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Studies on Rice Bran and its benefits- A Review

[1*]Renu Sharma, [2]Tanuja Srivastava, [3]D.C. Saxena
[1*]Department of Applied Sciences, Bhai Gurdas Institute of Engineering & Technology, Sangrur, Punjab, India.
[2]Department of Food Technology, Bhai Gurdas Institute of Engineering & Technology, Sangrur, Punjab, India.
[3]Deptt. of Food Engineering and Technology, Sant Longowal Institute of Engineering & technology, Longowal, Punjab, India.

Abstract
Rice bran, a by-product of rice milling industry is rich in micronutrients like oryzanols, tocopherols, tocotrienols, phytosterols and dietary fibers. The high nutritional profile of rice bran has not been utilized due to problems associated with lipase enzyme, which reduces the quality of rice bran and makes it unfit for human consumption. After the stabilization of lipase enzyme, it is possible to derive highly nutritious value-added products of rice bran. Due to the presence of antioxidants, it helps in lowering plasma cholesterol, decreasing serum cholesterol, decreasing cholesterol absorption and decreasing platelet aggregation. It has also been used to cure hyperlipidemia, menopause disorders and to increase the muscle mass. The most widely accepted product of rice bran is its oil that has exceptional properties as compared to other vegetable oils. This review paper describes the distinct properties of rice bran as well as its health benefits.

Keywords: Rice bran, oryzanols, value-added products, antioxidants, cholesterol.

I. Introduction

Humans have been enjoying grain foods from past thousand years. Grain foods including cereals are dietary staples for many populations over worldwide. India is no exception. Among major grain foods, rice is used as staple food for many populations in the country. It forms an important part of diet of many people in the country. Much of the nutritional value of rice lies in its germ and bran which has been discarded during milling process in the traditional times. During milling of paddy, rice endosperm (70%) obtained as a major product while rice husk (20%), rice bran (8%) and rice germ (2%) obtained as by-product[1,2,3,4] . During de-husking and milling of paddy, the brownish portion of rice taken out in form of fine grain, is the rice bran which is nearly 8% of milled rice[5,6,7]. The bran is multilayered structure composed of pericarp, nucellus, seed coat and aleurone. It is the outer coat of rice endosperm. When rice bran is obtained as by-product during milling process, it contains some fractions of rice endosperm, rice germ and aleurone layer which are rich in proteins, vitamins, carbohydrates and trace minerals. So, rice bran is also rich source of essential nutritients. It contains micronutrients like oryzanols, tocopherols, tocotrienols, phytosterols which comprises of vitamin E and exhibit significant antioxidant activity. Rice bran also contains 20% oil, 15% protein, 50% carbohydrates (mainly starch), dietary fibers like pectin, beta-glucan and gum[5,8,9,10].
In the earlier times, rice bran was used as either fertilizer or animal feed. But in these days, it is used for extraction of oil namely rice bran oil (RBO)[1,11,12]. The most successful countries producing rice bran oil are India and Thialand. In India, about 6.5 lakh tons of rice bran oil is produced from 40 lakh tons of rice bran by solvent extraction process[2]. The rice bran layer contains 20% oil and considered as richest oil sources among the grain by-products[13]. Rice bran oil contains about 4% unsaponifiable matter which includes nutrients like phytosterols, triterpene, tocols and oryzanol in comparison to other vegetable oils[14,15]. Various authors report that oryzanol is the only antioxidant found in rice bran and constitute around 20-30% in the unsaponifiable matter. It is reported to be more powerful and effective antioxidant than other micronutrients present in rice bran and has been shown many pharmaceutical uses such as growth acceleration, regulation of estrous cycle[16].

II. Stabilization of rice bran

Rice bran is rich source of proteins, vitamins, fibers, antioxidants and possesses several health benefits. Due to its beneficial nutritive and biological effects, it can be incorporated into functional foods, but it is still under utilized due to lipase enzyme. Lipase enzyme in the rice bran hydrolyzes the oil content into glycerol and free fatty acids. Due to this conversion, the quality of rice bran gets reduced. It produces foul smell and gives bitter taste. Because of this rancidity problem, rice bran becomes unsuitable for human consumption and most of the rice bran used as high protein animal feed or as fuel[17,18]. With this oxidation, quality of oil is adversely affected. To overcome this problem, stabilization becomes necessary. The process of stabilization is aimed at destruction or inhibition of lipase enzyme activity. A

variety of methods are available for stabilization of rice bran. The most practical and inexpensive method to deactivate lipase in fresh rice bran is heat treatment as reported by Randall et al.(1985)[19]. Heating of rice bran above 140^0c damages the rice bran quality and is not generally recommended. While heat treatment below 100^0c does not increase the storage capacity. Other methods of stabilization include microwave heating and ohmic heating. Tao et al. (1993) report that there is slight increase in free fatty acid content of rice bran stabilized by microwave heating[17]. Lakkakula et al. (2004) reported the stabilization by ohmic heating[18]. The use of single screw extruder to stabilize rice bran has been reported by Kurniawati et al. (2014)[20]. The most effective method of stabilization is ohmic heating. This method also improves the oil extraction yield. In this method, the concentration of free fatty acids increases at a slower rate without rise in temperature indicating the non thermal effect of electricity on the lipase enzyme. Some chemicals like sodium metabisulphate can also be used to stabilize rice bran. Presently, acid with antioxidant properties can also be used. Acids like ascorbic, ascorbyl, palmitate, phosphoric acid and mixture of any of the above can be used. About 0.10% to 2.0% (by weight) amounts of acids can be used to maintain the stability of food products for at least six months. Other examples of these compounds include acacetin, rosmarinic acid and phenolic compounds such as salicylic, cinnamic acid and trans-cinnamic, chlorogenic, quimic, ferulic, gallic, vanillic and caffeic acid.

