Stabilized Rice Bran
The functional food for the 21st century!

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INTRODUCTION
Rice bran and germ comprises 8-10 percent of the weight and accounts for 65 percent of the nutritional value of the rice kernel (1). Rice bran is the layer just below the hull of the rice kernel. Global production of rice is approximately 600 million metric tonnes (2) and 60 million metric tonnes of nutrient rich rice bran and germ are available as an underutilized product of the rice milling process. Rice bran becomes rancid within 48 hours of the milling process due to the presence of an enzyme called lipase. Lipase hydrolyzes the fat in the bran to form free fatty acids and glycerol rendering the bran rancid (3). Deactivation of the lipase enzyme helps to stabilize the rice bran from hydrolytic, and oxidative rancidity and preserve the nutritional value. Globally there are several stabilized rice bran's with a varied shelf life (4-6 months), from the date of production. Over the last decade a non chemical stabilization technique (NutraCed’s proprietary technology) has been developed with a guaranteed shelf life of 12 months when stored at ambient temperature. SRB offers shelf life and nutrient stability with a lower microbiological count. SRB is accorded a GRAS status (generally regarded as safe) and for the first time in human history this plethora of nutrient rich rice bran is available for feeding mankind!

Rice bran meets several of the Dietary guidelines for Americans and Europeans and is a perfect food for most of us for the following reasons:
- It is plant based
- It is rich in macro and micro nutrients with high fibre (29 percent)
- It is nutritionally dense
- It has no cholesterol or trans fatty acids
- It is low in sodium and high in potassium
- It promotes good gut micro flora
- It is low in sodium and high in potassium
- It is a complete protein with high digestibility and is hypoallergenic
- It reduces cholesterol and blood pressure
- It has been shown to have anti-cancer activity
- It prevents urinary stone formation
- Rice bran has one of the highest ORAC value among foods
- It is non-GMO, and all natural with non-bloating fibre

RICE BRAN COMPOSITION
Table 1 gives the macro and micronutrient composition of stabilized rice bran.

MACRONUTRIENTS

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Stabilized Rice Bran (SRB)</th>
<th>Rice Bran</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protein</td>
<td>12.90%</td>
<td>12.90%</td>
</tr>
<tr>
<td>Fat</td>
<td>7.20%</td>
<td>7.20%</td>
</tr>
<tr>
<td>Carbohydrate</td>
<td>77.50%</td>
<td>77.50%</td>
</tr>
</tbody>
</table>

VITAMINS

<table>
<thead>
<tr>
<th>Vitamin</th>
<th>Stabilized Rice Bran (SRB)</th>
<th>Rice Bran</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vitamin A</td>
<td>0.04 mg/100g</td>
<td>0.04 mg/100g</td>
</tr>
<tr>
<td>Vitamin C</td>
<td>64 mg/100g</td>
<td>64 mg/100g</td>
</tr>
<tr>
<td>Thiamine</td>
<td>0.34 mg/100g</td>
<td>0.34 mg/100g</td>
</tr>
<tr>
<td>Riboflavin</td>
<td>0.32 mg/100g</td>
<td>0.32 mg/100g</td>
</tr>
<tr>
<td>Niacin</td>
<td>1.69 mg/100g</td>
<td>1.69 mg/100g</td>
</tr>
<tr>
<td>Folate</td>
<td>0.98 mg/100g</td>
<td>0.98 mg/100g</td>
</tr>
</tbody>
</table>

MINERALS

<table>
<thead>
<tr>
<th>Mineral</th>
<th>Stabilized Rice Bran (SRB)</th>
<th>Rice Bran</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calcium</td>
<td>63 mg/100g</td>
<td>63 mg/100g</td>
</tr>
<tr>
<td>Iron</td>
<td>5.5 mg/100g</td>
<td>5.5 mg/100g</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>260 mg/100g</td>
<td>260 mg/100g</td>
</tr>
</tbody>
</table>

