



## Rice Bran as a Functional Food

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### Abstract

Rice Bran (RB), which makes up 10% of the entire rice grain and is the outer layer of the rice kernel, is a nutrient-rich by-product of the rice milling process. The pericarp, seed coat, nucellus, and aleurone layers make up this structure. RB, which is primarily utilized as animal feed at the moment, is a plentiful source of several nutrients, including fat, protein, carbs, dietary fibers, different minerals and vitamins, and phytochemicals (primarily phytosterols,  $\gamma$ -oryzanols, tocotrienols, and tocopherols). Numerous studies have shown that RB has positive health impacts because of its functional ingredients. It can have a significant impact on reducing serum cholesterol, hypertension, Coronary Heart Disease (CHD), Parkinson's and Alzheimer's disease, Colorectal Cancer, postmenopausal syndrome, diabetes, improving insulin sensitivity, reducing the development of malignant cells, and skin-related issues. It can also have a positive impact on bowel function and liver function when consumed. Additionally, rice bran has high properties as an antioxidant and Prebiotic. Rice bran oil is a by-product of rice bran and a rich source of  $\gamma$ -oryzanol and other antioxidants, it is increasingly significant because it is used in food applications and as a nutraceutical to reduce metabolic risk factors in people. Therefore, the focus of this review is on RB and its health advantages as a functional food.

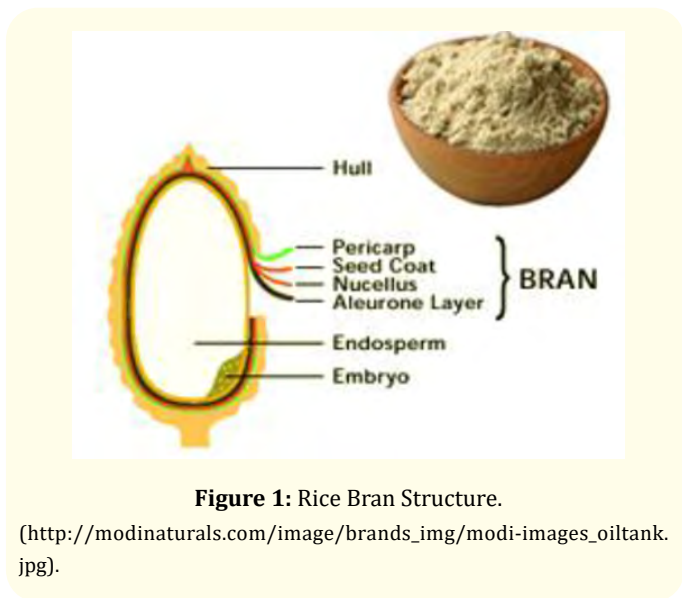
**Keywords:** Bioactive; Phytochemical Compound; Rice Bran; Nutrition; Functional Food;  $\gamma$ -oryzanol; Tocols; Dietary Fiber

### Introduction

The outer layers of the rice grain, known as rice bran, it is one of the most prevalent agricultural by-products, which is created when rice is milled., has a distinctive profile of phytochemicals that have medicinal and nutritional benefits for human health. Some of these compounds have been targeted for the development of nutraceuticals for diseases such as cancer [1]; type 2 diabetes [2]; immune regulatory processes [3], lipid metabolism regulation [4], and obesity [5].

The bioactive substances in RB include  $\gamma$ -oryzanol, phytosterols, tocols, and squalene. High nutritional values enable RB and its constituents to play a variety of roles in the food sector, including

those of alternative shortening, stabilizers, organogelators, and gluten flour alternatives [6]. Defatted rice bran, a low-value by-product of the extraction of rice bran oil and the milling of rice, has enormous promise as an additional source of several nutrients. Defatted rice bran is left over after the edible oil has been extracted from it and is either used as animal feed or thrown away as agricultural waste. Defatted rice bran by-products, however, offer special functional and dietary qualities. It still has substantial levels of different types of protein, carbohydrates, polysaccharides, vitamins, minerals, dietary fiber, and phenolic compounds, which are useful as functional and health-promoting ingredients in food [7]. According to research, defatted rice bran's soluble rice bran fiber is known for its anti-inflammatory, anti-tumor, and hypocholesterolemic properties in humans [8-11].



**Figure 1:** Rice Bran Structure.

([http://modinaturals.com/image/brands\\_img/modi-images\\_oiltank.jpg](http://modinaturals.com/image/brands_img/modi-images_oiltank.jpg)).

