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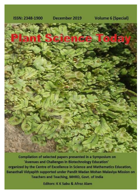

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Review Article

SPECIAL ISSUE on Current Trends in Plant Science Research

Composition, production, physicochemical properties and applications of lecithin obtained from rice (*Oryza sativa* L.) - A review

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Abstract

Rice bran oil is a rich source of lecithin and has many beneficial effects on human health. Apart from phospholipids (1-2%), different nutrients like γ-oryzanol, ferulic acid, phytosterols and vitamin B are also present in rice bran oil. These impart emulsifying property, anti-spattering property etc. and therefore, serve as potential nutritional food and nutraceutical. This review describes the composition, production, physicochemical properties, separation of individual phospholipids from rice bran lecithin and its applications in food industry. It is difficult to handle as compared to soyabean lecithin due to the problem of wax entrapment during the isolation of gums. It is characterised on the basis of physicochemical properties viz. solubility in acetone and hexane, colour, peroxide value, moisture content and acid value. Rice bran lecithin can serve as an excellent substitute to the available lecithins as it is non-GM and its nutritional and fatty acid composition imparts many properties which help it to find applications in the food industry. Future work must focus on proper processing of rice bran oil so that the lecithin obtained during processing is of high quality so that it can pave a way in the food sector.

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Introduction

Lecithin was first isolated from the egg yolk by Gobley in 1846 (1). He coined the term "lecithin" in 1850 and from *lekithos* (Greek word), which means egg yolk (1). Lecithin refers mainly to phosphatidylcholine and is a mixture of various other phosphatides which show colour variation (light to dense reddish brown); the consistency of lecithin varies from fluid to semi solid liquid. Lecithin has been described as "A combination of different phospholipids (PLs) removed from the foods of different origins (animal or vegetable) having at least 60% of acetone-insoluble substances" (2). Phospholipids are the biochemical intermediates involved in functioning and growth of cells in plants. Phospholipids are present in almost all the cells of the body. Phosphatidylethanolamine (PE), phosphatidylcholine (PC), phosphatidylinositol (PI), phosphatidylserine (PS), sphingomyelin and some other glycerol phospholipids are present in different amounts in lecithin. Lecithin products of animal origin are obtained from eggs and milk. Vegetable lecithins are obtained mainly from the oil seed crops like kernels of sunflower, rapeseed and soyabean (3). During the processing of crude vegetable oils, a gummy substance known as lecithin is removed during the degumming step.

Lecithins have a wide range of applications globally, namely as: releasing agents, wetting agents, emulsifiers, anti-dusting agents, separating agents, viscosity modifiers and instantizing agents. Apart from these, they are used as nutritional supplements and also enhance shelf-life of different food items. Phospholipids of very high purity are used as raw materials in formation of liposomes and lipid vesicles are used as mode of transport in drug delivery system (4). At present, the major sources of lecithin include soyabean, corn and sunflower oils. Among these, lecithin obtained from soyabean is the most common. The market for lecithin is fast growing and approximately 15-20% of the gums can be further converted into good quality lecithin possessing high nutritional properties and finds application in feed, pharmaceuticals and food industry (5). Since 1990's, extensive plantation of GM soyabeans has resulted in a fall in the demand of food grade lecithin at commercial level. This has led to an increase in the demand of lecithin from rapeseed and sunflower (6). Rice bran lecithin therefore, can also serve as a good alternative source for non-genetically modified lecithin. It has high nutritional value and finds application in the food industry but has remained unexplored at the commercial scale.

Rice bran lecithin

Rice bran lecithin (RBL) is a complex combination of major phospholipids including phosphatidylethanolamine (PE), phosphatidylcholine (PC) and phosphatidylinositol (PI) (Fig. 1). Apart from phospholipids, triglycerides, glycolipids, free fatty acids (FFA), sterols, oryzanol, waxes and tocols are also present as minor compounds in rice bran lecithin (2). The rice lecithin is superior to the lecithin obtained from soyabean, due to low amount of polyunsaturated fatty acids (PUFA) and presence of antioxidants such as tocotrienols, oryzanol and phytosteryl esters.

