

## Rice Bran Oil's Unique Nutraceutical Functions & Applications

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Item Title: **Rice Oil**

Content: This is a float layer on rice congee in a boiling pot, which is slippery as an oily ointment. It is real strength to nourish people, which good quality will be got by cooking the rice over 20kg. Shaoxing Chinese doctor said a weak thin person may become fatty strong, which the power of nourishing Yin will be better than the prepared rhizome of rehmannia. Take one bowl a day and it is best without salt. ....

A Supplement to the Compendium of Materia Medica, 1765.

### Composition of Crude Rice Bran Oil

	%
<b>Saponifiable Lipids:</b>	90-96
Triglycerides	80-90
Diglycerides	2-10
Monoglycerides	1-2
Free Fatty acids	4-40
Phospholipids	1-2
Glycolipids	1-2
Wax	3-6
Steryl Esters	2-3
Oryzanol	1-2
<b>Unsaponifiable Matters:</b>	3-4.5
Phytosterols, Triterpenols, Hydrocarbons	
Tocopherols, Tocotrienols	

### Fatty Acid Composition of Rice Bran Oil (RBO)

OIL	SFA		MUFA		PUFA		RATIO	
	16:1	18:1	20:1	18:2	18:3	SFA/MUF A	PUFA/MU FA	18:2/18:1
Canola	6	62	22	10	0.1	0.5	0.4	
Corn germ	13	28	58	1	0.5	2.1	2.1	
Cottonseed	26	1	19	54	1	1.3	2.8	2.8
Flaxseed	9	20	17	53	0.5	3.5	0.9	
Olive	17	1	71	10	1	0.2	0.2	0.1
Palm	50	40	10	1	1.3	0.3	0.3	
Peanut	19	48	2	32	0.4	0.6	0.7	
<b>Rice Bran</b>	20	45	37	1	0.4	0.8	0.8	
Safflower	9	13	78	0.7	6.0	6.0		
Sesame	13	40	46	0.3	1.2	1.2		
Soybean	15	24	54	7	0.6	2.5	2.3	
Sunflower	12	19	68	1	0.6	3.6	3.6	
Wheat germ	15	27	54	3	0.6	2.1	2.0	

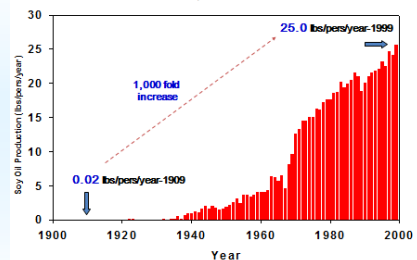
### Ranges of population nutrient intake goals © World Health Organization 2003

Dietary factor	Goal (% of total energy, unless otherwise stated)
Total fat	15-30%
Saturated fatty acids	<10%
Polyunsaturated fatty acids (PUFAs)	6-10%
n-6 Polyunsaturated fatty acids (PUFAs)	5-8%
n-3 Polyunsaturated fatty acids (PUFAs)	1-2%
Trans fatty acids	<1%
Monounsaturated fatty acids (MUFAs)	By difference <sup>a</sup>
Total carbohydrate	55-75% <sup>b</sup>
Free sugars <sup>c</sup>	<10%
Protein	10-15% <sup>d</sup>
Cholesterol	<300 mg per day
Sodium chloride (sodium) <sup>e</sup>	<5 g per day (<2 g per day)
Fruits and vegetables	≥ 400 g per day
Total dietary fibre	From foods <sup>f</sup>
Non-starch polysaccharides (NSP)	From foods <sup>f</sup>

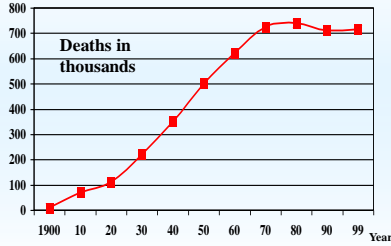
<sup>a</sup> This is calculated as: total fat - (saturated fatty acids + polyunsaturated fatty acids + trans fatty acids).  
<sup>b</sup> The percentage of total energy available after taking into account that consumed as protein and fat, hence the wide range.

