Waste to Wealth Creation- Story of Rice Bran Oil Industry

By

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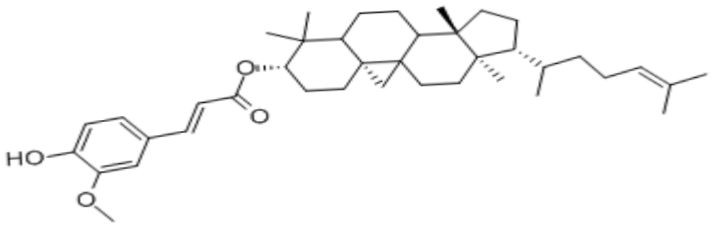
Why rice bran oil?

- It is the **Oil of Asia**
- **China** is the world's largest paddy producer followed **by India, Bangladesh, Japan,** etc.
- **India is the largest producer of crude rice bran oil-around 10.5 Lakh Tonnes per year**
- Rice bran oil is also an excellent source of poly- and mono-unsaturated fatty acids - t **"good fats"**
- **SFA : MUFA : PUFA (1:1.3:1) as recommended by WHO (1:1.5:0.7) and AHA (1:1:1)** is a ve important basic consideration at any fat intake for maintaining the best LDL/HDL ratic RBO very near to it
- Rich in anti-oxidants and nutraceuticals like oryzanol, toco-trienol, tocopherol, phytosterols, squalene etc.

Excellent cooking and salad oil

Enriched with Nutraceuticals

- Gamma-oryzanol, a mixture of ferulic acid esters of sterol and triterpene alcohols, present in rice bran oil at a level of 1 to 2%, where it serves as a natural antioxidant
- Tocotrienol, Tocopherol, squalene, and phytosterols like ß-sitosterol, campesterol, stigmasterol, cycloartenyl ferulate, 24-methylenecycloartanyl ferulate, and campesteryl ferulate
- Presence of all these components makes RBO an excellent source of nutraceuticals.



Chemical *vis-a-vis* Physical Refining

- **High FFA content restricts use of caustic soda during chemical refining** – Huge Processing Loss – Highly Polluting
- **High loss of important minor components like oryzanol , phytosterols etc.**

Due to addition of alkali

Refiner's Nightmare

- <u>Physical Refining is the Preferred Route for Refining of Rice Bran Oil</u>

More Stringent Pre-treatment Protocol

- ❖ Phosphorus content should be less than 5 ppm
- ❖ High vacuum during bleaching and deodorization
- ❖ Low Peroxide value
- ❖ Higher Bleachability

Degumming – A crucial need

Presence of gum:

- Leads to oil entrapment
- Leads to inefficient bleaching
- Foaming leading to operational hindrance
- Leads to dark colour generation during deodorization and deacidification
- Leads to entrapment and loss of important minor components

Remedies: Enzymatic Degumming

IICT Developed a Process

Chakrabarti *et al.* US Patent No. 7494676 B2

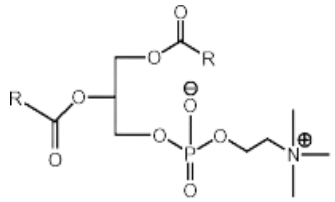
Rice Bran Lecithin & Lyso- lecithin

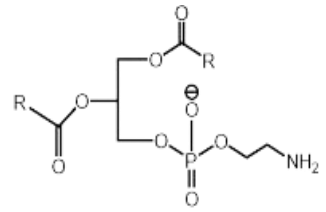
- India alone produces about 10.5 lakh tons of rice bran oil – followed by other Asian countries
- About 22,000 tons potential for rice bran lecithin in India itself
- No industry is producing good quality rice bran lecithin
- Extra-ordinary potential to exploit rice bran lecithin globally as it is superior to soybean lecithin with low PUFA load and enriched with nutraceuticals like oryzanol
- Main issue is the reduction of hexane insoluble in rice bran oil gums – There are innovative solutions – CSIR-IICT is currently working to produce edible-grade rice bran lecithin
- Recently Soybean Lecithin cost has gone up to Rs 550/- (from Rs 70/), and industry is showing interests about rice bran lecithin