Composition of rice bran lecithin

In Asian countries, *Oryza sativa* (rice) is one of the most important staple foods for the majority of population. After processing of rice on a mill, 70% of the rice is obtained as the major product, while other by-products mainly comprise the rice husk-20%, rice bran-8% and rice germ-2% (7). Though the percentage of lipids and starch in the grains is low but they contribute significantly in enhancing the nutritional properties of rice (2). The major class of lipids present in rice are "phospholipids" which consist of two parts: i) covalently bound phosphate and ii) lipids which comprise 10% of the total lipid content of the grain. The composition of lecithin depends upon the degumming conditions and consists of phospholipids and glycolipids

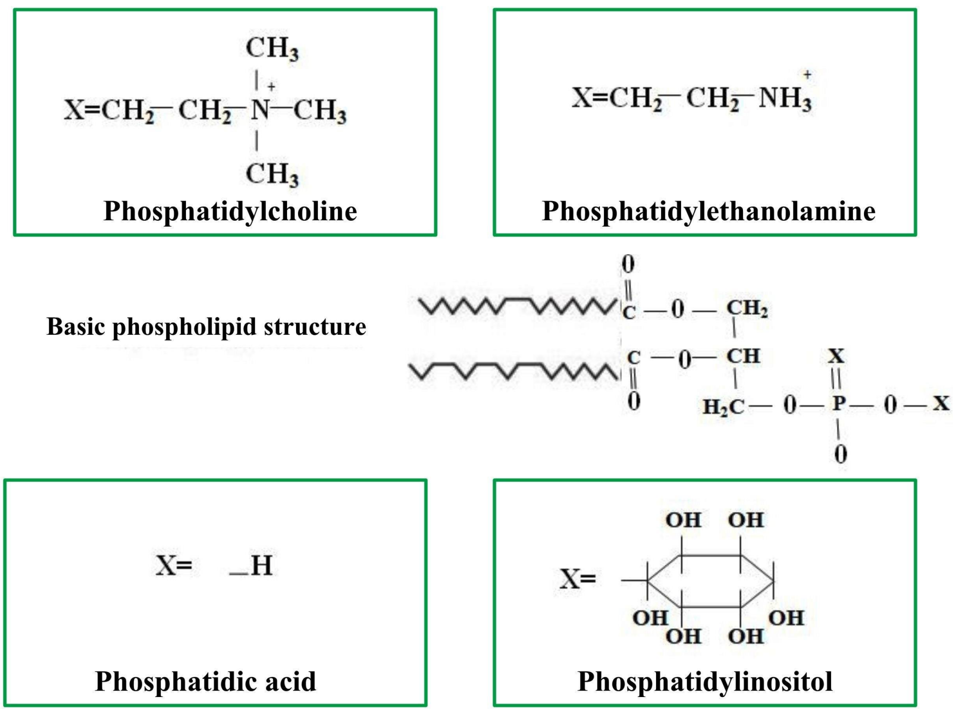

Fig. 1. Different phospholipids present in rice bran lecithin (12).

(60%) and neutral lipids (40%). The quality of rice depends on the phospholipids present in the rice bran and endosperm. These phospholipids affect properties of rice like rancidity of brown rice or paddy and also affect the physicochemical characteristics of starch (8-9).

Dietary phospholipids present in rice have potential health benefits to the majority of population in many Asian countries, where rice is the chief source of food. Apart from glycerphospholipids 1,2-diacyl-3-*O*-phospho-*O*-[6-*O*-acyl-(β-D-galacto-pyranosyl)]-*sn*-glycerol and 1,2-diacyl-3-*O*-phospho-*O*-[6-*O*-acyl-(α-D-galacto-pyranosyl)]-*sn*-glycerol were isolated from the rice bran oil (10).

