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Advances in Applied Science Research, 2012, 3 (3):1435-1439

Pelagia Research Library
ISSN: 0976-8610
CODEN (USA): AASRFC

A novel process for physically refining rice bran oil through degumming

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ABSTRACT

A new process for the physical refining of rice bran oil through combined degumming was developed on a laboratory scale. Studies were conducted to improve quality of rice bran oil by degumming to make it edible grade. Oil contains phosphatides, carbohydrates mucilages, proteins and resins as a gummy substance which impact colour turbidity and odour to rice bran oil. This investigation showen that phosphoric acid and water mixture (0.75 + 3 %) appear to be most effective degumming agent. The transmittance of oil improved from 37 to 57 % at 570 nm. The Viscosity, Unsaponification matter and melting point decrease and Iodine Value and Saponification value increased in degummed rice bran oil as compare to rice bran oil. The results of present investigation are shown to improve the quality of oil.

Key Words: rice bran oil, degumming agents.

INTRODUCTION

Annual world production of rice is approximately 500 million metric tons (MMT). Rice bran is a valuable co-product of the rice-milling industry, and its oil content ranges from 12–25% depending on the quality of the bran. The estimated annual production potential for rice bran oil is 3 to 4 MMT, but the actual annual production is far below this at 0.5 MMT, with much of it being of technical grade and mostly used for soap manufacture [1]. Owing to inferior processing conditions and lack of cost-effective technologies, the majority of the oil does not go into human consumption. Rice bran oil has a balanced FA profile and contains a host of minor constituents with proven nutritional benefits such as γ-oryzanol, tocotrienols, tocopherols, and squalene. At the same time, rice bran oil differs from other vegetable oils because of its higher FFA content along with its unusually high contents of wax, unsaponifiable constituents, polar lipids (including glycolipids), and pigments [2]. The majority of the nutritional components present in rice bran oil are destroyed or removed during traditional alkali refining. Chemical refining of rice bran oil generally results in losses that are considerably higher than those encountered with other vegetable oils [3, 4]. These higher losses are attributed to the presence of larger amounts of FFA and nonoily constituents. Refining losses can be considerably reduced using physical refining. The important prerequisite for successful physical refining is to reduce the phosphorus content in the oil to <10 ppm, as phosphorus-containing components cause color fixation in the final oil during exposure to the higher temperatures of physical refining. Water degumming is the simplest method for removing phospholipids (lecithin) from vegetable oils. However, only hydratable phospholipids can be removed during water degumming, leaving 80 to 200ppm of phosphorus in the oil, depending on the type and the quality of the crude oil and the presence of nonhydratable phospholipids [5]**.** Many refineries are

pretreating rice bran oil with phosphoric acid or an organic acid (such as citric) to remove nonhydratable phospholipids. Rice bran oil samples with varying contents of FFA have been degummed with a number of degumming agents, including water, organic acids, inorganic acids, inorganic salts, and surface-active compounds to obtain rice bran oil free of phospholipids [6]. However, these methods failed to reduce the phosphorus content to <10 ppm. Lurgi's Enzymax process (Lurgi AG, Frankfurt am Main, Germany) can also be used to convert nonhydratable phospholipids into water-soluble lysophospholipids, which are then removed by centrifugation, yielding degummed oil low in phosphorus. The Enzymax process employs phospholipase A2 isolated from porcine pancreas [7]. Microbial phospholipase has proven to be superior to porcine pancreatic lecitase and other phospholipases with respect to oil degumming performance and is suitable for degumming oil of different qualities, ranging from water-degummed to crude oil [8]. However, enzymatic degumming has only been reported for rapeseed, soybean, and sunflower oils [7,8]. FFA and phosphorus contents of crude, degummed, and bleached oils were determined by standard AOCS method [9] and standard IUPAC method [10], respectively. The removal of lipid and nonlipid components during degumming, dewaxing, and bleaching is therefore of prime importance. This investigation has focused on the removal of gummy materials under various conditions prior to physical refining, so that the quality of RBO as a final product is not impaired.

MATERIALS AND METHODS

Rice bran was obtained from rice mills at Rudrapur, Distt. Udham Singh Nagar (Uttarakhand). Allother raw materials were purchased from local market. All the reagents used in the investigation were of AR/GR grade. Rice bran oil was extracted from rice bran with n-hexane as solvent at 60º C using Soxhlet Apparatus for 6 hours. Rice bran oil contains waxes which were recovered by the hot extraction method [11, 12]. The dewaxed rice bran oil was degumming by adding degumming agents [13,14].