Diet, nutrition and the prevention of chronic diseases, Report of the joint WHO/FAO expert consultation

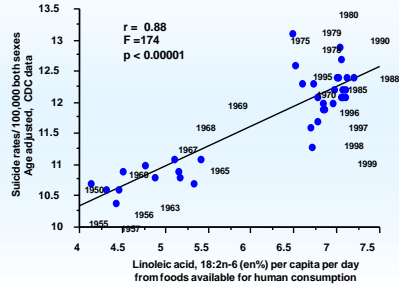
### Soy oil production for food consumption USA, 1909-1999



**Deaths From Diseases of the Heart\***  
United States: 1900-99



**Suicide mortality in the U.S. from 1960 to 1999**  
and linoleic acid (18:2n-6 en%) available in the food supply  
Soy oil is the primary source of 18:2n-6.



**Oryzanol in Rice Bran Oil (RBO)**

$\gamma$ -oryzanol, is a mixture of ferulic acid esters of triterpene alcohols and sterols

Three major compounds

	Cycloartenyl ferulate	24-Methylene cycloartenyl ferulate	Campesterol ferulate
	25-30%	35-40%	15-20%
Sources & Contents	Bran	Oryzanol ug/g dw	
	Rice	1550-8400	
	Rye	150-250	
	Corn	200-250	
	Wheat	297-584	

Mandak, et al 2012

**Nutraceutical functions & applications of Oryzanol**

Functions:

Neuroprotective  
Anti-oxidative  
Anti-atherosclerotic  
Anti-ulcerogenic  
Anti-cancerogenic  
Anti-stress  
Anti-diabetic  
Anti-inflammatory  
Antiallergenic

Muscle enhancing  
Immune modulatory  
Hypolipidemic  
Hypocholesterolemic  
Nourishing skin  
Hormones stimulate  
Effect on Menopause  
Effects on Dementia  
Other effects



**Unsaponifiable Matters in Some Edible Oils**

Oil	USM (%)	Oil	USM (%)
Cocoa butter	0.9	<b>Rice bran</b>	4.1
Coconut	1.2	Wheat germ	5.0
Cottonseed	1.5	Sesame	2.0
Groundnut	1.8	Olive	2.5
Palm	1.2	Mustard	2.0
Palm kernel	0.8	Soybean	1.6
Sunflower	1.3	Corn	2.8
Linseed	1.7	Kapok seeds	1.0
Safflower	1.3		

**Unique Unsaponifiable Matter in Rice Bran Oil (RBO)**

Components (%)	RBO	Wheat Germ Oil	Olive Oil
Hydrocarbons	18	7	30-50
<b>Phytosterols</b>	43	35	2
Triterpenols	28	9	19-34
Tocopherols	1	18	2-3
Others	10*	17**	18-37***

\*Sterol esters

\*\*Methysterols

\*\*\*Polyphenols

### Phytosterols Contents and Compositions of Some Oils

Oil	Total Sterols (ppm)	Sterol Composition (%)			
		Campesterol	Stigmasterol	$\beta$ -Sitosterol	Other
Soybean	2000-4000	15-21	10-24	57-72	-
Palm	2000-2500	25	14	65	-
Sunflower	2500-4500	7-12	8-12	62-75	-
Rapeseed	900-1000	30-33	<1	50-55	12-14 <sup>a</sup>
Cottonseed	2700-5500	6-14	3-6	75-90	2-5 <sup>b</sup>
Coconut	500-1000	6-9	18-19	69-75	13-25 <sup>b</sup>
Rice Bran	10000-32000	20-28	8-15	49-54	5-11 <sup>b</sup>
Corn	8000-20000	18-24	4-8	55-67	4-8 <sup>b</sup>
Olive	100	<1	<1	75-80	4-14 <sup>b</sup>