Rice bran lecithin production

Degumming is used for the removal of the gums from rice bran oil. During chemical refining of crude rice bran oil, phospholipids are generally lost along with the soapstock. The recovery of these phospholipids is not feasible commercially. During the phosphoric acid degumming, the lecithin obtained is inedible due to the presence of phosphoric acid contaminants.

There are different steps for the isolation of lecithin from crude rice bran oil (Fig. 2). To optimize the production of lecithin having low amount of residual dirt, improvements are continuously made for the proper filtration of the mixture of hexane-oil miscella in the filtering units. Lecithin which is well filtered has a glossy and transparent appearance having hexane insoluble matter (HI) and toluene insoluble matter (TI) below 0.3% and iron content less than 50 ppm (11).

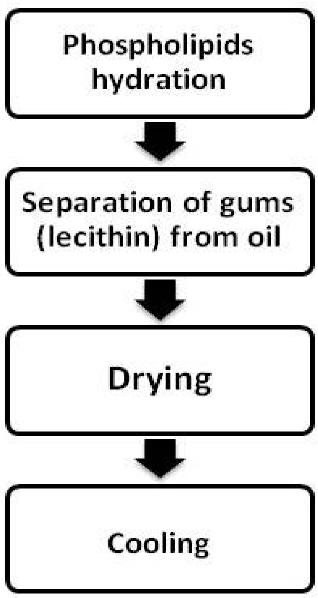

Fig. 2. Steps involved in the lecithin production (11).

The processing of rice bran lecithin involves following four main steps:

1. Hydration of phospholipids

For the hydration of phospholipids, (1-3%) water is added to the oil in the temperature range of 50º-70ºC. Hydration of phospholipids occurs in less than one hour, to form gums. Hydratable phospholipids include PC, PI and lyso-phoshposphatidylcholine whereas, phosphatidic acid and phosphatidyl-ethanolamine have low hydration capacity and are known as non-hydratable phospholipids (NHP) (11).

For the hydration of phosphatides in the preparation of rice bran lecithin, dewaxing of crude rice bran oil is done using hexane in the ratio 1:1 (v/v). The solution is stored for 4 hrs at 10ºC with occasional stirring, and then the oil is filtered to remove the wax and then desolventization of oil is done. This dewaxed oil is heated in the temperature range of 50º-60ºC and 2% (v/v) warm water (95ºC) is added with stirring at 250-300 rpm for approximately 15 min at the same temperature. Hydrated phospholipids are separated by centrifugation at 2000 rpm (12). The degumming of crude rice bran oil at 70ºC was carried out by addition of 800 ml water while stirring at 250 rpm for 30 min (13).

After water degumming, the resultant crude oil contains 50-100 ppm of residual phosphorus. In the next step, the non-hydratable phospholipids are made hydratable by citric acid superdegumming (14) or by enzymatic degumming using enzyme phospholipase A1 or A2 (15). The resultant oils contain the residual phosphorus in the range of 5-10 ppm. During enzymatic degumming, by-product obtained is lysolecithin. Lyso-gums are easily separated by centrifugation (16). Enzymatic degumming is less preferred for the production of the lecithin due to economic and technical factors.

For degumming, different methods are used, namely water degumming and acid degumming using oxalic, phosphoric, tartaric, citric acid etc. (17). Since 1976, many methods for degumming have been proposed by various researchers. The methods included water and acid as the source of degumming. In the acid degumming method, the crude oil is treated with water (95ºC); dilute acids like citric acid or phosphoric acid or a combination thereof are used in acid degumming method for removal of gums, waxes and some other impurities. This method is generally referred to as an operational method for the purification of different seed oils, having impurities in the dissolved or colloidal form. Super degumming method and total degumming process (TOP) are unique degumming processes and are applicable to only water degummed oil and crude oil (18). Enzymatic degumming is the widely used method (16).

