

# Pharmacognosy of rice bran oil - A review

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## Abstract

Rice bran is fabricated from the rice milling enterprise and contains about 10% of the entire weight of rough rice. It is especially composed of aleurone, pericarp, subaleurone layer, and germ. Rice bran is a fertile supply of nutrients, minerals, vital fatty acids, dietary fiber, and different sterols. The quantification of  $\gamma$ -oryzanol in rice bran can be conducted by many methods that require drawing out of rice bran oil (RBO) from the bran, accompanied by way of evaluation of the quantity of  $\gamma$ -oryzanol in the RBO with the aid of high-performance liquid chromatography. RBO is the oil drain out of the outer rigid surface of rice called chaff (rice husk). It is identified for its excessive smoke factor of 232°C (450°F) and soft taste, making it pleasant for excessive-temperature cooking strategies such as blend and deep frying. It is healthy for human expenditure, which is employed in the system of vegetable ghee. Wax was drawn out of RBO and palpanese extract, which is employed for carnauba wax in makeup, confectionery, shoe lotions, and sharpening compounds. It is accepted as a food preparation oil in numerous Asian countries, along with Bangladesh, Japan, India, and China. Regarding the importance of RBO, this overview intends to pay attention at the phytochemistry and therapeutic functions of RBO.

**Key words:** Bran, gamma-oryzanol, oil, phytochemistry, rice

## INTRODUCTION

Rice is widely produced and ate up as a staple food for extra than half the sector population. According to global rice production, paddy rice become created around 678 million metric loads in 2014.<sup>[1]</sup> Broadly speaking, the composition of the whole rice grain is comprised (63.6–73.2%) carbohydrate, (1.5–2.3%) fat, (5.8–7.7%) protein, (7.2–10.4%) fiber, and (2.9–5.2%) ash content.<sup>[2]</sup> Rice grain contains three parts which include major portion, i.e., endosperm or white rice (~70%), hull/husk (~20%), and bran (~10%). The white rice is usually fed by humans due to its soft texture and gorgeous appearance. This part is made up of carbohydrate (76.7%) which is the principal source of strength while the protein was found approximately 7.4%,<sup>[3]</sup> whereas hull fraction is not suited for consumption as it contains high fiber content (34.5–45.9%) making its heavy texture. Still, there were some researchers reported about recovery advantages of rice bran, resulting in increasing of brown rice consuming and generating some ideas to use rice bran as food constituents. Rice bran is an essential source of antioxidants together with tocopherols,  $\gamma$ -oryzanol, and other phenolics,<sup>[4]</sup> so one can assist in health results inclusive of lowering of blood cholesterol,

decreasing platelet aggregation, and anti-inflammation;<sup>[5]</sup> besides, it has additionally been stated as a basis of 12.6–15.4% hypoallergenic and superior protein<sup>[3]</sup> with protein effectiveness ratio of 1.6–1.9 as compared to casein 2.5.<sup>[6]</sup> Rice bran incorporates about 10% of tough rice grain and carries 18–22% oil. From an advertising and marketing point of view, the most to be had rice bran-derived product is the oil made from the pericarp and embryo of the *Oryza sativa* seeds. It is faded yellow, limpid (at 20°C), odorless with acid index <0.50, the density at 20° between 0.920 and 0.930, the refractive index at 20°C between 1.471 and 1.475, smoke point >200°C, and nice flavor lightly sweet. Its essential ingredients are oleic acid (38.4%), linoleic acid (34.4%), and  $\alpha$ -linolenic acid (2.2%) as unsaturated fatty acids, and palmitic (21.5%), and stearic (2.9%) acids as saturated fatty acids.<sup>[7]</sup> In assessment to most common subtle vegetable oils, crude rice bran oil (RBO) includes a rich unsaponifiable fraction (up to 5%) primarily composed by sterols (43%), triterpene alcohols (28%), 4-methyl-sterols (10%), and few polar components (19%).<sup>[7]</sup> Phytosterols include  $\beta$ -sitosterol