Specific gravity, Viscosity, refractive index of rice bran oil were determined by using Pycnometer, Synchroelectric Viscometer (VLT) modol, Butyrorefectometer,respectively [15]. Melting point was determined using Toshniwal melting point apparatus [16].

Similarly, Smoke Point, Colour, Iodine Value, Saponification Value, Acid value and Free fatty acids, Unsaponification matter, Peroxide Value, Phospholipids were estimated according to AOCS (1964) methods [17]. Fatty acid composition of rice bran oil were using high pressure liquid chromatography (HPLC) [18]. The wax content of oil was estimated with some modification using Colorimeter instead of turbidity meter [19].

RESULTS AND DISCUSSION

The rice bran oil contains phosphotides, protein, carbohydrates mucilages and resins as gummy substances which impart colour turbidity and odour to the oil. However, phosphotides are the major component of gum which increases refining losses, create foaming problem and generate more colour. The extracted rice bran oil was dewaxed than prepare to degumming. In the process of degumming, some degumming agents are used for recovery of oil and gums from the dewaxed rice bran oil.

Effect of degumming agent on the recovery of oil and gums from rice bran oil

The degumming of dewaxed rice bran oil was carried out with 2-4 per cent water, 0.25 to 1 per cent phosphoric acid and 3 per cent water + 0.25 to 1 per cent phosphoric acid. The recovery of oil and gums and losses of oil during degumming were estimated. The results obtained are presented in Table -1 and Fig.1. The data recorded indicate that 3 per cent water, 0.75 per cent phosphoric acid and 3 per cent water + 0.75 per cent phosphoric acid as degumming agents yielded maximum gum 1.80 per cent, 1.92 per cent and 2.13 per cent, respectively from dewaxed rice bran oil. The corresponding values for recovery of degummed oil were 97.77 per cent, 97.68 per cent and 97.5 per cent. The differences between degumming agents with respect to per cent recovery of oil were non-significant. While, significant ($P<0.01$) differences were observed with respect to per cent recovery of gums and per cent losses of oil during degumming. The levels of degumming agents also had a significant effect ($P<0.01$) recoveries of oil and gums.

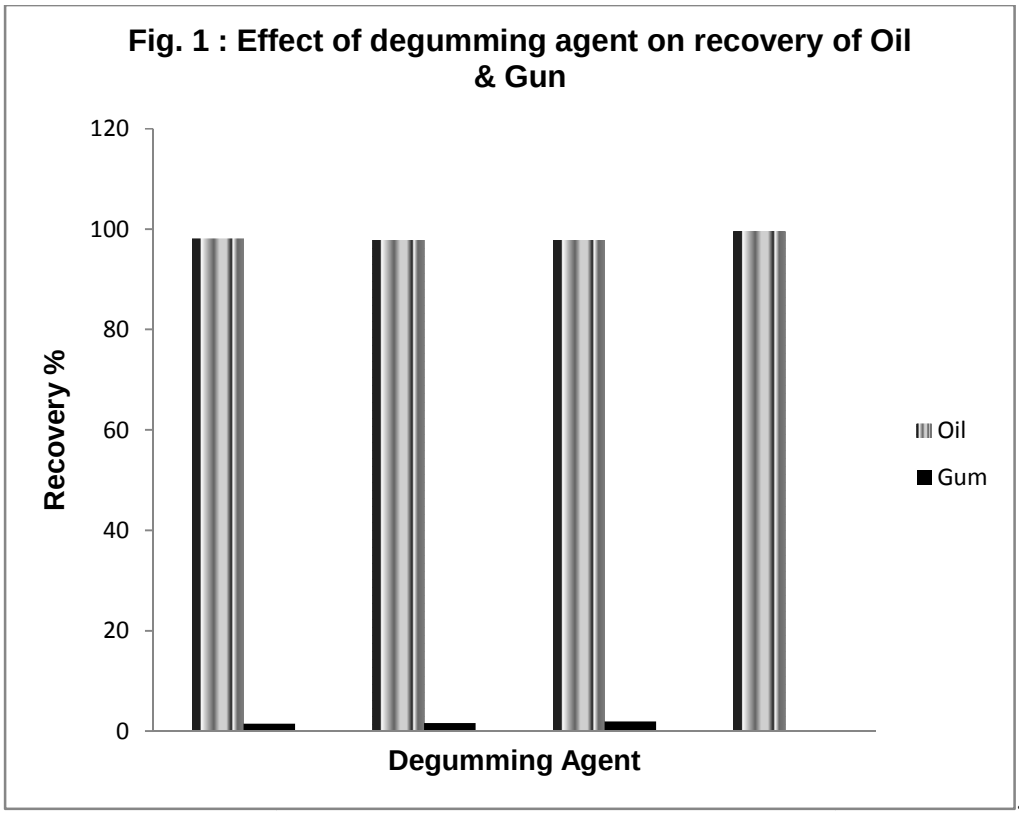
The result of this investigation showed that phosphoric acid and water mixture (0.75 + 3%) appear to be most effective degumming agent. Therefore, phosphoric acid and water mixture (0.75 + 3.0%) was used for degumming in the present investigation.