Use of membrane technology in the degumming process

Membrane technology serves as a tool to minimise the loss of oil during the conventional refining process (Table 1). Using this tool, a detailed and critical study was carried out in the refining of crude rice bran oil (19). For the treatment of rice bran oil, conventional degumming methods (water and acid) along with membrane technology were used as conventional methods are not adequate to produce oil with low phosphorus content. Membrane based technology is environment-friendly, cost-effective and an efficient process for the phase separations.

Table 1. Different degumming methods for rice bran oil

S.No.	Method
1.	By varying the amount of water and also varying the temperature, time and rate of agitation degumming of crude vegetable oils was done (31).
2.	Acid degumming was done using surface active compounds like sodium oleate and lauryl sulphate which have been shown to have less amount of phosphorus as compared to water and phosphoric acid (32).
3.	A unique degumming process TOP, was used which showed Fe <0.2 ppm and <5 ppm residual P in the total degummed oil (18).
4.	Water degumming was done which resulted in the permeate having 20-30 ppm phospholipids (20).
5.	Enzymatic degumming leads to the decrease in the quantities of acid and base used, increase in the yield of product, and decrease in the operational costs (33).
6.	After water degumming, the oil contained residual phospholipids in the range of 80-200 ppm (34).
7.	Enzymatic degumming of vegetable oils was carried out using the enzyme phospholipase- Lurgi'senzymax process (35).
8.	There was reduction in the phosphorus content (<5 ppm) after enzymatic degumming of rice bran oil (16).
9.	Non-hydratable phospholipids were removed from oil by using an electrolyte after water degumming (36).
10.	*F. oxysporum / T. lanuginosus* lipases possess a unique degumming characteristic. It hydrolyses phosphatides at temperature greater than 40 degree centigrade (37).
11.	At high temperature it becomes difficult to remove non-hydratable phospholipids as they cannot precipitate in water or form gels, therefore enzymatic degumming was applied to remove NHPL as it forms a complex with enzyme (38).
12.	Super degumming was applied to reduce the content of phosphorus to 30 ppm (39).
13.	To decrease the content of phosphorus from 350 ppm to 86 ppm in oil phase, acid degumming was used using phosphoric acid at conc. of 3.5 kg/ton (40).

Ultrafiltration and nanofiltration are used for the separation of phospholipids from triacylglycerols in the miscella stage. Application of inorganic ultrafiltration membrane reduced the phosphorus content from 2 to 0.02% under oil hexane miscella (20). Hexane resistant membrane for degumming of miscella led to reduction in the phosphorous content to less than- 10 ppm in the residue (21).

Due to wide range of chemical inertness, pH tolerance and ease of cleaning, ceramic membranes are considered superior than the polymeric membranes in the simultaneous dewaxing and degumming of crude rice bran oil (22). After the simultaneous degumming and deacidification using membrane processing, the monoglycerides were almost untraceable. After processing, the content of diglycerides remained unchanged. In achieving the economic benefits of physical refining of crude rice bran oil, use of non-porous membranes in the pretreatment step is advantageous (10). Refining was carried out and enrichment of γ-oryzanol in rice bran oil through optimization in solvent extraction system through nanofiltration (23).

2. Separation of gums (lecithin) from oil

The gums are separated from the oil by centrifugation at an optimum temperature. The hydrated phospholipids are separated from rice bran oil by centrifugation of the mixture at 2000 rpm for 10 min (12). By adjusting the optimal backpressure conditions of the centrifuge, efficient degumming of oil is achieved; having approximately 0.3% non-hydratable phospholipids and lecithin gums are also obtained with less amount of oil (30-39% oil on dry basis). Hexane fractionation is used for removal of the insoluble impurities by dissolving lyso-gums in hexane (1:10 w/v) (24). The composition of the gums is as follows: water-50%, acetone insoluble fraction-33% (minimum) and oil-17% (maximum).

3. Drying

In this step, the lecithin is dried to obtain less than 1% moisture content, long shelf life and fluidity. Different methods are used for drying of the wet gums which include semi-batch, batch and continuous drying film evaporators. The advantage of using film evaporators is short drying time of one to two minutes, to achieve a good quality material.