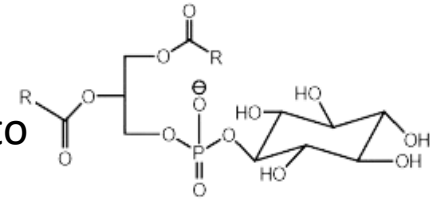
Lecithin	Fatty acid (wt %)				
	16:0	18:0	18:1	18:2	18:3
Soybean Lecithin	20.5	4.9	20.2	48.9	5.5
Rice bran Lecithin	22.1	1.8	41.8	31.8	2.5
Rice bran Lyso lecithin	18.2	1.5	43.5	35.1	1.7

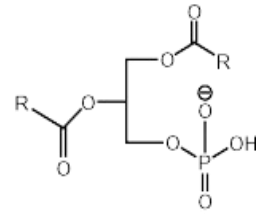
Processes developed for RBL production, upgradation, & modification

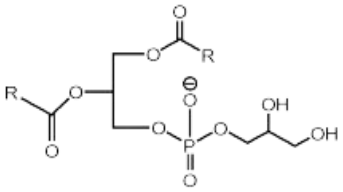
✓May replace soya lecithin significantly and reduce import burden
✓Unlike soya lecithin, RB Lecithin is a non-GM source- derivatives can be used in pharmaceutical/ cosmetic formulations


Phosphatidylcholine (PC)


Phosphatidylethanolamine (PE)


Phosphatidylinositol (PI)


Phosphatidic acid (PA)


Phosphatidylglycerol (PG)

Collaborative work with Industry

- Membrane Filtration followed by multistage centrifugation was done at a laboratory to remove bran fines and other impurities
- Use of bleaching agents could slightly **reduce the colour of lecithin**

Since this is an entirely new raw material, separate specifications may be required.

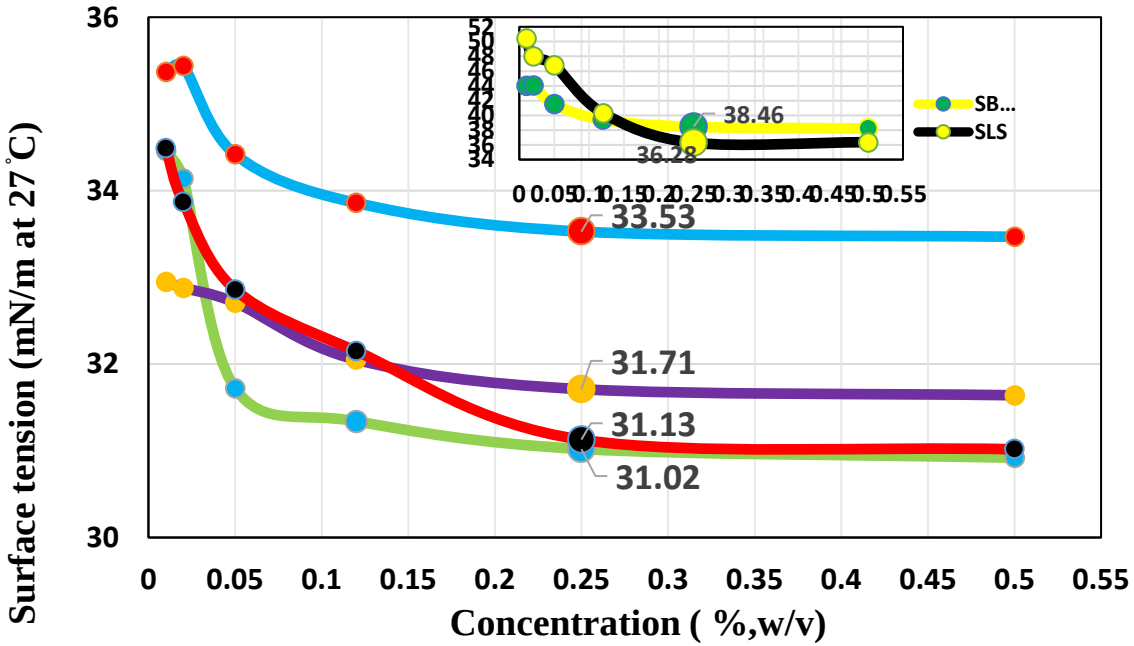
- A process developed for the reparation of **PC 35 and PC 50** (Lecithin enriched with Phosphatidyl Choline) using crude rice bran gums- pharmaceutical, nutraceutical & cosmetic industry
- Process developed to produce **powdered lecithin-** food and paint industry
- Process was also developed for the preparation of **acetylated rice bran lecithin** and the properties were evaluated- bakery and paint industry