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(900 mg%), campesterol (500 mg%), stigmasterol (250 mg%), squalene (320 mg%), and gamma-oryzanol (1.6%). The so-called gamma-oryzanol, often distinguished as the active molecule of RBO, is an aggregate of ferulic acid esters of triterpene alcohols such as cycloartenol (106 mg%) and 24-methylene cycloartanyl (494 mg%)<sup>[8,9]</sup> first separated by Kaneko and Tsuchiya<sup>[10]</sup> in the early 1950s. Its basic shape is the ferulic acid aromatic, phenolic nucleus esterified to cyclopentanoperhydrophenanthrene.<sup>[11]</sup> RBO includes a touch changeable amount of tocotrienols (from 72 to 612 ppm, particularly  $\beta$ , and  $\gamma$ -tocotrienols), merely it is obviously loaded with tocopherol (ca. 100 mg%), likewise to one more vegetable oil with famous antihyperlipidemic action, the soybean oil.<sup>[12]</sup> In this review, an overview of phytochemistry and therapeutic functions of RBO will be brought up.

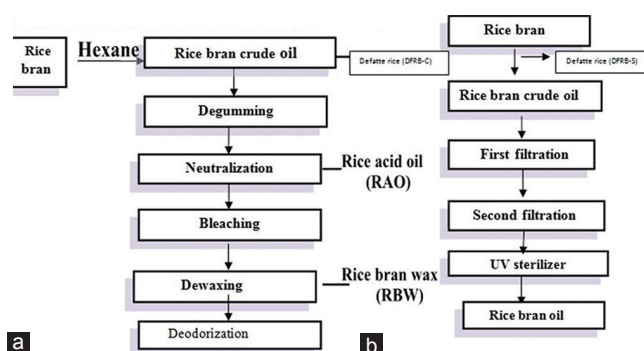
### Extraction and Refining of RBO

Extraction of oil from rice bran can be done by solvent extraction methods, by ohmic heating, or by supercritical fluid (SCF) extraction methods. In solvent extraction method food grade n-hexane is being used. In this process, rice bran is mixed with hexane in the ratio of 1:2 at 20°C or in 1:3 w/w after pre-heating at 60°C and then immersed in a constant temperature vacuum evaporation of the solvent.<sup>[13]</sup> Oil extracted by the solvent method has poor color quality. Therefore, to overcome these problems, some lower chain alcohols are being used as they are safe to human.<sup>[14]</sup> The study showed that the oil extracted by ethanol is rich in Vitamin B complex and tocopherols while isopropanol is rich in Vitamin B.<sup>[11,15]</sup> Another method also may use to enhance the yield of RBO by the enzymatic reactions before solvent extraction by hexane. Cellulose and pectinase enzymes can be used for enzymatic treatments.<sup>[16-19]</sup> The solvent extraction process has followed the scheme shown in the following flow diagram [Figure 1].

In the cold pressed method, RBO is produced by compressing the rice bran through a mechanical screw press under mild heating (<50°C). The RBO is now undergoing oil for filtration through filter paper, to get the refined oil.<sup>[21]</sup>

RBO extracted by SCF methods having greater potential advantages as SCF is a compound above its critical temperature and critical pressure. According to Kuk and Dowd,<sup>[22]</sup> the yield of RBO by SC-CO<sub>2</sub> was 19.2% and 20.4%. The oil yield may be improved by increasing temperature at isobaric conditions. RBO extracted by SC-CO<sub>2</sub> enriched from many essential fatty acids.<sup>[23]</sup> One drawback of using of SCF technology is higher cost.

After extraction of RBOs from RBO undergoes for the refining process. The refining of RBOs may be done either chemical or physical refining. In general chemical, refining is preferred because it provides better color and cloud point to the RBO as compared to the physical refining process.<sup>[24]</sup> In the



**Figure 1:** Flow diagram of rice bran oil (RBO) production, (a) RBO from solvent extraction process, (b) RBO from cold pressed extraction process<sup>[20]</sup>

chemical refining, process alkali was used which modify the composition of phytosterols and also showed a significant loss of gamma oryzanol, while physical refining retains a higher amount of oryzanol tocopherols, Vitamin E, and ferulic acid.<sup>[25]</sup>