**Table 1:** Nutritive value and Nutritional Composition of Rice Bran.

Chemical Composition of Rice Bran [12-18]			
Energy (kcal)	316.00 - 476.00	Protein (g/100g)	13.35 - 14.50
Crude oil (g/100g)	19.90 - 20.85	Crude fiber (g/100g)	9.53 - 17.74
Dietary fiber (g/100g)	21.00 - 33.80	Carbohydrates (g/100g)	38.20 - 49.69
Minerals			
Calcium (mg)	56.00 - 229.10	Iron (mg)	18.54 - 224.39
Magnesium (mg)	258.60 - 781.00	Phosphorus (mg)	1677.00 - 2680.00
Potassium (mg)	1485.00 - 12862.50	Zinc (mg)	6.04 - 40.16
Manganese (mg)	14.21 - 258.60	Copper (mg)	16.86
Sodium (mg)	111.70	Selenium (µg)	15.60
Fatty acids (FA) %			
Saturated FA(g/100g)	4.17 - 19.98	Monounsaturated FA (g/100g)	7.55 - 42.59
Di-unsaturated FA (g/100g)	33.82	Polyunsaturated FA (g/100g)	3.35 - 7.46
Phytochemical Compounds			
Phenols (mg/100g)	44.00	Tannins (mg/100g)	2.40
Tocopherols (mg/100g)	8.98	Oryzanol (mg/100g)	0.35

Phenolic and cinnamic acids	Anthocyanins, flavonoids	Steroidal compounds
Caffeic acids Coumaric acid Catechins Ferulic acid Gallic acid Hydroxybenzoic acid Methoxycinnamic acid Sinopinic acid Syringic acid Vanillic acid	anthocyanin monomers, dimers, and polymers apigenin cyanidin glucoside cyanidin rutinoside epicatechins  eriodtyol hermnetins hesperetin isorhamnetins, luteolin, peanidin glucoside, tricin	acylated steryl glucosides  cycloartenol ferulate campesterol ferulate 24-methylenecycloartenol ferulate  $\gamma$ -oryzanol $\beta$ -sitosterol ferulate tocopherols tocotrienol
	Vitamins Niacin, vitamin E, thiamine	

**Table 2:** Rice bran health benefits.

Rice bran metabolite profiling revealed a group of biochemical substances that can be investigated further and employed for a variety of medical food applications and nutritional therapies. These bioactive substances might also serve as dietary rice bran intake indicators. A network of metabolic pathways can be used by the rice bran’s medicinal compounds to function, and this network of metabolites may be created by the additive and synergistic interactions among the chemicals in the food matrix [19].

Diseases	Useful compounds	Benefits	Role of useful compounds	Ref.
Coronary Heart Disease (CHD)	Dietary fiber	Consuming the dietary fiber found in rice bran has diminished the risk of coronary heart disease (CHD) mortality.	Consuming the dietary fiber found in rice bran has been demonstrated to improve insulin sensitivity and lower blood cholesterol levels, lower blood pressure, all of which diminish the coronary heart disease (CHD) mortality risk.	[20,21]
Cholesterol	Stigmasterol Sitosterol Campesterol	hypocholesterolemic	They are the three main phytosterols found in the rice bran lipid extracts. The consequences of these are hypocholesterolemic effects.	[22,23]
hypertension	Nutritional factors (proteins, DF, and bioactive phytochemicals)	Managing hypertension	There are several ways that the protein of RB may lower blood pressure, including: a. by upregulating the endothelial nitric oxide synthase (eNOS) protein. b. inhibiting the angiotensin-converting enzyme (ACE). c. acting as an antioxidant. These actions would enhance endothelial function and blood pressure.	[24-26]

Diabetes Mellitus	Fiber (The fiber in rice bran contains just a small amount of soluble fiber (7-13%) while the majority is insoluble fiber.	The laxative properties of the fiber in rice bran result in increased frequency and volume of stools. Soluble fibers can lower postprandial blood glucose levels in both healthy and diabetic patients. It works like a sponge in the colon, absorbing water, turning the meal into a gel, and slowing down the rate of absorption.	Type I and type II Diabetes Mellitus are controlled by nutraceuticals made from the soluble and fiber fractions of rice bran.	[27-29]
Parkinson's and Alzheimer's disease	Lipoic acid	rice bran contains lipoic acid, which has antioxidant and antilipogenic qualities that can be used to treat Parkinson's and Alzheimer's disease as well as prevent diabetic neuropathy and retinopathy.	Ascorbic acid and vitamin E, two antioxidant vitamins, interact with lipoic acid and aid in their preservation.	[30]
Colorectal Cancer	Phytosterol	Animal experiments have demonstrated that phytosterol can prevent chemically caused cancers. Colonic microflora has been shown to produce coprostanol and other neutral sterols and bile acids from dietary cholesterol, which has been linked to colon cancer.	1- The findings demonstrated an antagonistic relationship between dietary fiber consumption and the development of colorectal cancer. 2- Phytic acid, ferulic acid, -sitosterol, triclin, $\gamma$ -oryzanol, and tocotrienols/tocopherols are some of the bran's possible chemopreventive agents. The capacity of these substances to cause apoptosis, suppress cell proliferation, and disrupt cell cycle progression in malignant cells is how rice bran exerts its anticancer properties. These prevent tissue damage by scavenging free radicals and preventing recurring inflammatory reactions. These have also been demonstrated to increase colorectal cancer chemoprevention by triggering anticancer immune responses and altering the microenvironment of colonic tumors. Human colon cancer cells cannot proliferate when rice bran is present.	[31-33]
Anti-Aging	$\gamma$ -Oryzanol	$\gamma$ -Oryzanol is a powerful sunscreen ingredient because it prevents lipid peroxidation caused by UV rays.	1- By blocking the transmission of UV radiation at the skin's surface, $\gamma$ -oryzanol can slow down the development of melanin pigmentation. 2- Ferulic acid and its esters in gamma oryzanol promote hair growth and delay skin aging.	[34]
	Tocotrienol	In rice bran, tocotrienol levels are around 500 ppm. When applied to the skin, tocotrienols quickly penetrate and are absorbed. They mostly build up in the stratum corneum of the skin and, thanks to their antioxidant properties, serve as the first line of protection.	1- They control the free radicals that the skin produces when it is subjected to oxidizing radiation. 2- They aid in skin regeneration by shielding the skin from ultraviolet (UV)-induced skin damage and aging. As a result, sunscreen, skincare, and hair conditioner all frequently contain rice bran oil.	[35]

