*Review Article*

# Formulation and biological activity of Rice Bran Oil: A brief review

**Dinesh Kumar Chauhan*, Neeraj Sharma**

*Department of Pharmacology, Bhagwant University, Sikar Road, Ajmer (Rajasthan) India*

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**Abstract**

In ancient time, diseases were treated by the use of herbal drugs and these drugs are cheap and easily available to all classes of people. In India, many types of medicinal plants are grown which contain several medicinal properties, this is used by the pharmaceutical industry for preparation of various products. Rice is the most common crop specially used in Asia and all worlds. Rice bran (*Oriza sativa*) and rice hull are produce by rice plant, which are useful for both man and animal. Rice bran is produced by milling of rice in the milling Industry. Several studies show that rice bran is rich source of nutrient like protein, fat, carbohydrate, vitamin, dietary fiber and minerals, gama-oryzanols, tocopherols, tocotrienols, phytosterols. Rice brain oil provides health benefit and antioxidant property due to presence of tocopherol, tocotrinol and gama-oryzanols. Rice Bran Contain antioxidant property, hence it is for treating various life threatening disorders like hypertension, cancer, lowering serum cholesterol, improving insulin sensitivity, skin related problems etc. Various Studies show that gamma-oryzanol has four times more antioxidant properties than tocopherols and 2-5 times more oxidative stability than groundnut oil.wax and rice bran oil are by product of rice bran .different food product are prepared by adding rice bran to improve nutritional concentration and increasing shelf life of product.

***Keywords*:** Rice bran, carbohydrates, Gama-Oryzanol, tocopherols, antioxidant, *Oriza sativa*

## Introduction

Rice bran oil is obtained from Rice plan, its botanical name is Oriza sativa. It is common food in the world taken by human. It consumed by the maximum human population of the World. Rice gives 50% calories, food consumed by Indian populations (Naomi, et al, 2019). It is the third highest agricultural crop after sugarcane and maize (FAOSTAT, 2012). Solvent extraction method produces 7.0 lakh ton of rice bran oil from 40 lakh tone of rice bran. Previously Rice Bran use as animal fee and fertilizer but now a days, it is used for extraction of rice bran oil. In 2019 rice consumption was approximately 491 million metric tons. Several studies show that the milling products of rice are verity of bioactive compound and nutrients (Faustino et al., 2019).

During rice milling a brown color product is obtained. This brown color product is known as rice bran. It occupied total 8% of total milled rice (Lopez Munguia et al., 2000). The rice bran composed of several layer i.e. seed cote, pericarp, aleuron, nucleus. Rice bran is rich source of vitamin, protein, carbohydrate, vitamin, minerals, and also rich source of gama-oryzanol, tocopherol, tocotrienol, phytosterol, which is similar to Vitamin E. all these chemical produce antioxidant property. Rice Bran contains rice oil 21 percent, protein 15.3 percent, carbohydrate 49.9 percent, and dietary fiber like pectin, beta-glucan and gum (Brancaccio et al., 2020).

## Plant taxonomy

**Synonym:** Rice, Rice bran oil, Rice oil, Brown Rice Bran,

**Biological Source: -**Rice bran oil is obtained from Rice bran of plant *Oryza sativa*, belonging to family Graminae.

**Scientific Classification of Rice**

| | |
|---|---|
| **Kingdome** | **:** Plantae |
| **Class** | **:** Magnoliopsida |
| **Order** | **:** Poales |
| **Family** | **:** Gramineae |
| **Genus** | **:** Oryza |
| **Species** | **:** Sativa |

***Address for Corresponding Author:***
Dinesh Kumar Chauhan
Department of Pharmacology, Bhagwant University, Sikar Road, Ajmer (Rajasthan) India
Email: dineshji9595@gmail.com