### Phytochemicals in RBO

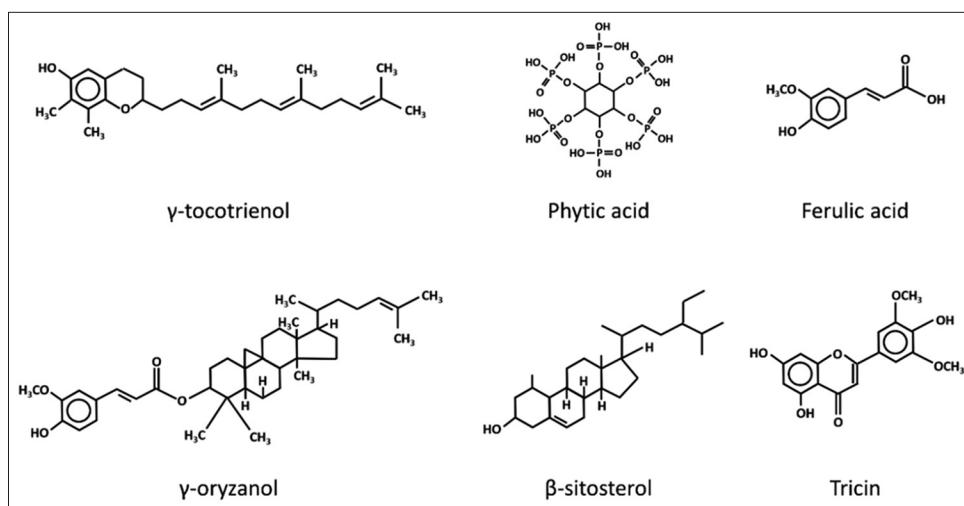
RBO contains biologically active phytochemicals in a higher level. Crude RBO contains wax (1.5–4%), free fatty acids (59.19%), and phosphatides (0.5–1.5%).<sup>[26,27]</sup> They includes oryzanols (1.2–1.8%), phytosterols (1.5–2%), and tocopherols and tocotrienols (0.15–0.2%).<sup>[27-31]</sup> Linoleic acid, linolenic acid, oleic acid, arachidonic acid, stearic acid, and palmitic acid are the prime fatty acids present in RBO.

Crude RBO contains 0.2% tocols, from which 70% is tocotrienols. They have potent antioxidant activity, antitumor activity as well as they also decrease the cholesterol level of the serum. It also prevents the lipid peroxidation and delays the pathogenesis of neurological disorder, cancer, inflammatory, and cardiovascular diseases.<sup>[32]</sup> Tocotrienols and tocopherols are natural forms of Vitamin E, which mutually among oryzanol in RBO have antioxidant effects. RBOs are a main natural source of oryzanols, and they help to decrease plasma and serum cholesterols, platelet aggregation and also showed antioxidant effects.<sup>[33-35]</sup>

### Health Benefits

#### Antioxidant property of RBO

The antioxidant materials are well known for deactivating to the free radicals produced during oxidative metabolism.<sup>[35,36]</sup> RBO contains gamma oryzanol, tocotrienols, squalene, and tocopherols and other phytosterol has been examined an antioxidant property against the free radicals.<sup>[37,38]</sup> The ferulic acid ester present in the gamma oryzanol is known as a potent antioxidant. It can inhibit the oxidation of low-density proteins Figure 2.



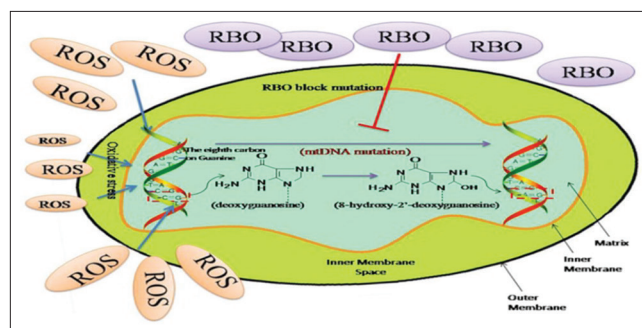
**Figure 2:** The chemical structures of phytochemicals present in rice bran oil<sup>[39]</sup>