Rice Bran Lecithin & Lyso- lecithin

By-product of Rice Bran Oil Enzymatic Degumming Process

- 100 TPD Plant produces around 1 to 1.5 Tons of Lysolecithin
- Contains Less Oil (15-25%) – Difficult to Convert into Soap
- Potential Applications – Surfactant, Poultry feed

Variation of Surface Tension



The coloured lines in graph represents RB-Lyso lecithin derivatives

RB Lyso-lecithin as a Source of Energy in Broiler Chicken Diet

Collaborative Studies with Project Directorate on Poultry (ICAR)

- Proved as Good Energy Supplement in Broiler Chicken Diet

Trt. No	Gum % in diet		Body weight (g)	
	0-21 days	22-35 days	21 days	35 days
1	0	0	687.1	1388.2
2	0	2.5	677.5	1391.5
3	0	5	709.7	1421.7
4	2.5	0	760.0	1411.9
5	2.5	2.5	752.5	1457.0
6	2.5	5	741.8	1498.6
7	5	0	766.7	1490.6
8	5	2.5	767.6	1519.1
9	5	5	767.0	1502.5

- British Poultry Science, **52 (2011) 769-774**

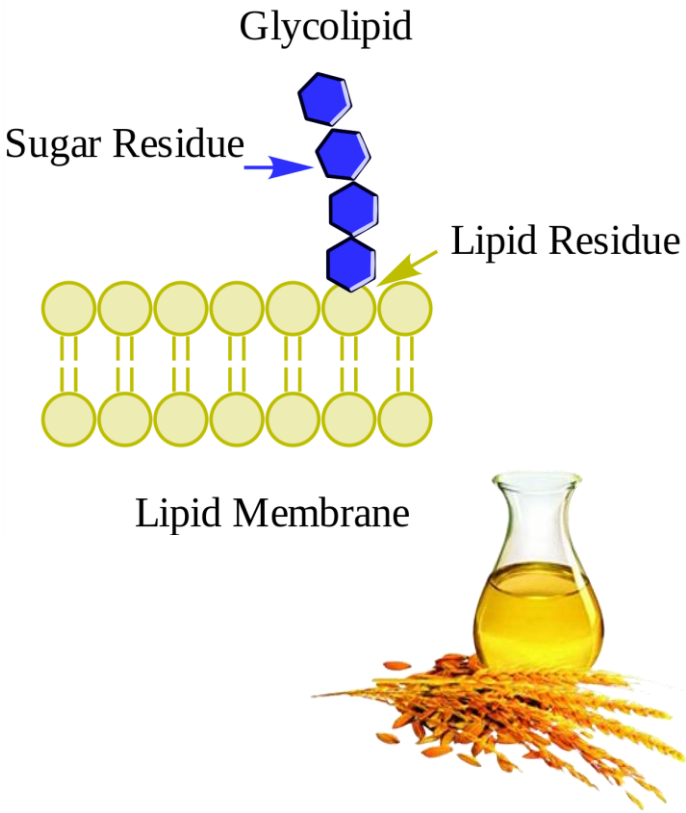
It increases the weight of eggs and feed efficiency in laying hens. It also shows higher body weight of broilers' chickens in the initial period because of improved fatty acid digestibility.

Rice Bran Oil – Glycolipid isolation

1. A process was developed for the isolation of a glycolipid enriched fraction from rice bran oil dewaxing/degumming steps.
2. A process was also developed wherein the glycolipid fraction is purified to obtain Substantially pure glycolipids.
3. A process wherein the glycolipid fraction is purified by column chromatography.