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**Figure 1**: Rice plant

**Chocolate Formulation**

Sun et al. (2021) studied on chocolate formulation by help of oleogels (Sun et al., 2021). This oleogels prepared from beta-sitosterol with gama-oryzanol. During preparation of oleogels corn oil used as base and beta-sitosterol used in combination with gama-oryzanol or steric acid or lecithine to prepared fallowing oleogels gama-oryzanol oleogels(GO), steric acid oleogel (SO) and lecithine oleogels (LO) respectively. Gama-oryzanol (GO) oleogels was prepared by adding beta-sitosterol with oryzanol. Steric acid oliogels was prepared by adding beta-sitosterol with steric acid. Lecithine oleogel was prepared by adding beta-sitosterol with lecethine. 12 % oleogels prepared by mixing of oleogelators at various proportion i.e. gama-oryzanol (2/3), lecethine oleogels (4/1) and steric acid oleogel (1/4) w/w in corn oil.

**Colorectal-targeted dietary supplement tablets**

Busaban and Chalermpong (2018) studied on colorectal targeted dietary supplement. This colorectal targeted tablet consists of purpal rice bran oil. It acts as chemoproctective agent in colorectal area. During studies they found that the colorectal cancer risk is reduce by presence of cyclooxygenase-2(COX-2) enzyme. In-vitro study show that [Khao' Gam Leum-Phua (KGLP)-natural purple rice bran oil (NPRBO)] no gama-oryzanol (GO) release at gastric pH from tablet coated with (Khao, Gam Leu-Phua-Natural Purple Rice Bran Oil) KGLP-NPKBO. At gastric pH 7.3, gama-oryzanol release up to 85% in 6 hrs in colorectal area. Hence it was confirmed that colorectal cancer was cure by the use of targeted delivery system of KGLP-NPKBO film coated tablet (Sirithunyalug and Saenjum, 2018).

**Gel and Cream**

Shah et al. (2021) studied on niosomal gel prepared by gama-oryzanol for treatment of skin cancer. The gama-oryzanol (OZ) niosomal gel improves physicochemical stability upon topical application against ultraviolet ray. The prepared optimized batch shows the average vesicle size 196nm and entrapment efficiency 78.4%. During two hour study 25 % drug release in receptor and 71% drug was remains in neosome gel. Hence this study confirm that the niosomal formulation show better retention of drug. Formulation can improve the patient compliance and therapeutic response and also decrease the administration of drug frequency (Shah et al., 2021).

**Liposome**

Viriyaroj et al. (2009) studied on topical application of gama-oryzanol loaded liposome formulation. They study on physiochemical and antioxidant property of gama-oryzanol liposome formulation. This liposome consists of Cholesterol, Sodium raurocholate and Phosphotidyl choline. Sonication method was used for preparation of this type of liposome. Liposome's prepared by using 3.5 and 10% gamma-oryzanol (Viriyaroj et al, 2009).

**Calcium pectinate microparticles**

Lee et al. (2009) studied on gama-oryzanol loaded calcium pectinate micro particles and confirm its compatibility with chitosan optimization and release characteristics. During this study they were observe release pattern of chitosan after its coating and blending, enclosed gama oryzanol loaded microparticles. Chitosan coated and blended calcium pectinate microparticles was effective in suppressing in release of gastric fluid (SGF) and intestinal fluid (SIF) (Lee et al 2009).

**Nanoethosome**

Zeinali et al. (2021) studied the prevention of mice skin cancer, by nanoetosomes containing gama-oryzanole. They found an effective signaling pathway during in-vitro study of anticancer and antioxidant effect of gama-oryzanol. By using this signaling pathway they were investigate a new factor known as sun protection factor of formulation and long term protective effect on ultraviolet induce skin cancer in mice by gama-oryzanol loaded nanoethosome (Zeinali et al, 2021).

**Nanofiber**

Hajilou et al. (2020) studied on, wound dressing material for healing wound effect of polycaprolacton containing nanofiber coated with gama-oryzanol and chitosan. During study they found that ppolycaprolacton loaded (PCL) with gama-oryzanol (GO), chitosan (CS) show less viscosity, higher conductivity, water contact angle and surface tension compared to unloaded polycaprolacton. Mupricine chitosan and gama-oryzanol containing polycaprolacton significantly reduce the bacterial count and promote wound healing. It reduces the expression of MMP-9, IL-Iβ, and

TNF-α but potentiate the expression of IL-10, vascular endothelial growth factor (VEGF) compared to the unloaded PCL group. Experiment showed that the PCL-CS-GO group shows the optimal response to physical parameters of wound healing (Hajilou et al., 2020).

