Removal of Phosphorus and Iron by Commercial Degumming of Soybean Oil[1]

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ABSTRACT

Samples of crude and water-degummed soybean oils were obtained from five commercial processors. Two sets were obtained from each processor with a period of at least 2 weeks between samples. The crude and degummed oils were analyzed for iron and phosphorus content. Phosphorus removal within each processing plant was consistent, but between plants removal varied from a low of 79% to a high of 95%. Removal of iron compounds during commercial degumming varied from a low of 14% to a high of 57%. Significance of these results in steam-refining operations are discussed.

INTRODUCTION

The soybean, in addition to being our most important source of edible oil and protein, is also the only current commercial source of lecithin (1). Worldwide consumption of this by-product of soybean processing is estimated at 100,000 tons/year (2), and it finds uses in a variety of food and industrial products. Industrially, lecithin is removed by treating the crude oil with water (2), inorganic and organic acids (3), or acetic anhydride (4) at elevated temperatures; the gums precipitate from the oil and are recovered by centrifugation or sedimentation. On the other hand, some processors refine the crude oil directly, and the gums are removed with the soapstock. Thus, to the processor, the soybean phosphatides may be considered valuable by-products or merely minor constituents that must be removed in order to render the final product suitable for end uses as salad-cooking oils, margarines, or shortening stocks.

Removal of phospholipids from soybean oil generally poses few problems for the processor providing the crude oil is extracted from undamaged beans. However, within the past few years, unusually early frosts and inclement weather have resulted in severe damage to the soybean crop in the midwest and southwest United States (5,6). Studies conducted at the Northern Regional Research Center (7,8) and at the Richard B. Russell Center in Athens, Georgia (9), have attributed changes in the iron and phospholipid content to the poor quality of crude and finished oils from damaged soybeans.

Further interest in the phospholipid and iron contents of soybean oil arises from the possibility of the extension of physical or steam refining from high acid-low phosphatide fats such as palm oil (10) into soybean oil processing. Relatively little is known about parameters influencing the removal of phosphatides and iron from crude soybean oil in commercial operations. We report here the phosphorus and iron contents of soybean oils degummed under commercial conditions.

EXPERIMENTAL PROCEDURES

Samples of crude and degummed soybean oils were obtained from the daily production streams of five processors located in Illinois, Iowa, Minnesota, Arkansas, and North Carolina. A second set of samples was received from each processing plant after a period of at least 2 weeks. Iron and phosphorus were determined as described previously (7).

RESULTS AND DISCUSSION

The phosphorus and iron contents of the commercially extracted crude and water-degummed soybean oils are shown in Table I. Although the conditions of degumming employed in the various plants (A-E) are unknown, the results are informative. On repetitive samples, each plant was consistent in the amount of phosphorus removed by the degumming step. However, it is apparent that some processors are consistently able to remove more gums than others. Removal of phosphorus varied from a low of ca. 80% (E) to virtually complete removal, 96% (D). The

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TABLE I

Removal of Phosphorus and Iron by Commercial Degumming of Crude Soybean Oil

Processor[a]	Phosphorus (ppm) Crude	Phosphorus (ppm) Degummed	Phosphorus removed (%)	Mean (%)	Iron (ppm) Crude	Iron (ppm) Degummed	Iron removed (%)	Mean (%)
A	733	167	77.2	82.8	0.90	0.78	13.3	34.0
	683	80	88.3		2.10	0.79	62.4	
B	867	53	93.8	92.3	0.51	0.27	47.0	56.7
	684	63	90.7		1.40	0.47	66.4	
C	711	89	87.5	84.8	2.05	1.75	14.6	13.7
	588	105	82.1		0.86	0.75	12.8	
D	615	40	93.4	95.9	0.62	0.23	62.9	57.7
	713	12	98.4		0.40	0.19	52.5	
E	623	102	83.6	79.7	1.26	0.76	39.6	39.6
	580	141	75.8		1.57	0.95	39.5	

[a]Plants located in Illinois, Iowa, Minnesota, Arkansas, and North Carolina. Two samples from each plant separated by at least 2 weeks.

average removal of phosphatide in all five plants amounted to 87%.

In contrast to the relatively high amount (80-96%) of phospholipid removal achieved by water degumming, iron removal was not nearly so complete. Although within each plant the amount of iron removed was fairly consistent, there is no correlation with amount of phosphatide removed. Iron removed varied from a low of ca. 14% (C) to a high of ca. 57% (B and D). Based on published (11) and unpublished data, the degummed crude oils shown here, which yield quality edible oils after caustic refining and deodorization, would have poor oxidative and flavor stability after a bleach and steam refining. A possible exception would be the degummed oil from plant D which was unusually low in iron (0.2 ppm) since water-degummed, steam-refined oil containing 0.4 ppm iron was of marginal quality (11).

It should be pointed out that conditions for commercial degumming may be dictated by factors other than those directed toward the most complete removal of phosphorus. For example, processors who remove the lecithin must take into account the quality of the crude gums. Higher temperatures may speed the operation and remove more phosphorous, but at the same time the lecithin may be degraded and darkened by the more drastic degumming conditions. Thus, while a higher degree of phosphatide removal is desirable, a lighter high quality lecithin may be obtained at the expense of higher phosphatide removal. On the other hand, processors who do not recover the lecithin may choose more drastic conditions that remove higher amounts of phosphorus to meet customer specifications for residual phosphorus in degummed oil. Here, a high degree of phosphorus removal is desirable, but for a different reason.

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