subjects.14

The mechanism of action of these compounds in reducing blood cholesterol is briefly described:

- **Tocols (vitamin E) (Tocopherols and tocotrienols):** Rice bran contains more tocotrienol than tocopherol. Rice bran is the only edible oil, besides palm oil, which is rich in tocotrienols. While both act as antioxidants, tocotrienol is better than tocopherol in this respect. Tocotrienol has also been shown to have a special role in reducing blood cholesterol and protect against heart disease, by reducing de novo synthesis of cholesterol in the body by inhibiting the key enzyme HMG CoA reductase15 and it is also reported to act as an anti- clotting factor.

- **Phytosterols:** The hypocholesterolemic potential of these phytosterols has been demonstrated both in man and experimental animals.16 There are a number of phytosterols in the unsaponifiable fraction of RBO. These phytosterols act at the intestinal level by interfering with the absorption of cholesterol from the gut.

- **Gamma oryzanol:** These are important antioxidants present in RBO. Although these compounds are present in small amounts in several other edible oils such as soyabean, palm, sesame, etc, RBO is the richest source of these compounds (nearly 1 g/100 g). Oryzanol levels get reduced on refining RBO. Attempts have been made to add back orzynol recovered during refining into the refined oil. Oryzanol has been shown to decrease absorption of cholesterol and inhibit aortic fatty streak formation in hamsters.

Other minor compounds present in RBO which are claimed to protect against heart disease are phenolic compounds, ferulic acid, methylferulate, coenzyme Q 10 and lipoic acid.

All the above bioactive phytochemicals are also present in the full fat rice bran but not in the defatted bran. But both contain dietary fibre and some of the lipid insoluble minor compound which can also reduce blood cholesterol levels.

The role of RBO or full fat rice bran in providing protection against heart disease is due to the contribution of all the phytochemicals described above and each of which has a tendency to reduce blood cholesterol by different mechanisms. It is not clear whether there is any synergistic effect of these compounds in reducing blood cholesterol. It must also be made clear that the hypocholesterolemic effect due to the inhibition of dietary cholesterol, in man, of some components such as dietary fibre and phytosterols may be evident only on cholesterol containing diets (that is, animal foods) as is evident from experimental studies. Their effect may be limited on vegetarian diets which have a low cholesterol content.

**Blending of RBO with other oils to enhance its hypocholesterolemic potential:** Recently, it has been reported by Sugano15 that blending RBO with safflower oil in the proportion of 7:3, wt/wt, magnified the hypocholesterolemic effect, but not when blended with corn oil. The authors state the mechanism underlying this interesting observation is not clear.

Another edible oil which could possibly enhance the influence of RBO in reducing the risk of heart disease when blended with RBO is palm oil. A blend of RBO with palm oil in the
promoting potential. This should be accompanied by research in processing technology of rice bran for its food applications. Suitable rice bran preparations would be quite useful for improving the nutritional quality of rice based dishes, weaning and supplementary foods for children. The possibility of using the low fibre rice bran and its soluble fraction as low cost nutrient supplements to cereal based supplementary foods used in the feeding programmes should be explored.

TABLE 3
Phytochemical Content of Rice Bran Oil

<table>
<thead>
<tr>
<th>Component</th>
<th>Content mg/100 g</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tocotrienol</td>
<td>11</td>
</tr>
<tr>
<td>Tocopherol</td>
<td>4</td>
</tr>
<tr>
<td>Tocotrienol</td>
<td>7</td>
</tr>
<tr>
<td>Gamma Oryzanol</td>
<td>1176</td>
</tr>
<tr>
<td>(Ferulic acid esters)</td>
<td></td>
</tr>
<tr>
<td>Cycloartenol</td>
<td>106</td>
</tr>
<tr>
<td>Cycloartenol</td>
<td>482</td>
</tr>
<tr>
<td>24-Methylene cycloartenol</td>
<td>494</td>
</tr>
<tr>
<td>Phytoestersols</td>
<td>1806</td>
</tr>
<tr>
<td>Campesterol</td>
<td>51</td>
</tr>
<tr>
<td>Stigmasterol</td>
<td>271</td>
</tr>
<tr>
<td>8-Sitosterol</td>
<td>885</td>
</tr>
<tr>
<td>Squalene</td>
<td>756</td>
</tr>
<tr>
<td>(Hydrocarbons)</td>
<td></td>
</tr>
<tr>
<td>Phospholipid (Lecithin)</td>
<td>4200</td>
</tr>
<tr>
<td>Waxes</td>
<td>3000</td>
</tr>
<tr>
<td>Unsaponifiable matter</td>
<td>4200</td>
</tr>
</tbody>
</table>

*Source: Ref 2 and 13.
Unrefined RBO. Some of these components get eliminated and some others are reduced while refining.

References

11. CFTRI. Rice Bran. RESC Scientific Series No 7, Department of Grain Science and Technology. Central Food Technological Research Institute, Mysore, 560 (Revised), 1995.

Foundation News

Foundation Day Lecture
- Dr Prema Ramachandran, Advisor (Health) Planning Commission, will deliver this lecture on November 24, 2000.

Study Circle Lecture
- Professor Astrid Fletcher, Professor of Epidemiology and Ageing, Director, Centre for Ageing and Health, Epidemiology Unit, London School of Hygiene and Tropical Medicine, on the “Role of antioxidants in age-related eye diseases”, on September 7.

President’s Engagements
- Participated in the World Health Policy Forum, at Sestri Levante, Italy, September 24 to 27.
- Visited the Nutrition Division of the FAO in Rome from September 27 to 30, 2000.

Centre For Research On Nutrition Support Systems (CRNSS)
- Dr Sarath Gopalan, Executive Director, participated in the First World Congress of Paediatric Gastroenterology, Hepatology and Nutrition at Boston, USA from August 5 to 9, 2000 and made a presentation on “Use of fermented foods to combat malnutrition and failure to thrive”.
- He also delivered a lecture on “The practical implications of enteral and parenteral nutrition in the Indian situation” at the Annual Meeting of the Indian Medical Association on September 10, 2000.
- CRNSS has launched its official website, http://www.cr NSSIndia.org All details about the activities of the organisation are available on this site.