III. Extraction of rice bran oil

From Rice Bran, oil can be extracted by the process of solvent extraction. In this process, food grade n-hexane can be used[21]. It can also be extracted by using ohmic heating[18] i.e. solvent free process or by using supercritical fluid extraction technology[22]. In the solvent extraction process, stabilized rice bran is mixed with hexane directly at 20^0c at 1:2 (w/w rice bran to solvent ratio) or pre-heated at 60^0c at 1:3 (w/w rice bran to solvent ratio) in capped flasks which are immersed in a constant temperature vacuum evaporation of solvent. This method gives crude rice bran oil (RBO). The method of extraction of oil from rice bran by using hexane is widely accepted. But this method possesses some limitations in terms of good colour quality. This may be due to the presences of specific component of oil seed lipids which cannot be controlled. Other drawback of hexane includes potential fire, health and environment hazards. To overcome this problem with hexane, lower chain alcohols such as ethanol and isopropanol can be alternatively used because of their greater safety[23]. As alcohols are polar in nature, leads to the greater extraction of non-glyceride materials. The oil extracted by the use of alcohols possesses higher concentration of phosphatide and unsaponifiable compounds[24,25]. Ethanol extracted rice bran oil is rich in tocopherols and vitamin B while isopropanol extracted oil is rich in vitamin B alone[10,16]. Weicheng et al. (1996) reported the extraction of vitamin E and oryzanol from stabilized rice bran by using isopropanol and hexane as extracting solvents and found that isopropanol is better alternative to hexane for extraction of oil from rice bran[26]. Another method for extraction of RBO is the super critical fluid extraction technology which possesses several advantages. The Supercritical fluid (SCF) is a compound above its critical temperature and critical pressure. It may be attributed to the fact that SCF possesses more versatile solvent properties[22]. These fluids possess the solubility power of liquids as well as diffusion properties of gases. So these results in improved lipid solubility and mass transfer due to high diffusion and low viscosities The yield of RBO extracted with SC-CO_2 ranged between 19.2% and 20.4% and it yield may be increased by increasing temperature at isobaric conditions[27]. Kim et al. (1999) have used SC-CO_2 for extraction and separation of rice bran oil enriched with essential fatty acids[28]. Giuseppe et al. (2003) recovered all the rice by-products by using SCF extraction technique and considered novel conversion process for the manufacturing of value added products[29]. Along with several advantages, this method has limitations in terms of high cost of equipment for extraction[30-34].
The yield of RBO can be increased by the application of enzymatic reactions before proceeding with solvent extraction by hexane[35-37,21]. In this method, rice bran was firstly treated with cellulose and pectinase and then extracted with n-hexane. The use of enzymatic reactions alone did not give reasonable yield of RBO[5,38]. In this method, yield of oil is significantly affected by enzyme concentration whereas temperature as well as incubation time has no significant effect[38]. Alternatively, Alpha –amylase can be used to gelatinize starch and the residue is treated with solvent to obtain oil[39].

IV. Refining of rice bran oil

To make fit for consumption as well as to meet the specifications of edible vegetable oil, rice bran oil undergoes refining process. The refining may be either chemical refining or physical refining.

Chemical Refining

Generally chemical refining is preferred because it gives better products in terms of color and cloud point[40]. However this process leads to significant looses in the form of wax, sludge, Gum sludge and soap stock[41]. As rice bran contains different compositions of minor components i.e. gamma oryzanol, tocopherols, tocotrienols and phylosterols, the chemical refining process also leads to change in

the composition of these components[1,30]. For example physically refined RBO has 1.1% -1.74% Gamma oryzonol content whereas It is reduced to 0.19%-0.20% in chemically refined oil[42]. In the chemical refining process, the use of alkali leads to modification of phytosterols composition and significant loss of gamma oryzanol. Gamma Oryzanol retained in deodorization Because of its non volatile nature, result in the formation of trans FA (less than1%) while components like phytosterols and tocotrienols are stripped off due to volatile nature. The whole chemical refining process removes almost 99.5% of the FFA component[1].

Physical Refining

This method of refining is very simple method. It involves low oil losses, lack of environment impact, simplicity, reduction in neutral oil loss, elimination of soap stock by removing FFA and gives good quality product. This method also leads to high refining losses of RBO and darkening of colour due to the presence of wax, oryzanol and phosphatides. The quality of final product obtained in this process is affected by incomplete removal of undesirable components during pre-treatment steps[43]. The residues like wax, sludge, Gum sludge and soap stock produced in RBO refining industry are enriched in many neutraceuticals like oryzanols, tocopherols, vit. E, ferulic acid, phytic acid, lecithin, inositol and wax[44].