The Major Advantages of Present Invention :

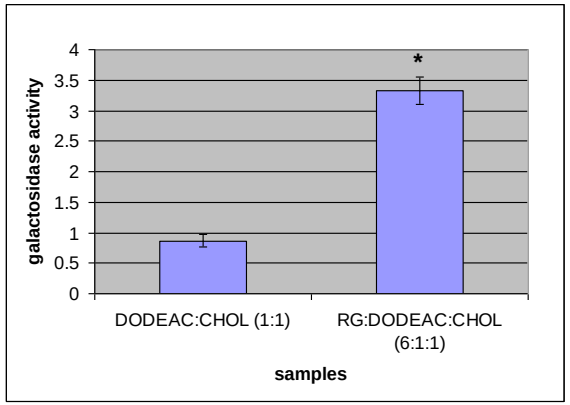
1. The process uses a low-value byproduct to recover a high-value product.
2. The process is simple, cost-effective, and does not involve any costly chromatographic steps as in conventional processes for the isolation of glycolipids.
3. The process can easily be exploited commercially as it does not entail high capital costs.
4. The recovery of glycolipids is quite high and is in the 70–80% range.
5. The recovered product can be utilized in cosmetics/ pharmaceuticals/food formulations.



Patent No.: US 6,953,849 B2

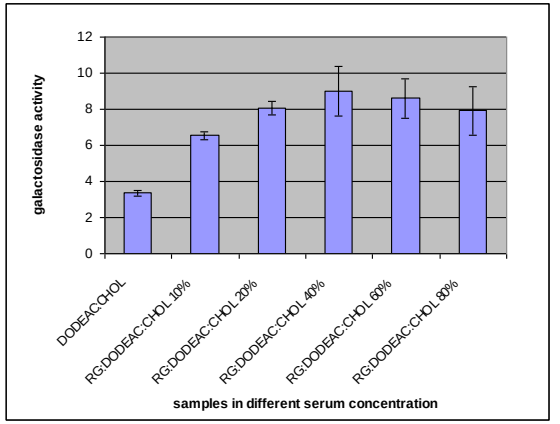
Rice Bran Oil - Glyco- & Phospholipids

Cocktail mixture of glycolipids and phospholipids isolated from rice bran gums was supplemented to DODEAC: CHOL/ DNA lipoplex and delivered to A549, human lung cancer metastatic cell line and in case of breast cancer cell line, MCF-7



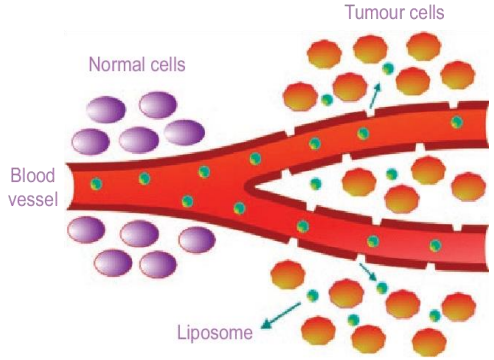
Formulations having glycolipid-phospholipid cocktail mixture (RG) along with regular cationic lipid could achieve more gene transfection in both the cell lines

Enhanced transfection efficiency of RG-associated lipid –DNA complex is maintained even at a serum conc. Of 80%, which is much higher than the normally permitted serum concentration, as lipid/DNA generally tends to collapse at high serum conc.



RG showed specific affinity toward cancerous cells

Scopes for developing cationic lipid-based gene delivery systems for delivering polyanions, polypeptides, etc to cancer cells, especially specific to lung and breast cancer cells.