The wet sludge of gums obtained from the crude rice bran oil (2-5 kg) is dried by using roller drum driers. The lecithin obtained after drying process is dark in colour as oxidation takes place during the drying process (13, 25). Batch drying for a prolonged time often results in the intense darkening because of the occurrence of Maillard reaction of the adherent sugars and the Amadori reaction which occurs between sugars and phosphatidylethanolamine (3).

Dark coloured lecithin is obtained when the dried gums are cooled. The main pigments present in the rice bran lecithin are chlorophyll and carotenoids. Apart from these pigments brown pigments and porphyrin are also present (26). The colour of rice bran lecithin can be removed with the help of the bleaching agents, viz, sodium chlorite, hydrogen peroxide and benzoyl peroxide (27). During the process of drying, the gum viscosity increases rapidly, having residual water in the range of 5-15%. This occurs due to the alteration in the arrangement of the phospholipids aggregates during transition (aqueous to oil phase). Further drying to obtain 1% moisture content decreases the viscosity and provides a stable shelf life. The process conditions include: (a) heating temperature of 90–100ºC, (b) rotor–stator gap of 1–2 mm, (c) residence time of 1–2 min and (d) vacuum of 50–200 Torr.

4. Cooling

To prevent post-darkening of rice bran lecithin, it should be cooled below 50ºC. It is advisable to use the heat exchanger immediately after the drier. Else, even after cautious drying, post-darkening will occur in the slow cooling regime from 90–100ºC to ambient temperature. A temperature of around 40ºC and dry conditions are suggested for bulk storage of lecithin. To keep lecithin homogeneous, it is advisable to use suitable tanks having stirring facilities and temperature of 20–30ºC. These conditions help to maintain the quality of the product and its functional properties.

Physicochemical properties of rice bran lecithin

The major physicochemical properties of rice bran lecithin include acetone insoluble matter (%), hexane insoluble matter (%), moisture (%), acid value (mgKOH/g), colour (Gardner scale and Lovibond units), peroxide value (ppm) and oryzanol content and other nutritional components (%) (28).

Acetone insoluble matter

Oils and other fatty acids are acetone soluble; however, phospholipids, carbohydrates and glycolipids are acetone insoluble. For determining the quantity of various phospholipids different techniques like High Performance Liquid Chromatography-Evaporative Light Scattering Detector (HPLC-ELSD) and Nuclear Magnetic Resonance (NMR) are used.

The Ja 4-46 method given by American Oil Chemists Society (AOCS), 2017 is available for the determination of acetone insoluble matter. Acetone insoluble (AI) matter represents the phosphatides or phospholipids and is expressed in terms of percentage (%).

In rice bran lecithin, the acetone insoluble matter lies in the range of 40-60%. The reported AI matter in rice bran lecithin is 43.5% (11) and 50-60% (28).

Rice bran oil also contains some amount of wax, which is insoluble in acetone and accompanies the phospholipids. The wax influences the emulsifying property of lecithin (13).

Hexane insoluble matter

Hexane insoluble (HI) property denotes the amount of substance insoluble in hexane under test conditions and signifies the purity of lecithin and its products. Residual fibre and some contaminants are mainly present in the hexane insoluble matter. The level of HI should be less than 0.3%. For rice bran lecithin, the amount of hexane insoluble matter is 0.11% (13) and 1-3% (28).

Moisture content

Moisture content is represented in terms of percentage (%). The moisture content in lecithin should be less than 1%. Due to the negligible amount of moisture present in lecithin, products can be stored for longer duration with less chances of contamination. High level of moisture increases the rate of contamination and food spoilage. Karl Fisher method is used for moisture content determination. Apart from this method, different methods like distillation or oven drying at 105ºC can also be used. The moisture content in rice bran lecithin is 0.75% and 0.2-0.8%.