V. Use of Rice Bran in neutraceuticals and pharmaceutical industry

Due to the presence of significant levels of micronutrients such as oryzanol, tocotrienol and phytosterols, rice bran possesses unique properties that render its suitability for the production of value added products in neutraceuticals and pharmaceutical industry[2]. Out of these components, Gamma oryzanol has been found to have more antioxidant activity. It is the first neutraceutical to be incorporated into extruded product. It was considered as a single compound. But later it was determined to be a mixture of ferulate (4-hydroxy-3-methoxy cinnamic acid) esters of sterols and triterpene alcohol[45]. The three major components of gamma oryzanol that account for 80% are cycloartenyl ferulate, 24-methylenecycloartanyl ferulate and campesteryl ferulate[46]. Due to its antioxidant activity, it helps in lowering plasma cholesterol, decreasing serum cholesterol, decreasing cholesterol absorption and decreasing platelet aggregation. It has also been used to cure hyperlipidemia, menopause disorders and to increase the muscle mass[47-52] . Oryzanol also has been reported to be used in the preparation of functional food as well as in cosmetics[53].

VI. Use of Rice Bran as functional food

Rice bran is rich source of essential nutrients like carbohydrates, proteins, fats, dietary fibers and antioxidants like tocopherols, tocotrienols, phytosterols and oryzanol. The nutritional composition of rice bran confirms its potential for the development of food products. Premakumari et al. (2012) develop breakfast/dinner recipes by substituting cereals with microwave stabilized rice bran at different levels and determine the acceptability of the food mixes. The results revealed that the recipes with 25 per cent incorporation of rice bran had a good acceptability in par with standard recipe[54]. The studies of Sekhon et al. on different types of bran revealed that the volume of bread and cookie spread decreased while muffin volume increased with the increase in bran levels[55]. The acid and dry heat stabilized rice bran was used by Younas et al. to prepare the highly nutritious cookies. They conclude that moisture, crude protein, fat and mineral contents, average width, thickness and spread factor of cookies increased with the increase in percentage of rice bran. They also show that supplementation of heat stabilized rice bran upto 10% is more suitable for production of cookies[56]. After extraction of oil from rice bran, residue is known as deoiled rice bran, also keeps humans healthy due to low fat content. Defatted rice bran also possesses unique functional and nutritional properties. Keeping in view, the nutritional importance of defatted rice bran, Charunuch et al. (2014) made an attempt to prepare ready-to-eat breakfast cereals enhanced with defatted rice bran[57]. Al-Okbi, 2014 studied the production of corn flakes and tortillas chips, by supplementation of gelatinized corn flour with rice bran from 10 to 30% and conclude that the maximum breakdown viscosity and color quality was affected and sensory parameters decreased While protein percentage was increased depending on the level of rice bran[58].

With the use of stabilized rice bran, a source of dietary fiber, frozen pizza was prepared by De delahaye et al. (2005)[59]. The physical, chemical rheological and sensorial characteristics of the pizzas during the storage period of 2 months at -18 °C were studied. They report that increasing the stabilized rice bran content results increase crude fat, ash and dietary fiber content of pizza dough.

VII. Health benefits of rice bran

The nutritional composition of rice bran shows the presence of several compounds which possesses significant anti-oxidant activity to prevent chronic diseases. The incorporation of dietary fiber into the functional food have reported to decrease the risk of coronary heart disease, reduction of blood cholesterol levels and improvement of insulin sensitivity[60-63]. The oryzanol component acts as protective agent against UV light and is used in cosmetics as sunscreen agent.

The ferulic acid esters of gamma oryzanol act as anti-ageing compounds as they stimulate hair growth[64,65]. Rice bran also prevents high blood pressure, hyperlipidemia and hyperglycemia. Both Type I and Type II Diabetes Mellitus also controlled by neutraceuticals developed from fiber fraction of rice bran[66]. Food supplemented with rice bran also lead to reduced bone loss in women suffering from postmenopausal osteoporosis[67].

VIII. Conclusion

Rice bran is a highly nutritious compound as it is rich source of oryzanols, tocopherols, tocotrienols, phytosterols, and dietary fibers. All these micronutrients comprise of vitamin E and possess significant antioxidant activity. Many nutraceuticals have been developed from rice bran which have hypolipidemic, anti-tumor, anti-oxidant, ergogenic and laxative properties. Inspite of having good nutritional composition as well as providing health benefits to humans, rice bran is still underutilized. An important consumer product of rice bran is rice bran oil which meets the specifications of edible vegetable oil after physical and chemical refining processes. The rice bran can be used as a source of healthy food as well as a source of oil, provided it is stabilized by suitable method to inactivate lipase enzyme, which gets released after bran is separated from the grain. So, keeping in mind the benefits of rice bran, it should be provided opportunity for incorporation into food products to enhance their nutritional value.

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