<sup>a</sup>brassicasterol; <sup>b</sup> $\Delta$ -5avenasterol

RBO plant sterols concentration: 32.25 g/kg. Ref. Baileys 523, 2005

### Relative Distribution of Different Free & Esterified Sterols in Some Vegetable Oils

Source	4-Desmethyl sterols	4-Monomethyl sterols	4,4-Dimethyl sterols	Ratio esters/free sterols
Palm	++	-	-	-1
Rape seed	+++	-	-	<1
Soybean	++	+	-	>1
Sunflower seed	++	+	-	>1
Corn fiber	+++	-	-	<1
Shea nut	-	+	++	-
Rice bran	+++	+	++	<<1

<sup>a</sup> Esters are fatty acid, ferulic or cinnamic acid type.

Duchateau et al.

### Phytosterols Nutraceutical Functions

#### Functions:

Cholesterol-lowering	Anti-cancerogenic
Anti-oxidative	Immune modulatory
Anti-atherosclerotic	Hypolipidemic
Anti-ulcerogenic	Hypocholesterolemia
Anti-inflammatory	Hormones stimulate
Anti-allergenic	Growth regulation
Anti-bacterial	Other effects
Anti-fungal	-----



### Triterpenols Contents & Functions in RBO

Sample	H.C. Alc.	Sterols			Cyclo- alitanol	Cyclo- alitenol	24-methyl- ene cycloalitanol	Cyclo- branol
		Campe.	Stigma.	$\beta$ -sito.				
A	14.6	15.6	5.2	24.6	6.8	12.1	17.1	3.1
B	12.3	12.0	4.7	23.6	6.7	12.0	25.3 <sup>a</sup>	2.4
C	10.0	12.1	5.4	27.2	7.9	14.5	16.5	2.9
Industrially Ext. Oil	14.2	15.5	5.7	25.7	6.6	12.7	16.5	2.6

#### Functions:

Anti-oxidative	Immune modulatory
Anti-inflammatory	Improving fat utilization
Anti-Alzheimer	Relax smooth muscle
Anti-dementia	Cure skin trauma
Anti-obesity	Anti-bacterial
Anti-asthma	Anti-fungal
Anti-cancerogenic	Other effects

### Tocopherols and Tocotrienols in Some Oil

Oil	Rice Bran	Olive	Canola	Groundnut	Soybean
Tocopherols (ppm)	81	51	650	487	1,000
Tocotrienols (ppm)	336	0	0	0	0

Content of tocopherols and tocotrienols (ppm equivalent to mg/kg) in selected vegetable oils

Oil	$\alpha$ -toc	$\beta$ -toc	$\gamma$ -toc	$\delta$ -toc	$\alpha$ -T3	$\gamma$ -T3	$\delta$ -T3	Total
Canola	272	-	423	-	-	-	-	770
Coconut	3	1	1	-	4	-	-	10
Corn	191	-	942	42	-	-	-	1175
Cottonseed	-	-	-	-	-	-	-	1000
Groundnut	-	-	-	-	-	-	-	650
Linseed	8	-	500	6	-	-	-	514
Linola	20	-	471	16	-	-	-	507
Olive	-	-	-	-	-	-	-	200
Palm	189	-	-	-	207	405	99	900
Palinkernel	2	21	9	-	-	2	-	34
Rice bran	347	-	89	42	126	301	10	915
Sesame	-	-	335	-	-	-	-	507
Soybean	144	16	870	342	-	-	-	1370
Sunflower	608	17	11	-	-	-	-	-
Walnut	563	-	595	450	-	-	-	-
Wheatgerm	1330	71	260	271	26	18	-	1976

- not detected or not reported

Information taken from appropriate chapters in Ganstone (2002).

Other sources provide different figures so these should only be taken as typical. They refer to crude oils and levels will probably be reduced in refined oils.