Osteoporosis and Post-Menopausal Syndromes	$\gamma$ -oryzanol	It was discovered that feeding ovariectomized rats a 7% $\gamma$ -oryzanol rice bran oil (RBO) concentrate reduced bone loss at multiple bone locations compared to control rats. Menopausal women and those who had their ovaries surgically removed participated in clinical trials that showed considerable improvement in menopausal symptoms in 67 to 85% of the women treated with $\gamma$ -oryzanol.	1- The pituitary gland secretes excessive amounts of luteinizing hormone (LH) and follicle-stimulating hormone (FSH) during menopause (LH). 2- According to a study conducted in Japan, $\gamma$ -oryzanol supplementation lowers the oversecretion of these hormones.	[36-38]
Prebiotic properties of RB	Defatted rice bran	DF, which has demonstrated prebiotic effects in several studies, is abundant in RB., hydrothermally treated RB at a pressure (of 0.22 MPa) and a temperature (135°C) for 0.5 to 3 hours) created a combination of oligosaccharides that aided in the growth of <i>Lactobacillus</i> and <i>Bifidobacterium</i> . Similar to fructooligosaccharide, oligosaccharides from RB were observed to promote the generation of SCFAs and alter the population of gut microbiota, primarily, <i>Dorea</i> , <i>Prevotella</i> , and <i>Bacteroides</i> , after fermentation in fecal samples over a 24-hour period. In human investigations, RB also had a prebiotic effect and enhanced intestinal health.	Secondary biliary aids and branched chain fatty acids were enhanced by RB supplementation. It was reported that <i>Ruminococcus</i> and other gut bacteria could use branched-chain fatty acids to benefit intestinal health.	[39-44]
liver function	RB oil or $\gamma$ -oryzanol	RB oil (300 mg) or $\gamma$ -oryzanol (50 mg/kg) supplementation significantly improved renal function.	It was proposed that $\gamma$ -oryzanol played a role in mediating the mechanisms by inhibiting inflammatory markers including prostaglandin E2 (PGE2), which is important in the development of renal failure.	[45,46]
Antioxidants	Polysaccharides Tocols $\gamma$ -Oryzanol other phyto-sterol	Good source of antioxidants.	a. good potential for chelating ferrous ions. b. reducing power. c. scavenging effects of 1,1-diphenyl-2-picrylhydrazyl (DPPH), hydrogen peroxide, and 2,2-azino-bis(3-ethylbenzthiazoline-6-sulphonate)	[47]

## Conclusion

Due to the fact that rice is a staple food for half the world's population, it is widely accessible. A recent development in nutrition is rice bran. Rice bran is a palatable health product for

a variety of tastes because it is naturally lactose-free, gluten-free, and hypoallergenic. By encouraging a sense of fullness without overeating, the fiber in rice bran helps people manage their weight. It also helps reduce heart attacks, intestinal issues, tumor

incidence, and cancer risk, delays gastric emptying, and promotes gastrointestinal health. By regulating blood LDL, cholesterol, and triglycerides, lowering blood pressure, and slowing down the rate of cholesterol and fat absorption, the nutrients in rice bran have a known potential function in lowering the risk of coronary heart disease. In addition, phytosterols, which support prostate health, cholesterol metabolism, and blood sugar regulation, can be found naturally in rice bran. Because it contains a lot of different antioxidants, including  $\gamma$ -oryzanol and tocopherols, rice bran oil is a significant byproduct of rice bran. RB and its derivatives may be utilized as nutritional supplements for the management of metabolic syndrome in humans because there is data demonstrating the benefit of this by-product in reducing metabolic risk factors. To better understand how RB and its components affect the creation of functional foods and health consequences, more research is necessary.

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