Cycloartenyl ferulate and 24-methylenecycloartanyl ferulate showed antioxidants activity the “scavengers,” in methyl linoleate bulk and multiphase lipid systems.<sup>[38,40]</sup> Gamma oryzanol showed higher antioxidant capacities when compared to Vitamin E components (alpha-tocopherol, beta-tocopherol, alpha-tocotrienol, and beta-tocotrienol).<sup>[41-43]</sup> Reactive oxygen species (ROS) is one of the important causes of protein oxidation damage. 8-OHdG is a biomarker of DNA oxidative break during oxidative stress in kidney, liver, pancreas, and brain and these ROS can affect its linkage.<sup>[37]</sup> The mechanism of function of RBO on oxidative damage relief is given in Figure 3.

According to Hsieh *et al.*<sup>[45]</sup> after consumption of RBO, the 8-OHdG content found reduced significantly in the liver, kidney, and pancreas of mice. As it is also beneficial to reduce the effects of streptozotocin induced diabetes in rats, as it increases the amount of hepatic antioxidant defense mechanism.<sup>[46-48]</sup> This could be seen due to the  $\gamma$ -tocotrienol present in RBO, which has antioxidant properties to prevent protein oxidative damage and lipid oxidation.<sup>[49-51]</sup> Oryzanol of RBO is able to resist the oxidation and peroxide formation by hindering the production ROS.<sup>[52]</sup> The synergistic effect of these substances presents in RBOs may exist by promoting the effects of oxidation resistance of the RBO.<sup>[32,46]</sup>

### Prevention of hypercholesterolemia

RBOs have hypocholesterolemic power consequential from a selective decrease of low-density lipoprotein (LDL) cholesterol. Chen and Cheng<sup>[46]</sup> has been reported in their study that phytosterols of RBO have a quite similar structure to cholesterol; therefore, it can inhibit the absorption of cholesterol and finally it interfere with the movement of cholesterol into micelles. RBO is more beneficial in the reduction of LDL-C levels by rising cholesterol 7-alpha-hydroxylase, and it also promotes the metabolism of cholesterol decomposition that reduces cholesterol

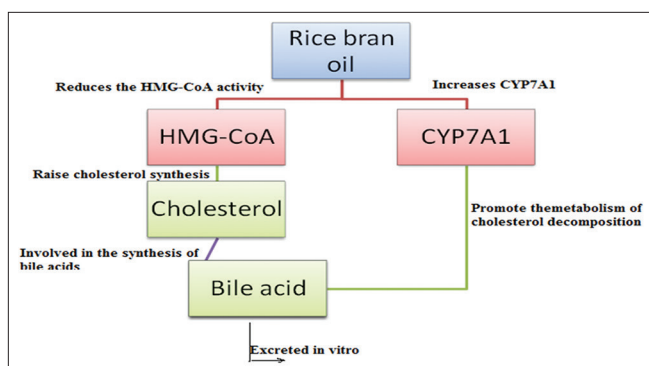


**Figure 3:** Mechanism of the function of rice bran oil on oxidative damage relief<sup>[44]</sup>

absorption in the intestines. Oryzanol of RBO can reduce plasma non-high-density lipoproteins (HDL) - levels and elevate HDL-Cholesterol by increasing the release of cholesterol and its metabolites.<sup>[53]</sup>  $\beta$ -sitosterol and other 4-desmethylsterols present in RBO showed more cholesterol-lowering activity. Further, 4-desmethylsterols have a more similar structure to the cholesterol so this 4-desmethylsterols are showed highest cholesterol-lowering activity. Chen and Cheng<sup>[46]</sup> found that the 3-hydroxy-3-methylglutaryl coenzyme A reductase (HMG-CoA) can elevate the cholesterol synthesis balancing body cholesterol. Ausman *et al.*<sup>[51]</sup> showed that RBO can decrease significantly HMG-CoA reductase activity by 300–500%. Similar results were found by Minhajuddin *et al.*<sup>[54]</sup> They reported that compound tocotrienol of RBO can reduce the HMG-CoA reductase activity. Another study on the rats showed a positive effect on decreased serum lipoprotein at 5% RBO while in animals 20% RBO showed increased HDL.<sup>[53,54]</sup> Wilson *et al.*<sup>[53]</sup> worked on hamsters and fed them diet added ferulic acid and  $\gamma$ -oryzanol and they found significantly lower aortic cholesterol ester accumulation.