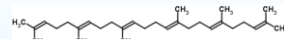
**Tocopherols & Tocotrienols**

- Anti-oxidative
- Anti-tumor
- Anti-inflammatory
- Anti-aging
- Cardioprotective
- Anti-diabetic
- Bone-protective
- Immunomodulatory

Biological Function of Tocopherol and Tocotrienols	
Tocopherol	Tocotrienol
Antioxidant activity	Suppressing inducible Ptd0 C-Src kinase activation
Inhibition of protein kinase c (PKC) activity	Suppressing inducible 12-O-tetradecanoylphorbol-13-acetate 12-O-tetradecanoylphorbol-13-acetate kinase activation
Modulation of gene expression	Inhibiting Bcl-2 expression
Inhibition of vascular smooth muscle cell proliferation	Potent neuroprotection
Inhibits platelet aggregation	Inhibiting cholesterolemia by suppressing hmg-coa reductase
Delays intra-arterial thrombus formation	Stimulating ApoB degradation
Attenuation of IRT(Thb1) phosphorylation	Preventing increased blood pressure
Membrane translocation	Decreasing platelet aggregation
Inhibition of monocyte adhesion	Reducing lipid peroxides in plasma & blood vessels
Inhibition of $\alpha$ -tropomyosin expression	Enhancing total antioxidant status
Inhibition of fibrinogen expression	Protecting against free radical-induced impairment of erythrocyte deformability
Inhibition of scavenger receptors CD36	Reducing the accumulation of protein carbonyl
Preservation of endothelial function	Reducing LDL oxidation
Inhibition of the oxygen burst in neutrophils	Inhibiting monocyte-endothelial cell
Enhancement of immune responses, interference with $\alpha$ 1-acid glycoprotein	Endothelial cell proliferation
Suppression of tumor angiogenesis	Inhibiting proliferation of estrogen receptor-negative Mda-Mb-435 and -positive MCF7 breast cancer cells
	Inhibiting growth of Zr-75-1 breast cancer cells
	Modulating normal mammary gland growth, function and remodeling
	Antiproliferative and apoptotic effects
	Inhibiting angiogenesis and telomerase activity
	Inhibiting of adhesion molecule (e.g. ICAM-1 and VCAM-1) Expression and monocyte cell adhesion

**HYDROCARBONS IN RICE BRAN OIL**

**Squalene:**



Oil	Squalene (%USM)
Rice bran oil	11.75
Palm oil	1.8-2.3
Olive oil	0.5-0.65
Walnut oil	2.83

Functions:	
Oxygen carrying	Anti-cancer
Anti-oxidative	Anti-radiation
Hypolipidemic	Anti-bacterial
Hepatoprotective	Anti-fungal
Cardioprotective	Other effects

**PHOSPHOLIPIDS IN RICE BRAN OIL**

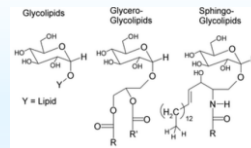
	16:0	18:0	18:1 n-9	18:2 n-6	18:3 n-3
Soybean PC	20.5	4.9	20.2	48.9	5.5
Rice Bran PC	22.1	1.8	41.8	31.8	2.5
Rice Lyso-PC	18.2	1.5	43.5	35.1	1.7

PC: Phosphatidylcholine

**Main Functions as Structural Lipids:**

- Forming the cell membrane
- Regulating cellular activities
- Joining circulation delivery system

**GLYCOLIPIDS IN RICE BRAN OIL**



**Glycolipids:** Glycosphingolipids and Glycoglycerolipids

**Main Functions:**

- Anti-oxidant, anti-virus, anti-bacterial, anti-inflammatory, anti atherosclerosis, Anti-inflammatory, anti-cancer, anti-tumor, immune activity, etc

**POLICOSANOLIN RICE BRAN OIL**

Wax → Policosanol (main C30, C28)

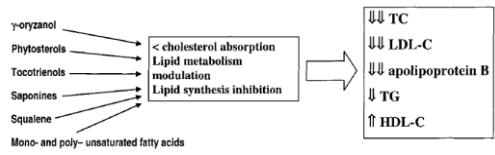


**Functions:**

Anti-fatigue . potent antioxidants, promote proper arterial endothelial cell function, inhibit platelet aggregation and thrombosis, and serve as effective treatments for intermittent claudication.

