Utilization of Rice Bran Oil to Produce an Antifoamer

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Crude rice bran oil was dewaxed by chilling to 17°C, followed by centrifuging. The wax sludge obtained was 68% free fatty acids and 32% waxes, whereas the oil phase was 65.65% fatty acids and 34.35% glycerides. The dewaxed oil was evaluated as an antifoaming agent for aqueous media and compared to commercial oleic acid. It was thought that dewaxed rice bran oil has an antifoaming power greater than oleic acid, especially when used in small proportions.

Dewaxed rice bran oil was also applied to break and control the foam formation in a phosphoric acid production unit.

Rice bran is produced in Egypt as a by-product of rice milling, in large quantities which amount to 150,000 tons a year (1). This quantity would yield from 10,000 to 15,000 tons of oil upon extraction. However, this oil is usually rich in free fatty acids, which are developed by lipase hydrolysis in the bran directly after milling, and during storage prior to extraction (2). Therefore, special refining techniques are usually required to produce an edible grade oil. Extensive worldwide studies have been carried out to process rice bran oil to yield a product suitable for edible purposes (3-7). However, this oil has not yet been processed in Egypt for this purpose. It is presently utilized in other industries, such as the paint and soap industries. This paper is concerned with the utilization of crude rice bran oil to produce a cheap antifoamer for local chemical industries.

It is usually desirable to collapse the overflow of foam during chemical processes. This can be accomplished by several means including thermal, mechanical or chemical (8). Foam can also be broken by sound or ultrasound. There is a wide variety of antifoaming agents of different trade names. The correct formulation and proportion of an antifoamer must be determined by trial and error as they will vary with the foamer.

Crude rice bran oil usually contains 6-8% waxes in addition to free fatty acids and glycerides. Removal of waxy material from its blends with fatty acids was found to considerably improve the efficiency of the latter as a defoamer (1). Therefore, dewaxing of crude rice brain oil is a recommended step prior to its use as antifoamer in chemical industries.

In the present investigation, the process of dewaxing crude rice bran oil was studied and the dewaxed oil was then tested as an antifoaming agent, and compared to commercial oleic acid. The latter is imported in considerable quantities to both break and control the foam level in many chemical industries in Egypt.

EXPERIMENTAL

Dewaxing of crude rice bran oil. The optimum conditions for dewaxing rice bran oil was studied initially on a bench scale using 3-3.5 kg oil batchs. The crude oil was cooled and then centrifuged at 2800 rpm in a basket centrifuge of 5 kg capacity lined with a filter cloth. The crude oil temperature, the type of filter cloth used and the number of the cloth layers were the variables considered in this study.

On the basis of the dewaxing results on the bench scale, a process was designed to dewax the crude oil on a pilot scale. A schematic diagram for the dewaxing process is shown in Figure 1.

It includes: A primary filter unit, mesh size 3 mm, to remove any solid impurities in the crude oil; crystallization vessel, 100 kg capacity, provided with a cooling lead coil, 1.6 m^2 surface area. The flow rate of the cooling water from the chiller was adjusted so that the inlet and outlet temperatures were 8 and 12°C, respectively. A chiller, produced by Corning company, to supply cooling water, ranged from 20 to --20°C; and a basket centrifuge, 100 kg capacity, running at 750 rpm and provided with a double layer polypropylene cloth.

The separation efficiency was primarily determined by the crystallization temperature. Oleic acid, which constitutes about 45% of total fatty acids in rice bran oil, melts at 14°C (Table 1). Thus, it was possible that a portion of free oleic acid would separate together with the wax and palmitic acid whenever the crystallization temperature was less than 14°C. Therefore, the cooling time in the crystallizer was adjusted so that the separation temperature was 16-17°C.

The wax sludge was then separated from the oil phase by centrifuging for about 15 min at 750 rpm, and another was allowed 15 min for drying.

The dewaxing process was applied for 9.50 ton crude oil on a batch-wise process.

The separated wax sludge and oil phases were analyzed for their fatty acid content using the AOCS Official Methods of Analysis (9).