**Niosomes**

Manosroi et al. (2012) studied about niosomes containing rice bran oil as a bioactive compound on enhancement of transdermal absorption. Niosome consist of Tween 61 and cholesterol in the molar ratio 1:1. This mixture entrapped with the mixture of three semi purified rice bran chemical constituents. These chemical constituents are ferulic acid (F), Gama oryzanol (O), and Phytic acid (P). This mixture was prepared by adding 0.5% of ferulic acid, 1.5% of gama oryzanol, and 1.5% Phytic acid by supercritical $CO_2$ technique (Manosroi et al., 2012).

Study showed that the transdermal absorption of gama-oryzanol i.e. hydrophobic compound increased by niosome while decreasing the absorption of hydrophobic compound like ferulic acid and phytic. This indicates that niosome containing ferulic acid, phytic acid and gama-oryzanol has les systemic effect. Hence Ferulic acid, gama-oryzanol and phytic acid transdermal absorption depend on size of noisome, compound lipophilicty and formulation (Manosroi et al., 2012).

**Emulsions**

Khalid et al. (2017) prepared water in oil emulsion containing beta-sitosterol with Gama-oryzanol. They also study about evaluation of stability, formulation characteristic with microchannel emulsification. In this formulation gama-oryzanol (Gama-OZ) and Beta-sitosterol were encapsulation done at higher concentration in various type of food grade oil-in-water emulsion by using micro channel emulsification method. The milli-Q water dispersed phase consists of 0.5 to 4.0 percent gama-oz and beta-sitosterol and continuous phase consists of 1.0 percent Decaglycerol mono laurate or Tween-20 in medium chain triglyceride. The emulsion granule was prepared by different concentration of Beta sitosterol and gama oryzanol. The main droplet diameter of 1.0 percent gama-oryzanol and beta-sitosterol loaded oil-in-water emulsion range in between 26μm to 28μm. The relative e span factor range was below 0.22. During evaluation period these emulsion was stable at 4°C and 25°C. The encapsulation efficiency of gama-oryzanol and beta-sitosterol lies above the 80 percent when emulsion stabilized with Tween-20 at 4°C and 25°C. Those stabilized with decaglycerol monolaurate have encapsulation with efficiency above 50 percent 4°C and 25°C (Khalid et al., 2017).

**Biological activity and pharmacological property**

**Antioxidant property**

Antioxidant are those products that deactivate the free radical produce as a byproduct of oxidative metabolism (Patel and Naik, 2004). The main chemical of Rice bran is gama-oz and phytosterol conjugates. These phytosterol conjugates contain potent antioxidant activity against the free radicles. Its (gamma-oryzanol) ferulic acid ester is a potent antioxidant at elevated temperatures (Xu et al., 2001). Several studies indicate that gamma oryzanol is four times more antioxidant property than vitamin E. Alpha, beta tocopherol and alpha, beta tocotrinol are essential component of vitamin E. Antioxidant properly of these components are used to develop neutraceuticals and other neutraceutical from various chemical compounds of rice bran (Patel and Naik, 2004; Fukushi, 1966).

**Rice bran in food products**

Rice bran has high nutritional food value and it is used as food additives in neutraceutical food industry (Sekhon et al., 1997). Due to content of dietary fibers it is use as a laxative. The effect of several cereal like rice, wheat and oat bran and dietary fiber on preparation of cake butter, self-life of product, quality of cake and other parameter like viscosity, porosity, butter viscosity etc were studied (Gordon, 1989). Rice bran posses a peanut oil like flavor that is nutty flavor. This flavoring properly of rice was used in pharmaceutical industry. In industries they are used for snacks as well as backed goods (Prakash and Ramaswamy, 1996). The food quality like appearance, texture, color, taste is improved by use of rice bran (Esa et al., 2013).