US Patent No. 9763881

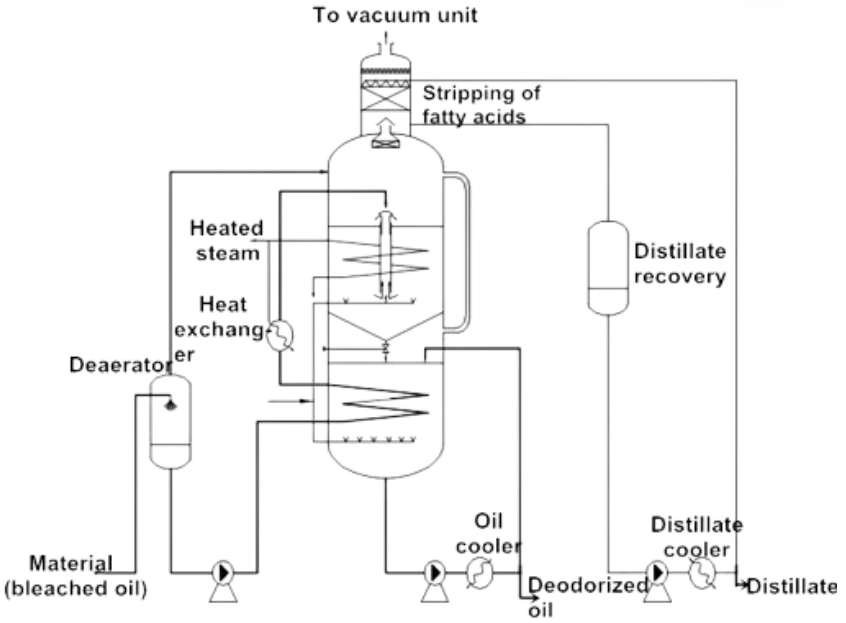
ICRBO, April 23rd, 2023

Recovery from RBO De-odourizer

- Rice bran oil de-deodorizer distillate – might not be a very good source for tocopherols, tocotrienols, etc

- However, technologies are still under various stages of developments

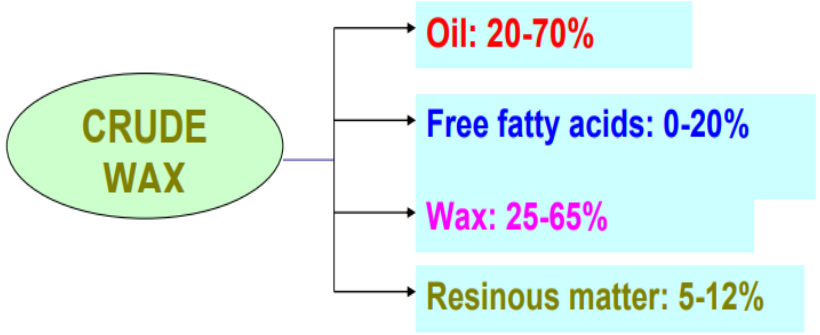
In order to recover the high-value molecules from this step, there are some issues that need to be taken care of as such:

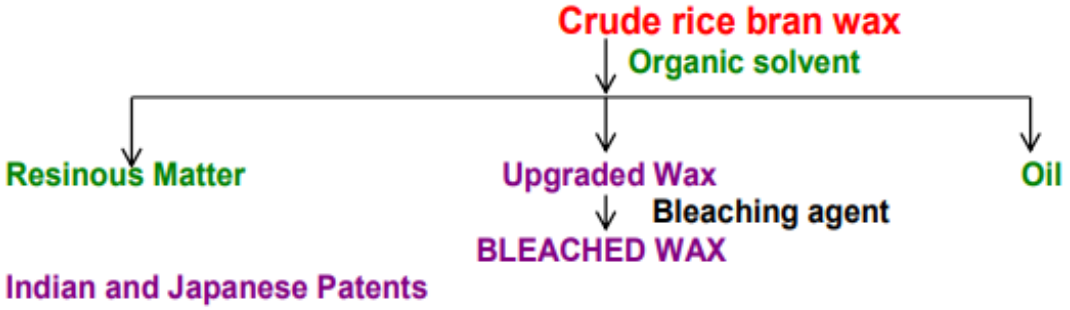


Deodorization/Deacification Issues & Remedies

- < 5 ppm of ‘ P’ content
- Proper design of Deodorizer/Deacidifier – Heat Transfer and Heat Recovery
- Fixing Deacidification temperature - Avoiding trans- and 3-Mcpd (**3-monochloropropane-1,2-diol)** formation
- Material of Construction – SS Preferred
- High vacuum system

Rice bran Wax





Applications:

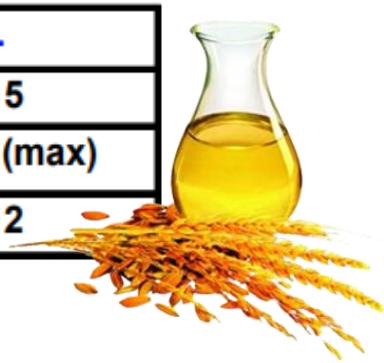
Paper coating, Polish (floor, furniture, shoe), Fruit & Vegetable coatings, Adhesives, Greases, Electric insulation, Waterproofing, Lubricants, Carbon paper, Printing inks, Typewriter ribbons, Textile & Leather sizing, Candles, Cosmetics, Chewing gums, Pharmaceutical

COMPOSITION OF POLYCOSANOL / OCTACOSANOL

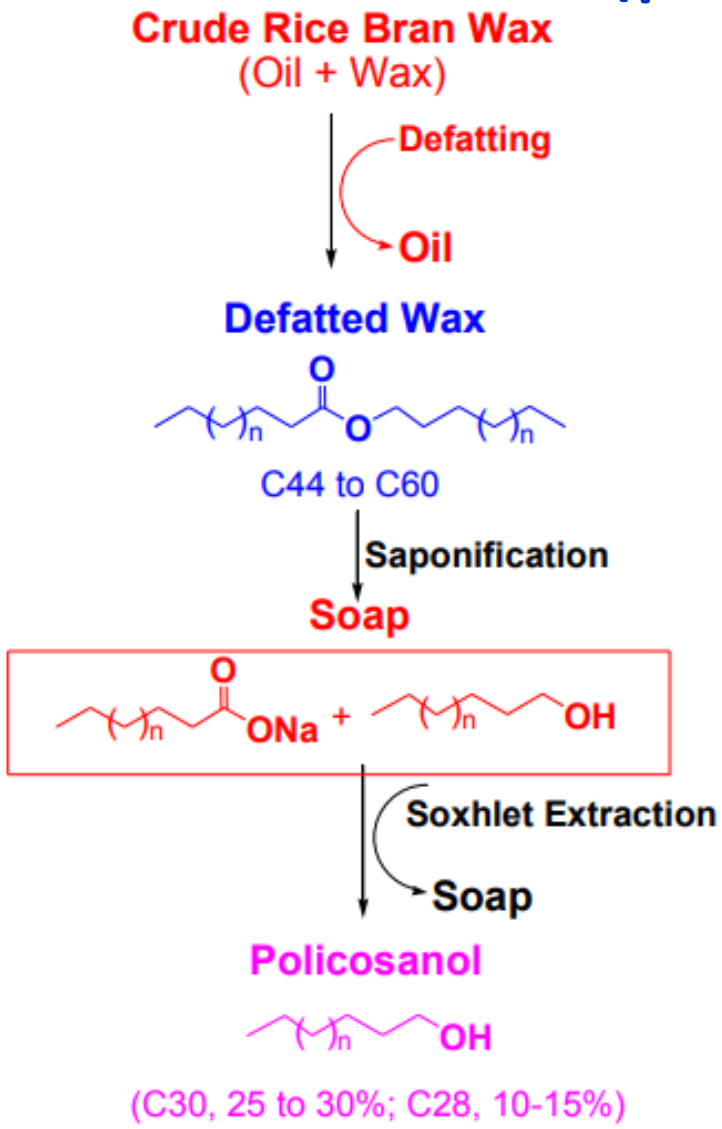
		Sugar Cane Wax	Rice Bran Wax
1-Octacosanol	-	60-70	15-20
1-Triacontanol	-	10-15	25-30
1-Dotriacontanol	-	5-10	15-20

PHYSICAL AND CHEMICAL CHARACTERISTICS

	M.P. (°C)	A.V.	S.V.	I.V.
Bleached rice bran wax (IICT-H)	79-80	0-5	75-90	8-15
Rice bran wax (FDA specifications)	75-80	20 (max)	75-120	20 (max)
Carnauba wax	83-86	3-8	72-85	8-12



Process for triacontanol / octacosanol (policosanol) from rice bran wax



- **Triacontanol is useful for stimulating growth in a wide variety of plants, including agricultural crops such as corn, soybean, wheat, rice, and tomatoes**
- Oral preparations containing 0.5-5% of a mixture of higher fatty alcohol formulations were reported to be useful for the treatment of hypercholesterolemia and hyperlipoproteinemia
- **Octacosanol can block the formation of cholesterol in the liver**
- In addition to preventing the formation of cholesterol, octacosanol can also help to clear the blood of "bad" cholesterol that is already present