TABLE 1

Fatty Acid Composition of Rice Bran Oil

Fatty acid	Mole %	Melting point, °C
Myristic ($C_{14}H_{28}O_2$)	0.4	54.4
Palmitic ($C_{16}H_{32}O_2$)	20.0	62.9
Stearic ($c_{16}H_{36}O_2$)	1.1	69.6
Palmitoleic ($C_{16}H_{30}O_2$)	0.9	0.5
Oleic ($C_{18}H_{30}O_2$)	44.7	14.0
Linoleic ($C_{18}H_{32}O_2$)	32.6	-5.0
Linolenic ($C_{18}H_{30}O_2$)	0.3	-11.0

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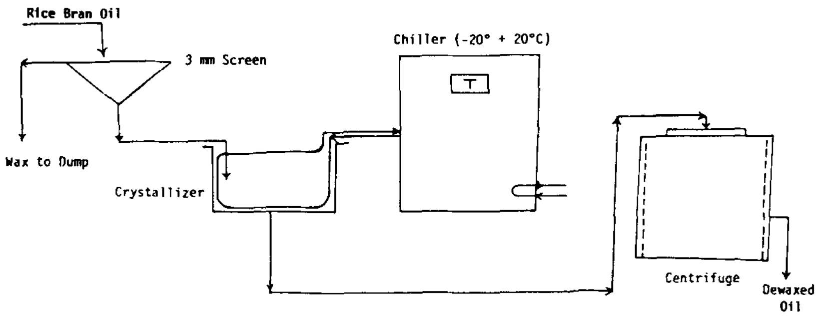

Fig. 1. Process diagram of dewaxing unit.

Evaluation of the dewaxed rice bran oil as a foam breaker. Dewaxed rice bran oil was evaluated as an antifoamer for aqueous media and compared to commercial oleic acid, which was used in local chemical industries as an antifoamer. A solution of a commercial detergent (sodium dodecyl benzene sulfonate, 10%) at 15 g/liter, was selected to give the foam media. Two hundred ml of this solution was poured into a 500-ml graduated cylinder, 5 cm internal diameter, and the foam height determined following the procedure of Ross *et al.* (10). This procedure was repeated after adding 0.5, 1, 2, 4, 10 and 15 cm^3 of dewaxed rice bran oil, and the foam height determined in each case. The effect of commercial oleic acid on the foam level was similarly studied.

The dewaxed rice bran oil was also compared to commercial oleic acid for its ability to break and control the foam formation in a continuous unit for phosphoric acid production at the Central Metallurgical Research and Development Institute, Academy of Scientific Research and Technology, Cairo.

RESULTS AND DISCUSSIONS

Dewaxing of crude rice bran oil. The results of the dewaxing process on the bench scale have shown that the best separation of waxes from crude rice bran oil could be achieved by chilling at 16–17°C, followed by centrifuging and filtering off the dewaxed oil through double layers of polypropylene filter cloth. The time needed to attain this temperature was found to be 30 min during summer and 20 min during winter (Fig. 2).

Dewaxing of crude rice bran oil on the pilot scale was carried out following the optimum dewaxing conditions on the bench scale. About 7.2 tons dewaxed oil were produced from 9.5 tons crude oil. The composition of the dewaxed oil, the wax sludge as well as the composition of the starting crude oil, are recorded in Table 2.

TABLE 2

Composition of the Phases Separated by Dewaxing

	Weight, tons	% free fatty acids	% glycerides	% waxes
Crude rice bran oil	9.5	66.22	26.03	7.75
Dewaxed oil	7.2	65.65	34.35	—
Wax sludge	2.3	68.00	—	32.00

It is obvious that the wax sludge was rich in free fatty acids (68%). The quantity of free acids separated together with the waxes was about 25% of total free acids in the crude oil, while 75% was left in the dewaxed oil. By referring to Table 1, it is expected that the high melting point [palmitic acid (mpt 62.9°C)] was the main fatty acid com-

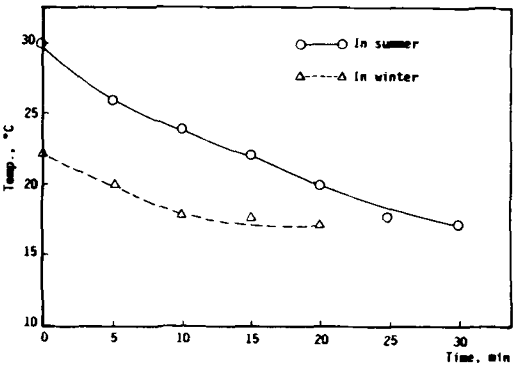

Fig. 2. Cooling curves of crude rice bran oil in the crystallization unit.