**Lowering cholesterol**

Rice bran oil (RBO) have hypocholesterolemic property by lowering Low Density Lipoprotein (LDL) Cholesterol. Due to availability of Tocotrinol, OZ and phytosterol, RBO has hypocholesterolemic property (Lichtenstein et al., 1994). From 1950s Phytosterols has been considered as cholesterol-lowering agents. After several studies a new compound discovered known as beta sitosterol and sitostanol. RBO also contain sitostanolol and β-sitosterol and hence RBO reduces the blood cholesterol and low density lipoprotein level. They decrease the malic acid and acetyl Co-A activity on lipid metabolism (Kahlon et al., 1992). Gama oryzanol are also act as hypocholesterolemic agent. Rice bran oil containing gamma-oryzanol reduced total plasma cholesterol in four weak is approximately 6.3% (Bhaskaragoud et al., 2016).

**Coronary heart disease (CHD)**

The consumption of cereal dietary fiber reduce the risk of coronary heart disease by reducing the blood pressure, blood cholesterol and improving insulin sensitivities (Walsh et al., 2008). The risk of coronary heart disease increases with less/reduces consumption of dietary fiber i.e.

cereal or fruits (Pereira et al., 2004).

Amount of LDL is directly proportional to the coronary heart diseases, whereas HDL has inversely proportional to CHD (Kahlon et al., 1992; Margolis and Dobs, 1989). In human diets presence of sufficient amount of sitosterol reduces the total circulating blood cholesterol approximately 7.5% and low density lipoprotein (LDL) 10% (Ehnholm et al., 1993; Frohlich and Moghadasian, 1999). Phytosterols increases the amount of lecithin cholesterol Acyl Transferees (LCAT) level in blood (Kahlon et al., 1992; Moghadasian and Frohlich, 1999; Laraki et al., 1991), which is responsible for the release of cholesterol in hydrophobic core of high density lipoprotein.

**Anticancer effects**

Tocotrienols is a potent antioxidants found in rice bran oil. Tocotrienols have anticancer effects. Various studies showed that the tocotrienols suppress growth of various cancer cells (breast, lung, ovary, liver, brain, and pancreas). Tocotrienols protect human and animal cells exposed to ionic radiation (Yu et al., 2019). It has been observed that the effect of rice bran oil in reducing the local inflammation, arresting cancer cell growth by blocking cancer cell cycle, promoting cancerous cell apoptosis and enhancing chemopreventive effects (Noboru and Yusho, 1970).

**Preparation of Anti-ageing/cosmetics and personal care product**

UV light induces lipid peroxidation of skin cell. It also induces skin cancer. Rice bran oil contains oryzanol which protect skin from UV light. Gama-oz consists of ferulic acid and its ester. Ferulic acid is help in preventing skin ageing and hair growth (Tomeo et al., 1995).

**Anti-diabetic effect**

RBO and its components have ability to lower the blood glucose level i.e. known as hypoglycemia. Several studies show that extract of rice bran increases glucose uptake in 3T3-L1adipocytes by inhibiting the activity of α-glucosidase and α-amylase. Hence they reduce the glucose absorption in body (Wahiyuni et al., 2016).

Rice bran extract potentiate the ribonucleic acid or messenger RNA to increase glucose uptake into cell.

This stimulated mRNA to produce insulin signaling pathway protein i.e. insulin receptor substrate (IRS), insulin receptor gene (INSR) and two glucose transporter (GLUT1 and GLUT2) (Wahiyuni et al., 2016). Glucokinase is an enzyme which responsible for regulation of blood glucose level. Glucokinase facilitate the phosphorylation of glucose into glucose-6-phosphate in liver (Chen and Cheng, 2006).