The phosphotides reduction by phosphoric acid was in line with the finding of [20] who reported 96.6 per cent reduction in total phospholipids content of rice from oil. [21] also reported that degumming by phosphoric acid at 0.4 per cent level reduced the phospholipid content of rice bran oil from 3.6 to 0.6 per cent. The results of present investigation are in conformation with these earlier reports.

Physico-chemical characteristics of degummed rice bran oil

Degumming of dewaxed rice bran oil reduced its phospholipids content from 3.90 to 0.51 per cent (Table - 2). [21] also made similar observations. They noted a significant reduction in phospholipids content of rice bran oil from 3.6 to 0.7 per cent under optimized dewaxing conditions.

The removal of phospholipids by water and phosphoric acid mixture appears to be most effective in improving the colour of rice bran oil. The transmittance of 20 per cent oil in acetone improved from 37 to 57 per cent at 570 nm. [22] also noted that phosphoric acid treatment resulted in marked reduction in colour of rice bran oil by destruction of pigments. The process of degumming of dewaxed rice bran oil had little or no effect on its specific gravity, refractive index, smoke point, acid value and peroxide value (Table - 2). Similar observations were recorded by [13].



The viscosity melting point and unsaponifiable matter of degummed oil decreased as compared to dewaxed oil. However, iodine value and saponification value increased upon degumming of dewaxed oil. This might have been observed due to removal of same saturated fatty acids during degumming process.

Table (1): Effect of method of degumming on the recoveries of oil and gum and losses of oil

Method of degumming (M)	Degumming agent level (%) S	Recovery of oil (%)	Recovery of gum (%)	Losses of oil during degumming (%)
Degumming with water	2.0	98.49	1.19	0.32
	3.0	97.77	1.80	0.43
	4.0	98.12	1.43	0.45
	Mean	98.12	1.47	0.40
Degumming with phosphoric acid	0.25	98.34	1.35	0.31
	0.50	97.78	1.90	0.32
	0.75	97.68	1.92	0.31
	1.00	98.09	1.60	0.31
	Mean	97.82	1.64	0.31
Degumming with water + phosphoric acid	3+ 0.25	98.26	1.42	0.32
	3 + 0.50	98.00	1.60	0.40
	3 + 0.75	97.56	2.13	0.31
	3 + 1.00	97.58	2.10	0.42
	Mean	97.85	1.94	0.41
Central		99.58	0.12	0.30
CD (P < 0.01) M		ns	0.196	0.052
S		0.176	0.248	ns
M x S		ns	0.362	ns

* *Values are an average of five replications.*
** *One hundred grams of dewaxed oil was degummed in each treatment.*
*** *Colour values are given as % transmittance of 20% oil in acetone at 570 nm.*

Table (2): Physico-chemical characteristics of degummed rice bran oil

S. No.	Characteristics	Value
1.	Colour (% transmittance)	57.0
2.	Specific gravity at 30°C	0.925
3.	Viscosity (centipoise)	41.30
4.	Refractive index at 40°C	1.472
5.	Melting point (°C)	10.50
6.	Smoke point (°C)	212.00
7.	Saponification value	190.59
8.	Iodine value	99.25
9.	Peroxide value (meq/kg oil)	43.10
10.	Acid value (as oleic acid)	28.07
11.	Free fatty acids (%)	14.03
12.	Unsaponifiable matter (%)	2.37
13.	Phospholipid (%)	0.51
14.	Wax (%)	0.07

* *Values are an average of five replications.*
** *Colour values are given as % transmittance of 20% oil in acetone at 570 nm.*
*** *One hundred grams of dewaxing oil was degummed in each replication.*

CONCLUSION

The study was started with the objective of investigating the effect of different pretreatment processes on the recovery of rice bran oil as well as gum. Not only that, it was also aimed to find out the better quality of rice bran oil. It is observed that higher recovery of oil and gum are obtained through phosphoric acid and water mixture (0.75 + 3%). It is also found that degumming agent have more color reduction power of an oil so obtained is best in quality.

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