Rapid Equilibrium Extraction of Rice Bran Oil at Ambient Temperature

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Rapid equilibrium extraction of soybean flour has been effective in obtaining an oil with reduced phospholipid content. This technique was examined to obtain a low phospholipid and low free fatty acid rice bran oil (RBO). The amount of RBO extracted with hexane from 1 g of rice bran at 22°C was measured over a 10-min period. The amount of oil extracted from variable amounts of bran with a fixed volume of solvent was also studied. Ninety percent of the oil was extracted in one minute, with 93% of the total RBO being extracted after ten minutes. This compares with the 98% yield obtained from soy flour, but increasing the amount of bran used did not reduce the extraction rate. This extraction method produced a good quality RBO with low phospholipid, low free fatty acid and low peroxide values.

KEY WORDS: Free fatty acids, phospholipids, rice oil quality.

There is increasing interest in using rice bran oil (RBO) in food systems. However, rice bran has considerable lipase activity, which can increase the free fatty acid (FFA) content of extracted oil (1). Oil extraction should be done soon after milling (2) to limit FFA formation and to ensure oil quality. Rapid oil extraction reduces FFA and phospholipid (PL) content, minimizes oil processing needs and avoids the removal of natural oil antioxidants (3). Furthermore, subsequent oil processing, such as deodorization, fixes the oil color and makes it difficult to remove pigments (2).

Recent findings on oil extraction from soy flour may be relevant to RBO processing. A rapid equilibrium method for measuring total soy oil in a soy flour by hexane extraction was reported by Sheu (4). A one-minute extraction time at room temperature removed 98% of the oil (5). One percent less oil was extracted by this technique than by the official American Oil Chemists' Society (AOCS) extraction method (6). Significantly less PL was extracted from soy flour than from soy flakes, which represents an important increase in soy oil quality (7). Similar results were obtained in a pilot-plant study (8), and the process was patented (7).

The objectives of this study were to observe how much oil could be extracted from rice bran by the rapid ambient-temperature extraction method and to examine the quality of oil obtained.

MATERIALS AND METHODS

Bran preparation. Rice bran was recovered after dehulling long grain rice with a Satake Rice Machine (Satake, Tokyo, Japan) and milled in a McGill No. 2 mill (McGill, Brookshire, TX). Only bran that could pass through a 40-mesh screen was used.

Effect of extraction time. The method was adapted from that of Clark and Snyder (5). Two grams of rice bran was mixed with 20 mL hexane and mixed with a vortex stirrer for 1, 2, 5 and 10 min. The oil hexane miscella was centrifuged and recovered, and the percentage oil was measured gravimetrically after evaporating the hexane in a drying oven. Determinations were made in duplicate, and control data were obtained by the AOCS Goldfisch extraction method (6).

Effect of bran weight. Bran (1, 2, 3, 4 and 5 g) was mixed with 20 mL hexane in 100-mL flasks with ground-glass stoppers and shaken in a water bath at 22°C for 1 min. and it was then centrifuged, the oil miscella was recovered, and the percentage oil was measured gravimetrically after evaporating the hexane in a drying oven.

RBO quality. Thirty grams of rice bran was mixed with 150 mL hexane for 1 min and centrifuged for 10 min at 35,000 rpm. With the exception of the peroxide value, all analysis were performed on the miscella and expressed on an oil basis. FFA levels were measured according to the AOCS method (9) with the modification by Lin (10). PLs were measured by the method of Bartlett (11). Oil peroxide values were measured after evaporating hexane under nitrogen by the AOCS method (12) by using a 1-g sample. The whole experiment was done in triplicate.

RESULTS AND DISCUSSION

The data showing the effect of extraction time and bran weight are shown in Table 1. Ninety percent of the oil could be extracted in a minute, with little increase in yield with time. Equilibrium was established rapidly, with little increase in yield afer 10 min. The one-minute rice bran extraction was not as efficient as it was with soy flour, which extracted 98% of the oil (5), but it was comparable with carbon dioxide critical-fluid extraction of RBO (13). Previous studies on extracting RBO (14) reported that boiling hexane extracted about 92% of the oil after 20 min and that an extraction time of almost an hour was necessary to obtain 1% residual oil in the bran. Therefore, it would seem that temperature is not the limiting factor in oil extraction. The lower extraction rate relative to soy flour may be due to the greater fiber content of the bran, which restricts solvent and oil movement. However, increasing the bran/hexane ratio from 2 g of bran in 20 mL hexane to 5 g in 20 mL hexane did not greatly reduce the oil yield.

The RBO extraction and quality data from 30 g of bran by 150 mL hexane after 10 min is shown in Table 2. The extraction rate was less than when using smaller amounts of bran and may again be due to oil retention. PL levels were low but variable, which may be due to differences in oil retention between samples. PL levels were similar to those obtained from soy oil extracted by this process (5). FFA levels were considerably less than those obtained from commercially-extracted RBO, which are typically 7.5–11% (2). Peroxide values were typical of crude RBO, indicating little peroxide formation during extraction (15).

Rapid equilibrium extraction rates for one minute approach those reported for high-temperature solvent extraction (14), but were less than obtained by Goldfisch extraction. PL and FFA levels were low, but further processing

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TABLE 1

Oil Extraction Yield of 2 g of Rice Bran with Time and from Variable Amounts of Bran[a]

	Oil weight (% of bran extracted)	% Extracted of control
Extraction time (min)		
1	19.15 ± 1.2	90
2	19.00 ± 1.0	89
5	19.20 ± 1.8	90
10	19.75 ± 0.07	93
Control	21.25 ± 0.07	100
Bran weight (g)		
1	19.35 ± 2.2	91
2	20.60 ± 1.4	97
3	19.85 ± 1.4	93
4	19.95 ± 0.21	94
5	20.0 ± 0.35	94

[a]In 1 min, at 22°C. Data is the mean of duplicate determinations with standard deviation.

TABLE 2

Quality of Rice Bran Oil Extracted from 30 g of Bran with 150 mL of Hexane[a]

	Rice bran oil quality			
Oil extracted (%)	Moisture (%)	Phospholipids (ppm)	Free fatty acids	Peroxide values
17.7 ± 0.51	9.2 ± 0.30	42.7 ± 30.17	2.215 ± 0.41	4.08 ± 0.38

[a]At 22°C for one minute. Data is the mean of single determinations from triplicate extractions with standard deviation.

would be required to remove them in order to produce an acceptable food-grade product. Although there is concern about elevating the peroxide values during processing, degumming is a processing step that would have little effect on oxidation.

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