Acid value

Acid value is an important characteristic and is defined as the amount of potassium hydroxide (milligrams) required for the neutralization of free fatty acids present in one gram of sample. The presence of PLs and free fatty acids contribute towards the acidity of lecithin. High acid value of liquid lecithin is due to the presence of the free fatty acid (FFA), which is added for altering the viscosity of lecithin. The process of hydrolysis releases the FFA, which is present in the hydrolysed lecithin. For rice bran lecithin, free fatty acid is expressed in terms of oleic acid. In dried lecithin, the reported acid value is 20.9 (13), 20.8 (12), 37.0 (27) and 25-35 (28).

Colour

To determine the quality of standard lecithin, colour is considered to be an important characteristic. Lecithin with dark colour is not preferred by the users. Earlier in the United States, lecithin was categorised on the basis of bleaching, viz. (a) unbleached (b) single-bleached (c) double-bleached. Gardner scale measures pure and uncoloured lecithin in the range of 9-17. To measure the colour of turbid lecithin toluene or hexane can be used in the ratio of 1:10. Lovibond Tintometer is also used for the measurement of colour of lecithin. The colour of rice bran lecithin is 10 (maximum) on Gardner scale (12), 60.4 (5R+Y) 1 cm cell (Lovibond units) (13) and 24.4 (5% solution) 1 cm cell (Lovibond units) (27), 18+ (on Gardner scale) and 18+ (on Gardner scale) (28).

Peroxide value

This property measures the quantity of oxygen which is chemically bound as peroxides to lecithin and is expressed in ppm (parts per million). For obtaining low microbial counts in the production of the foodgrade lecithin, the lecithin is treated with hydrogen peroxide. Lecithin's peroxide value is due to the hydrogen peroxide remaining after treatment of lecithin. The reported peroxide value of rice bran lecithin is 15.0 (27) and 15-20 (28).

Oryzanol and some other nutritional components

Oryzanol is one of the important components present in rice bran oil. Due to presence of oryzanol, rice bran oil is considered to be one of the best oils for human health. Rice bran lecithin also contains oryzanol. Apart from oryzanol rice bran lecithin also contains some other nutritional components which are extracted out in the gums during the degumming process and are present in the range of 1-2% in lecithin (28).

Composition of fatty acid of rice lecithin

Rice bran lecithin contains greater proportion of saturated fatty acids than soyabean lecithin (27), the major fatty acids in RBL are oleic acid (C18:0) (43.2%), linoleic acid (C18:1) (35.4%), palmitic acid (C16:0) (19.1%), stearic acid (1.2%), linolenic acid (C18:2) (0.9%) and myristic acid (C14:0) (0.2%) (Table 2). RBL contains more oleic acid and less linolenic acid as compared to other lecithins. Due to low levels of linolenic and linoleic acids, RBL is more resistant to autoxidation, than other lecithins.

Table 2. Fatty acid composition of rice bran lecithin in comparison with the other commercially available lecithin from different oil sources

Fatty acid	Soyabean			Rapeseed	Corn	Sunflower	Rice bran	
References	(12)	(41)	(24)	(42)	(38)	(41, 43)	(12)	(27)
C14:0	-	-	-	-	-	-	-	0.2
C16:0	10.8	20.0	21.7	18.0	22.0	15.0	18.1	19.1
C18:0	3.9	4.0	3.0	1.0	2.0	3.0	4.0	1.2
C18:1	24.2	12.0	16.7	21.0	27.0	13.0	42.8	43.2
C18:2	54.8	57.0	53.2	48.0	48.0	69.0	33.6	35.4
C18:2	6.3	7.0	5.4	7.0	1.0	-	1.5	0.9
Other	-	-	-	5.0	-	-	-	-

Separation and identification of different components from rice bran lecithin

Separation and identification of various phospholipids from rice bran lecithin was studied in detail (12). Preparative TLC was performed for separation of phospholipids into different classes using a solvent system of hexane, diethyl ether and acetic acid (80:20:1, v/v/v). The components were identified by comparison of different R_f (Retardation Factor) values against the standards of particular phospholipids. Acetone fractionation was used for the purification of the phospholipids from the crude rice bran lecithin. Crude rice bran lecithin was washed with acetone 3-4 times till deoiled pure phosphatides are obtained.