ABSTRACT
Rice bran obtained as a by product of rice milling, accounts for 8-10 percent of the rice kernel and includes the germ and the outer layers of the kernel. Rice Bran is rich in nutrients and needs stabilization to prevent rancidity and protect its nutritional value. Stabilized Rice Bran (SRB) is energy dense, with a good blend of fats. It is a complete protein, hypoallergenic and easily digestible. SRB is a complex carbohydrate mixture of soluble and insoluble fibres that slow down glucose uptake. SRB is an excellent source of B complex vitamins; antioxidants and polyphenols. SRB has been shown to lower blood glucose and cholesterol and reduce colonic adenomas by 51 percent. These mechanisms we believe are brought about by a synergistic effect of several nutrients and non nutrients. SRB is nutritious and sweet to taste with a nutty flavour and can be added to any recipe to augment the nutritional value and fibre content.
An unsaponifiable fraction consists of tocopherols, tocotrienols, gamma oryzanol, phytosterols and furfuralic and squelane. Rice bran with full fat shows the same effect as oats in lowering cholesterol (11).

**Micronutrients & other nutrients**

Stabilized Rice bran is a rich source of B complex vitamins; it has a very high amount of niacin, thiamine, pantothenic acid, and pyridoxine. It has several carotenoids (129.30 mcg/100 grams). Of the 27 identified sterols in rice bran, beta sitosterol (216mg/100 grams) is the highest followed by campesterol (96.35 mg/100 grams). It is rich in vitamin E and contains all the four isomers of tocopherols and tocotrienols (alpha, beta, gamma and delta). It is a rich source of over 113 antioxidants including gamma oryzanol and its furfuralic acid esters. Natural antioxidants work synergistically with other metabolites within a system. Gamma oryzanol and its furfuralic acid esters along with phytosterols, tocopherols/tocotrienols with other metabolic cofactors contribute to an antioxidant capacity-higher than blueberries (12). The rich array of nutrients and non nutrients present in SRB makes it a unique functional food. Several studies show the beneficial health effects of these nutrients. Studies conducted with SRB or rice bran document these benefits and are discussed below.

**Rice bran’s cardiovascular effects**

Stabilized Rice Bran has been shown to be affective in lowering cholesterol in both type I and type II diabetics and in hypercholesterolemic humans (13-15). The cardiovascular benefits of SRB may stem from different mechanisms operating synergistically namely through:

- a) Decreasing cholesterol absorption,
- b) Increasing competitive binding by plant sterols
- c) Increasing excretion of fat, cholesterol and bile acids
- d) Inhibiting HMG CoA reductase
- e) Decreasing fat absorption
- f) Lowering low density lipoprotein cholesterol and increasing high density lipoprotein cholesterol
- g) Inhibiting platelet aggregation
- h) Inhibiting formation of aortic streaks
- i) Reducing triglycerides
- j) Reducing blood pressure
- k) Inhibiting phospholipase A2, thromboxane B4 and prostacyclin production