On the Basis of the above data, we can conclude the mechanism of RBO hypercholesterolemia inhibiting activity [Figure 4].





**Figure 4:** Hypercholesterolemia inhibition mechanism of rice bran oil<sup>[44]</sup>

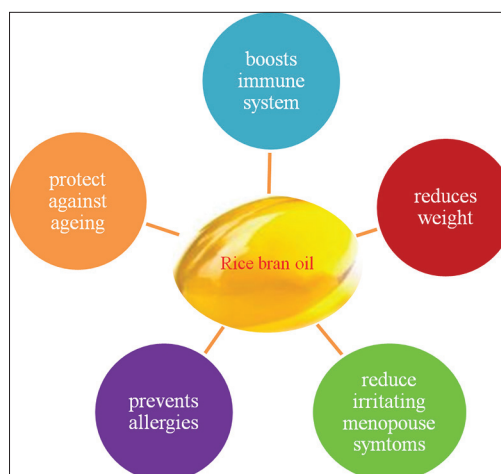
### Anticancer and antidiabetic property

Several studies have been done in favor of anticancerous and antidiabetic properties of RBO. Kannappan *et al.*<sup>[55]</sup> reported that tumor cells sensitive against the  $\gamma$ -T3 present in RBO, especially carcinoma cells of the human colon. Monounsaturated fatty acids present in RBO show an antitumor effect. Immunity can be achieved by the action of conjugated linoleic acid (CLA) by means of peroxisome proliferator-activated receptor (PPAR). This PPAR  $\gamma$  can be found in many cancer cell lines, such as high-expression lipoma, pancreatic cancer, colon cancer, breast cancer, prostate cancer, bladder cancer, and stomach cancer. The activity of PPAR  $\gamma$  can be enhanced by CLA, and PPAR  $\gamma$  N-end phosphorylation and p65 can reduce the activity of NF- $\kappa$ B, thus promotes apoptosis and inhibits cell proliferation. At the same time, the CLA can also inhibit c-myc and endorse p53 and caspase expression by changing the peanut acid signal conditioning Tumor necrosis factor - $\alpha$ . Lai *et al.*<sup>[56]</sup> reported in their study RBO-modified milk (i.e., 18 g of RBO) daily and they found significant decreases in total and LDL cholesterol but not in the index of insulin resistance. They concluded that RBO can recover the abnormal lipid profile of diabetic patients. Similar results were also found by Chou *et al.*<sup>[57]</sup> they found that  $\gamma$ -oryzanol and  $\gamma$ -tocotrienol helps to improve the lipid abnormalities, and it reduces the atherogenic index, increased fecal neutral sterol, concealed the hyperinsulinemic response, and increase bile acid secretion. Shakib *et al.*<sup>[58]</sup> reported the lowering in the fasting and postprandial blood glucose and glycosylated hemoglobin levels after consumption of RBO.

### Other health benefits of RBOs

Other health benefits of RBO are given in Figure 5. RBO contains high levels of natural antioxidants activity which boost up the rate of metabolic activity that may help with weight loss.

The antioxidants also help to oppose the rancidity and spoilage; it increases the shelf life of the products. RBO also showed an anti-inflammatory and some studies have shown



**Figure 5:** Other health benefits<sup>[32,35,44]</sup>

that its consumption can reduce the effects of menopause like hot bursts.<sup>[19]</sup>

## CONCLUSIONS

RBO, nowadays, has gained wide attention as healthy cooking oil among the consumers. Scientific data showed the importance of RBO and its important physiological achievement in health and different diseases and disease producing factors. Evidence obtained from several observational and animal studies, it was found that the RBO has a key role in the prevention, management, and control of chronic diseases.

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