Silica gel thin layer chromatography was used to resolve the isolated phospholipids by using either of the following mixtures:

i) Chloroform (65): methanol (25): water (1) (v/v/v)

ii) Chloroform (65): methanol (25): 28%ammonia (5) (v/v/v)

iii) Chloroform (6): acetone (8): acetic acid (2): methanol (2): water (1) (v/v/v/v)

Different spray reagents were used for the visualization of the spots as follows:

1. *Iodine vapour* for unsaturated lipid materials.
2. *Ammonium molybdate-perchloric acid reagent* for phospholipids.
3. *Dragendroff's reagent* for choline lipids.
4. *Ninhydrin spray* for amino groups (primary and secondary).

To liberate the bases and inositol or glycerol and also to further confirm the identity of the phospholipids, strong acid hydrolysis was done. After this, the phospholipids were further separated into distinct classes by preparative TLC using a solvent system of chloroform, methanol and water (65:25:4, v/v/v) (11) (Table 3).

Table 3. Composition of phospholipids in rice bran lecithin (12)

	Crude rice bran oil	Dewaxed rice bran oil
Phosphatidylcholine (PC)	20.4	23.1
Phosphatidylethanolamine (PE)	17.8	20.2
Phosphatidylinositol (PI)	5.8	6.6
Phosphatidic acid (PA), LysoPhosphatidylcholine, LysoPhosphatidylethanolamine	9.4	10.8
Triglycerides	39.2	35.2
Wax	3.1	-
Carbohydrates, FFA, Sterols	4.0	3.8
Moisture	0.3	0.3

Role of dietary food lipids present in rice lecithin

Rice bran lecithin contains different nutrients which play an important role in human health. These nutrients include γ-oryzanol, vitamin B1, some acids like ferulic acid and phytic acid and others like phytosterols and dietary fibres. The polar lipids present in soyabean lecithin and rice bran lecithin have low foaming, low emulsifying and low wetting ability in comparison to the lysolecithin of rice bran (24).

A study was conducted in which phospholipids and glycolipids were isolated from rice bran lecithin and other sources of lecithin (soyabean, sunflower etc.) were used in the formulation for gene delivery along with the lipids carrying genes, to test the effectiveness for selective gene delivery to the cancer cells. The non-cancerous cells were not harmed and therefore, this formulation can be used in cancer treatment without any negative effect on the non-cancerous cells (29).

Applications of rice bran lecithin

Lecithin plays crucial role in food processing. It helps to maintain the texture of the food items like chocolate, margarine and mayonnaise and imparts property to instant foods to dissolve easily (Fig. 3). Various applications of rice bran lecithin in food industry are listed below (Table 4).

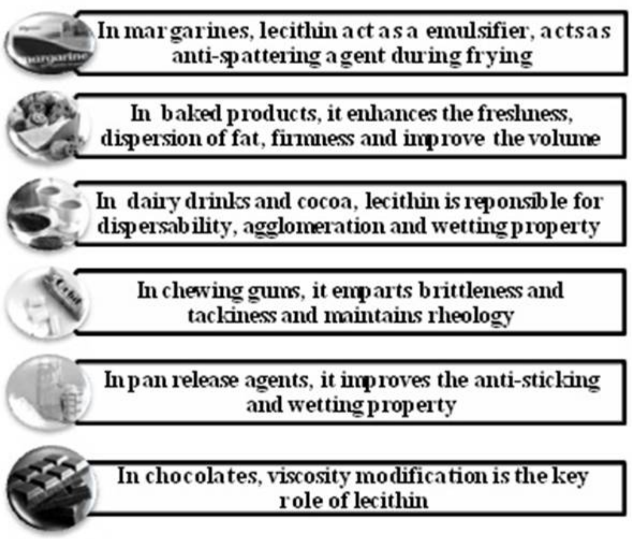

Fig. 3. The role of rice bran lecithin in different applications of food industry (24).