The phospholipase A2, thromboxane B4 and prostacyclin are involved in controlling the inflammatory response implicated in all chronic diseases including cardiovascular diseases. Intake of 20 grams/day of SRB has been shown to reduce cholesterol (13, 14). Tocotrienols have been shown to inhibit the HMGCoA reductase activity. (hydroxyl methyl-glutaryl-CoA reductase) and independently lower lipids and blood pressure (13-16). Tocopherols also inhibit LDL-Cholesterol oxidation. Research shows that tocopherols decrease total fat and cholesterol in the liver and heart and increase the excretion of faecal fat and cholesterol. The fibre present in SRB helps lower the fat and cholesterol. The fat present in rice bran has been shown to reduce serum cholesterol and LDL cholesterol and elevate HDL cholesterol (11). Cholesterol is better absorbed than phytosterols in humans. Plant sterols or phytosterols have a structural similarity to that of cholesterol (only the side chain is different). This similarity in structure helps phytosterols compete with cholesterol for absorption thus reducing the overall cholesterol absorption. This effect has been observed even in healthy human volunteers with normal levels of cholesterol (17). Clinicians regularly use Niacin to reduce cholesterol. Niacin is known to be effective in increasing high density lipoproteins (29 percent), decrease triglycerides (23-28 percent) and low density lipoproteins (LDL-C) (8 and 9 percent) in patients with and without diabetes (18-20). Rice bran contains high levels of Niacin (47 mg percent). The high levels of Vitamin B6 present in rice bran may also help normalize homocysteine levels (18). Rice bran contains over 113 antioxidants and has an ORAC (oxygen radical absorbance capacity) value of 82.0 micromoles TE/g (unpublished data). The antioxidants inhibit LDL-C oxidation and exhibit a significant anti-inflammatory role (20). Inflammatory processes are implicated in chronic diseases such as cardiovascular diseases. Tocopherols, Tocotrienols, Gamma Oryzanol present in rice bran has been studied for its antioxidant activity. Research shows that Gamma Oryzanol present in rice bran may play a more significant role than Vitamin E in the reduction of cholesterol oxidation (16). Gamma Oryzanol present in rice bran is shown to inhibit platelet aggregation, aortic streaks, and has a hypolipidemic effect. It also reduces triglycerides and increases HDL or good cholesterol (21, 22). Gamma Oryzanol seems to slow down the hepatic synthesis of cholesterol and increase faecal excretion (16). Phenolic acids present in the water extract of rice bran have also been implicated in free radical scavenging activity (23). In a study in hypertensive rats rice bran has been shown to lower blood pressure after 8 weeks of supplementation. The supplemented group had significantly lower levels of angiotensin I converting enzyme that converts angiotensin 1 to angiotensin 2 and leads to narrowing the blood vessels (24). Inositol has been shown to be an anti-neoplastic and lipid lowering agent. Serum cholesterol and triglycerides have been shown to be lowered with divalent cations and dietary phytates (25).

Rice bran is a rich source of inositol hexaphosphate and has high levels of Magnesium that could contribute to the lipid lowering observed with SRB.

**Rice bran and glucose metabolism**

Glucose metabolism is regulated through several mechanisms. B complex vitamins, gamma oryzanol, protein, carbohydrates, polysaccharides, hemicelluloses fat and fibre, tocopherols and tocotrienols, antioxidants are all known to play a significant role in glucose regulation. The regulation of fasting serum glucose by B complex vitamins was observed in 1996 (20). B complex vitamins improve glucose metabolism and non starchy polysaccharides increase insulin release from pancreas and increase insulin receptors sites. Gamma Oryzanol may activate beta cells and increase insulin production (20). Tocopherols and Tocotrienols have a similar effect and in addition have a role to play in diabetic retinopathy, nephropathy and cardiomyopathy. Nicotinamide preserves residual beta-cell function when given to insulin dependent diabetics receiving insulin. Foods with low glycemic index improve sensitivity to insulin and suppress non essential fatty acids leading to improved tissue uptake of glucose (26). Studies have shown that the colonic fermentation of undigestible carbohydrates produce short chain fatty acids improve fasting blood glucose and glucose tolerance at breakfast when low glycemic index evening meals are taken (26). The type of fat also has an impact on the glucose regulation. N-6 fatty acids could reduce blood glucose levels (27). Rice bran is a very rich source of n-6 fatty acids. Fibre regulates fasting serum glucose levels and improves glucose utilization. The effect of SRB and its derivatives on glucose levels were studied. Consumption of 20 grams of the water soluble fraction (Solubles) significantly reduced hyperglycemia (p<0.01) whereas the SRB derivative with high fibre significantly reduced hyperglyceremia. (p<0.05) in both type I and type II diabetes. The glycosylated haemoglobin showed a decrease and fasting glucose levels decreased significantly (p<0.001). A water extract from rice bran has been shown to suppress visceral fat. The water extract inhibits the pancreatic lipase activity in vitro, leading to a decrease in plasma triglycerides, resulting in a decrease in visceral fat accumulation. Consumption of at least 3 servings of cereals/whole grains is recommended to ensure proper regulation of blood sugars especially in western society where refined sugars are readily available. Studies show that low levels of plasma and intracellular Magnesium are associated with diabetes. Low Magnesium is also associated with low insulin levels (29). Magnesium improves glycemic control and reduces complication of diabetes. Complications of Diabetes include neuropathy, cardiomyopathy and retinopathy. Hyperglycaemia has an important role in the pathogenesis of diabetic complications by increasing protein glycation and the gradual buildup of advanced glycation end products (AGE's) in body tissues. These AGEs form on intra- and extracellular proteins, lipids, nucleic acids. AGE’s are accompanied by increased free radical activity and contributes towards the biomolecular damage in diabetes. Antioxidants are known to help prevent protein glycation. Rice bran is a very rich source of over 113 antioxidants.