**Antihypertensive effect**

Several studies show that the various proteins obtained from plant and animal are essential nutrient for reducing blood pressure. RBO contain several proteins, and phytochemicals, which help in managing hypertension (Kukongviriyapan et al., 2015). There are several processes by which rice bran protein may lower the blood pressure. Rice bran regulate the synthesis of nitric acid synthase and antioxidant activity by inhibiting angiotensin converting enzyme (ACE) .inhibition of angeotensin converting enzyme (ACE) leads to improvement of endothelial function and blood pressure (Ogawa et al., 2018).

**Effect on gastrointestinal functions**

Fiber is essential for health of gut. However, excess consumption may cause gastrointestinal disturbance in colon by the gut bacteria. Colorectal cancer patient can consume to RB up to 32gram/day for four week help in changing the stool consistency (Kamiya et al., 2014). Fermentation of rice bran in gut shift the microbiota and maintain mucosal balance in intestinal tract (Frokiaer and Nielson, 2013).

**Effect on Liver function and kidney function**

**Kidney** help in regulating body water and electrolyte balance. Certain disease like diabetic mellitus and cardiovascular diseases, was produce by generating inflammatory cytokines and defective kidney function. Diabetic nephropathy produces by increase creatinine and albumin level in urine.

Certain studies show that, rat treated with high fat or high sucrose and cisplatin diet, γ-oryzanol help in improving liver and kidney function (Li et al., 2022). In fatty rat or sucrose feed rat, Cisplatin injection increase the plasma creatinine, urine volume, urea and also decrease urinary creatinine and creatinine clearance. If these rats provides nutrient containing γ-oryzanol (50 mg/kg), after some time kidney function can restore (Li et al., 2022).

**Uses**

1. Anticancer
2. Antioxidant.
3. Emollient
4. Manufacture of cosmetics
5. It is very effective skin protectant, moisturizer and as an emollient.
6. It has an antioxidant property so it is good for health
7. Rice bran oil is used for treating obesity, high cholesterol, alcoholism, high blood pressure, and diabetes (Estman and Orthoefer, 2004).
8. Best composition of fat.

9. Due to its hypoallergenic effect, it is the best alternative to other cooking oils.
10. Rice bran oil used in deep and pan frying because rice bran oil has high burn point.
11. RBO is less greasy than other oils hence it is easy to clean-up.
12. The absorption of rice bran is less than other edible oil hence it favors' palatability.

Rice Bran Oil contain balanced fatty acid composition which is required for the several agencies like World health organization (WHO), the national institute of nutrition (NIN), American heart association (AHA) and Indian Council of Medical Research (ICMR) for conduction of various type of experiment.

## Conclusion

RBO is common herbal product obtained from rice bran in milling industries, widely rice bran is highly nutrient compound because it contains protein, carbohydrates, fats, dietary fiber, gama-oryzanols, tocotrinols, tocopherols, phytosterol and dilatory fiber etc. These nutrients have similar property like vitamin E hence posses' significant antioxidant, ergogenic and laxative properties. Other benefits are it contains nutritional supplements as well as health benefit to human and animal. RBO is used for treatment of several diseases, and has a diverse pharmacological spectrum. Rice bran oil contains several chemical constituents like γ-oryzanol, tocopherols, and tocotrienols that have several pharmacological properties like other herbal drugs. RBO has potent antioxidant activity due to presence of Gama-oz, tocopherol and tocotrinol. Various studies showed that gamma-oryzanol has four times more antioxidant properties than tocopherols and 2-5 times more oxidative stability than groundnut oil. Its smoking point is 213°C. Due to its smoking point, rice bran oil does not denature at high temperatures, and hence its antioxidant property retains.

Antioxidant property of gama oryzanol uses in formulation of various pharmaceutical preparation like chocolate formulation, colorectal-targeted dietary supplement tablets , gel and cream, liposome, calcium pectinate microparticles, nanoethosome, nanofiber, niosomes, emulsions etc. to improve the therapeutic activity of various formulation. These formulations are used to treat and control the various diseases like cancer, hypertension, hyperlipidemia etc. After several studies, due to the presence of antioxidant properties, we suggested that the rice bran oil is used for treatment of cancer, although further studies should be conducted to confirm the possible anticancer effect of rice bran oil.

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