Oryzanol

- Crude rice bran oil contains 1-2% of Oryzanol
- Rice bran oil soap-stock, a **by-product in RBO chemical refinery contains 3-4% of Oryzanol**
- Soap-stock contains gums, waxes, pigments etc. – **difficult to handle**
- CSIR-IICT along with a leading industry developed technology to isolate oryzanol in enriched form from such complex matrix

- **Technology Transferred to AP Organics, Dhuri, Punjab**
- **Collaboration with ICMR-NIN for pre-clinical studies**
- **Funding from BIRAC (DBT) for the establishment of a Commercial Plant**
- **Producing 100 kg/day**
- **Sold with the trade names of Ricela – Available on Amazon/Flipkart**

Ricela Gamma Oryzanol 150mg, 60 Capsules (1 month pack) | For Healthy Cholesterol level and Heart

Visit the Ricela Store

4.3 ★★★★☆ 107 ratings

-40% ₹599 (₹9.98 / count)

M.R.P.: ~~₹999~~

prime

Inclusive of all taxes

With **Amazon Business**, you would have **saved ₹3,157.52** in the last year. Create a free account and **save up to 11%** today.

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List of Patents of Centre for Lipid Research, CSIR-IICT, Hyderabad, India On Refining of Rice Bran Oil and Value-added Products from Processing By-products of Rice Bran Oil

RICE BRAN OIL PHYSICAL REFINING	Enzymatic Degumming of Rice Bran Oil using Phospholipase A1	Ind. Pat: 228300 (2006) US Pat: 7494676 (2009) Jap. Pat: Application pending China Pat: ZL03826393.9-356076 Indonesia Pat: IDP0033123 Vietnam Pat: 1-0008605
SOAPSTOCK / ACID OIL	Isolation of Gamma oryzanol from Rice Bran Oil Soap-stock	US Pat: 6,410,762 (2002) Jap. Pat: 4170599 (2008) Ind. Pat: 231670 (2009)
RIC BRAN WAX	Upgradation & Bleaching of Crude Rice Bran Wax	Ind. Pat: 228674 (2009) Jap. Pat: 4125532 (2008)
	1-Triacontanol from Defatted Rice Bran Wax	Ind. Pat: 184307 (2001)
SYNTHETIC ORYZANOL	Preparation of Phytosteryl Ferulate (Equivalent to Natural Oryzanol)	Japan Pat: 5730789 (2015) Ind. Pat: Application pending (2009) China Pat: Application pending (2011) US Pat: Application pending (2013)
LECITHIN	Acetylated Lecithin	US Pat. No.: 6,403,344 (2002) Ind. Pat.: 227530 (2009)
	Hydroxylated Lecithin	US Pat.: 6638544 (2003) Ind. Pat.: 199806 (2006)
GLYCOLIPID	Isolation of Glycolipids from Rice Bran Oil Gums	Indian Patent 230570 (2009) US Patent Number 6,953,849 (2005) ❖Gums GGG
	Specific Rice Bran Glycolipid and Phospholipids associated with Cationic Lipid Formulations	Indian Pat: Application pending (2012)s

Acknowledgment to all my present and former colleagues and students at CSIR-IICT

Take-home Message

- ✓ A lot of initiatives for the Exploitation of Value-added Products from Rice Bran and Rice Bran Oil has been taken
- ✓ Some Products have already **been in the Market**… However Long Way to Go…
- ✓ Rice Bran Oil R&D is full of **Challenges and Opportunities- Generation of wealth from by-products being the most important**
- ✓ **Integrated Technology Management** is Essential for the Production of High-Quality Rice Bran Oil and Value Added By-products from Rice Bran Oil refinery by-products
- ✓ **Forming a consortium – industry, research organizations and forums like IARBO**
- ✓ Development of **Feasible Technologies- propagation through Professional Bodies**

Thank you

Sustainable Technology Development for generating wealth from waste

ICRBO, April 23rd, 2023