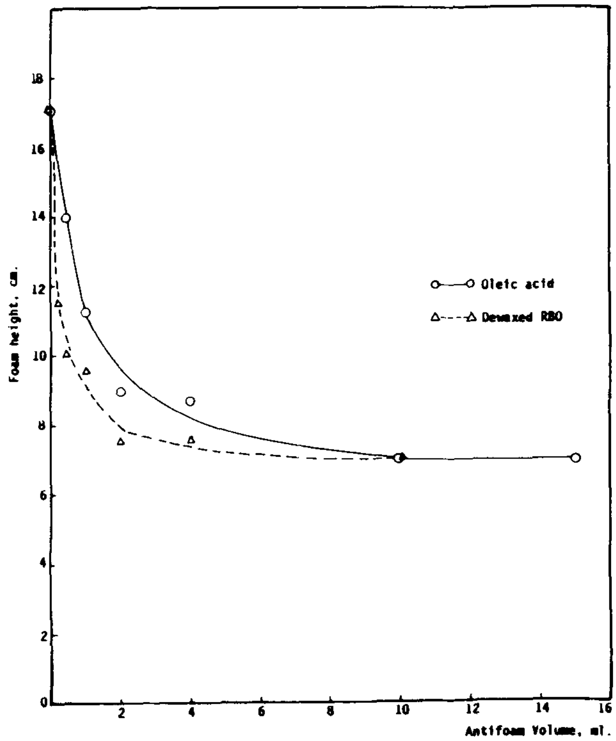

Fig. 3. Effect of dewaxed RBO and oleic acid on foam level.

ponent in the wax sludge while oleic and linoleic acids were the main components in the dewaxed oil.

It should be emphasized that the wax sludge obtained as a by-product from the dewaxing process could be utilized as a source of waxes as well as of free acids. The two components can be separated either by liquid-liquid extraction using a solvent selective to the free acids, or by distilling off the free acids under vacuum.

Antifoaming power of dewaxed rice bran oil. The results presented in Figure 3 show that the power of dewaxed rice bran oil to break and control the foam formation in an aqueous solution of sodium dodecyl benzene sulfonate was greater than that of commercial oleic acid. The foam height could be reduced from 17 cm to 14 cm using 0.5 cm^3 oleic acid and to 10 cm using 0.5 cm^3 dewaxed-rice bran oil. The foam height levelled off at 7 cm when 10 cm^3 of each of oleic acid and rice bran oil was added. It should be emphasized, however, that different results could be obtained for different types of foamers. The correct proportion of a specific agent to break and control the foam formation in a particular medium could only be determined by several trials (8).

Although dewaxed rice bran oil has proved to be more efficient than oleic acid to break the foam of sodium dodecyl benzene sulfonate, it was found to be less efficient with the foam developed in a phosphoric acid unit. In order to collapse the overflow of foam in this unit, the optimum dosage required from dewaxed rice bran oil was found to be 4.1 kg for each ton of P_2O_5 produced, as compared to 2.98 kg commercial oleic acid or 6.1 kg crude rice bran oil.

REFERENCES

1. Progress Report No. 1, submitted to Abu Zaabal Fertilizers and Chemicals Company, July, 1987.
2. Browne, C.A., Jr., *J. Am. Chem. Soc. 25*:948 (1903).
3. El-Khalafy, H.M., *Grasas Y. Aceites 22*:12 (1971).
4. Zachariassen, B., *Chem. Age India 15*:89 (1964).
5. Dressler, R.G., *Oil and Soap 17*:124 (1940).
6. Han, S.Y., I.C. Im, Y.K. On and D.H. Cho, *Kisul Yon'guso Pogo 2*:57 (1963).
7. Han, S.Y., I.C. Im, Y.K. On and D.H. Cho, *Ibid. 3*:43 (1964).
8. Perry, R.H., and C.H. Chilton, *Chemical Engineers Handbook*, Fifth Edition, McGraw-Hill, Kogakusha Ltd. Tokyo, 1973.
9. *American Oil Chemists' Society Official and Tentative Methods*, Third Edition, AOCS, Champaign, IL, 1978.
10. Ross, J. and J.D. Miles, *Oil and Soap 18*:99 (1941).

[Received April 4, 1989; accepted August 31, 1989]
[JS/D 5698]