**NUTRACEUTICAL SYNERGISM AMONG BIOACTIVE COMPOUNDS**

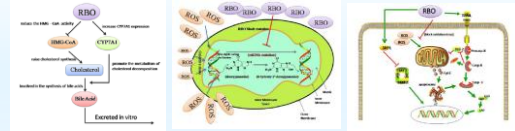
- RBO is a nutraceutical oil of multi-bioactive synergism
- The pigments bioactivities in coloured rice bran synergize with the bioactives in normal rice bran
- RBO blended with other oils eg. olive oil etc
- RBO with other nutraceutical foods
- Concentrated or refined RBO bioactives with other bioactives
-



Main effects of RBO components on plasma lipid pattern.

Cicero, et al. 2001

Current Studies on Nutraceutical Mechanisms

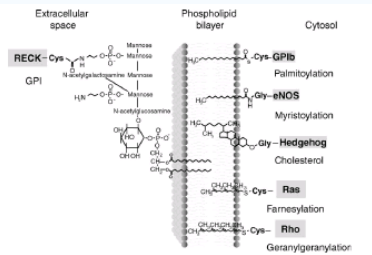


Hypercholesterolemia inhibition mechanism

Antioxidation mechanism

Anticancer mechanism

LIPIDOMICS AS A POWERFUL TOOL TO STUDY NUTRACEUTICAL MECHANISM



Ferri N, et al. Biomarkers, 2005

New Publications of RBO R&D in 2018

Banerjee, N., Chatterjee, S., Bhattacharjee, S., Bhattacharya, B., De, S. and Mukherjee, S., 2018. Rice bran oil consumption: Cardiovascular disease and obesity risk reduction. *Journal of Pharmacy Research* 61, 12(3), p.402.

Yulianto, R. and Xuan, T.D., 2018. Antioxidant and Allelopathic Activities of Rice (*Oryza sativa* L.) Bran. *Journal of Horticulture and Plant Research*, 1, p.26.

Kurtys, E., Eisel, U.L., Hagerman, R.J., Verkayl, J.M., Broersen, L.M., Dierckx, R.A. and de Vries, E.F., 2018. Anti-inflammatory effects of rice bran components. *Nutrition reviews*, 76(5), pp.372-379.

Sivamaruthi, B.S., Kesika, P. and Chaiyaset, C., 2018. A comprehensive review on anti-diabetic property of rice bran. *Asian Pacific Journal of Tropical Biomedicine*, 8(1), p.79.

Ha, S.J., Park, J., Lee, J., Song, K.M., Um, M.Y., Cho, S. and Jung, S.K., 2018. Rice bran supplement prevents UVB-induced skin photoaging in vivo. *Bioscience, biotechnology, and biochemistry*, pp.1-9.

Moreau, R.A., Nyström, L., Whitaker, B.D., Winkler-Moser, J.K., Baer, D.J., Gebauer, S.K. and Hicks, K.B., 2018. Phytosterols and their derivatives: Structural diversity, distribution, metabolism, analysis, and health-promoting uses. *Progress in lipid research*.

SUMMARY & FURTHER WORK

- Further to understand the nutraceutical characteristics of RBO
- To fully use more rice bran for producing more RBO
- To improve the processing technology of RBO and its other products
- Further to study the RBO nutraceutical mechanism
- To fully take the unique nutraceutical roles of RBO
- To maximize the RBO nutraceutical functions by synergism with other bioactives
- To balance the dietary intakes of RBO with other foods
- To improve and optimize the local dietary patterns

Thanks!