**Rice bran & cancer**

 Gamma Oryzanol exhibits an antimutagenic and anticancerogenic effect. Rice bran is a rich source of Inositol (1496 mg) with known anticancerogenic effects on several organs. Insoluble fibre is known to have a protective effect on colonic and large bowel cancer. Similar protective effects have been observed for tocotrienols in rice bran. The lipoprotein fraction of rice bran has been shown to suppress cancer progression and apoptosis of cultured human endometrial adenocarcinoma cells and inhibit cell proliferation. Polysaccharides, polyphenols and antioxidants all have chemo preventive properties.
Inositol mitigated the tumour incidence and growth rate of fibrosarcomas (25). Gescher A. et al. (2007) studied the affect of SRB in the formation of adenomas in mice. He observed a 51 percent drop in incidence of adenomas in mice fed SRB. The fibre more particularly the insoluble fibre undergoes fermentation and produces good gut bacteria coupled with the production of short chain fatty acids is thought to play a major role in protection against colonic cancer. SRB is also rich in polyphenolic compounds. Polyphenolic compounds such as caffeic acid are known to inhibit cell proliferation and induce cell death or differentiation in tumour cells, suggesting that they may antagonize all phases of carcinogenesis.

Rice bran and liver disorders
Inositol is known to control liver cirrhosis, improving liver cell regeneration and helps in detoxification of the liver. B complex vitamins have a similar function. Tocotrienols, Gamma Oryzanol, antioxidants all have a protective role on the liver and they also are immune boosting.

OTHER HEALTH BENEFITS

Gamma Oryzanol regulates endocrine system, improves blood circulation, and has neuro regulatory action and increases lean body mass. Gamma Oryzanol protects against UV radiation and is shown to be effective in treating dermatitis. Inositol has also been shown to protect against kidney stone formation and promotes gastrointestinal and colon health.

Food applications
Rice Bran and its unique value added products have applications in a multitude of food products. For example, Solubles can be used in beverages, juices, ice cream, cultured products, milk shakes, and smoothies to improve the nutrition. Fiber Complex, Dextrinized and beverages, juices, ice cream, cultured products, milk shakes, and rice bran and liver disorders

PURITY STANDARDS

EPAX AS, supplier of marine-derived omega-3 fatty acid concentrates, continues to improve the purity and quality levels for its products. The company confirmed it has lowered the acceptable level for dioxins, furans and dioxin-like polychlorinated biphenyls (PCBs) in its specifications for its omega-3 concentrates. EPAX’s levels are now 60 percent lower than required by the European Union (EU) authorities. In addition, the company has widened its specifications for dioxin furans and dioxin-like PCBs. In 2005, the company lowered the limits for all PCBs.

MANNASTAR™

Genencor announced the availability of a new bright cleaning enzyme product that targets the removal of mannans from fabrics. Genencor’s Mannastar™ enzyme provides detergent manufacturers around the world the opportunity to increase their products’ performance to match or exceed the leading high end detergent brands in variable wash conditions. Mannans, of which guar and locust bean gum are among the most common, are among the most common, are used as thickeners and for gel texture in food and cosmetics.