Table 4. Applications of lecithin

Application	References
Baking	44, 45
Beverages	46
Confectionaries	30
Emulsifier	47
Dispersing agent	48
Anti-spattering agents	49
Browning agent	50
Release agents	51
Viscosity modifier	52
Heat resistant agent	53
Aids separation of products	54
Lubricators	5, 55
Preservative in food coatings	56
Pan release agents	57
Additives	58
In liquid seasonings	59
Shortening enhancement	60
Chewing gums	61, 62
Miscellaneous applications	
• Egg yolk extender, replacements	63
• Compositions for meat curing	64, 65, 66
• Nutrient for production of mushroom	67

Margarine formulation

Margarine is an oil in water emulsion which contain less than 80% fat and 18% milk or water which is well homogenised. For the preparation of margarines, different components including lecithin are agitated at high speed with water. To make margarine suitable for use in the kitchen, rice bran lecithin is used in the range of 0.3-0.8%, which imparts anti-spattering property (3). In European countries, margarines with no or less salt are preferred. In these types of margarines, standard lecithin does not play any special role. Therefore, modified lecithins are used which include phosphatidylcholine rich fraction (0.1-0.3%), while the phosphatidylcholine and phosphatidylethanolamine ratio should be above 4.2 (3).

Bakery products

Bakery products make use of a number of emulsifiers. Rice bran lecithin is used directly or in combination with different emulsifiers in bakery products and ingredients. Lecithin is an important ingredient in bread making. It is used directly or modified lecithin is used for the enhancement of the freshness and volume of the bread, which are considered as important quality parameters. The elasticity and volume of the bread is increased due to the linkage between the phospholipids of lecithin with the gluten present in wheat through hydrogen bonds. The complexes formed between monoacylglycerols present in the α-gel and modified lecithin from rice bran play a crucial role in bread making.

In preparation of cookies, lecithin helps in the shortenings dispersion during preparation of dough. For production of light cookies, fat should be less than 30% which is achieved with the use of rice bran lecithin. To reduce the stickiness in dough, 0.5% lecithin is used (30).

In animal fodder

Foodgrade rice bran lecithins are used as emulsifiers in animal feed formulations, as choline complements and as sources of vital fatty acids. To improve the density of the feed pellets, deoiled lecithin powders and liquid lecithin are used in feed formulations. The phospholipids in lecithin are the vital nutrients for shrimps and larvae (3).

Food supplements

Since 1950, lecithin is used in various food supplements due to cholesterol-lowering property. Pure fractions of phosphatidylcholine are rapidly used as excipients viz. miscelles, emulsions and liposomes in different pharmaceutical products (3).

Conclusion

India is the second largest producer of rice. This leads to large amount of bran production. Extraction of oil from bran generates large amount of by-products with lecithin as one of the major by-products during the degumming process. Due to exceptional combination of different nutrients and a good fatty acid profile, rice bran lecithin can be an excellent alternative to other commercially available lecithins from soyabean, rapeseed and sunflower. Rice bran lecithin can find various applications in food industries after proper extraction and processing. It can also find applications in cosmetic industry due to the presence of unsaponifiable matter. Due to its excellent emulsifying property it can be used as an emulsifier in production of different nanoemulsions which can be used to transport drug molecules and other small bioactive molecules. Despite the vast potential of phospholipids present in rice bran lecithin, there are still some unexplored properties of rice bran lecithin which can be used for the formulation of surface active emulsifiers. Optimum facilities for production, availability of proper units for degumming in an oil mill are considered to be essential for the production of high quality lecithin.

Competing interests

The authors declare that they have no competing interests.

Authors' contributions

DL wrote the manuscript. NK, RPS and VS reviewed and edited the manuscript.

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