New Concepts of Bleaching of Soy Oil

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When we talk about bleaching, we think first of decolorizing a fat or oil in classical oil refining, the chemical or caustic refining somewhere between neutralizing and deodorizing or neutralizing and hydrogenation (Fig. 1).

This classical process of bleaching had and still has the only objective to transform an oil or fat from a more or less dark, opaque substance into a clear, transparent liquid or solid which, in contrast to the original substance, is also stable with respect to shelf-life and flavor.

The bleaching is performed by adding a certain amount of natural or activated clay (montmorillonite) of great adsorptive power to a heated, agitated oil and after a proper contact time, the oil is filtered.

The filter-cake has to be removed and the filter leaves cleaned by steam or hot air. According to size and speed of production, the whole process of bleaching can be performed continuously or in batch, in vacuum or at atmospheric pressure.

The application of clay, even with its relative cheapness, was always considered a necessary evil for different reasons, such as cost of equipment and handling, oil retention and disposal of the spent clay, which can sometimes cause ecological problems.

For more important and aggravating reasons such as high cost of alkali, soap-stock removal and also energy-saving by improved heat exchange, physical refining was suggested as a new process and deodorizing was highly improved. Both processes apply heat and have, especially in soybean oil, a positive influence on bleaching. The amount of bleaching clay applied could be reduced or even completely eliminated in very light oils. However, it soon was established that the use of bleaching clays was beneficial not only to the color of an oil, but also in the preparation of the oil for physical refining or hydrogenation (prebleaching) or in a postbleach operation after hydrogenation. In this aspect, the term "adsorption treatment," as suggested by O.L. Brekke in the *Handbook of Soy Oil Processing*, is more appropriate than "bleaching."

Among others, it was found by Gutfinger and Letan (*AOCS Manual*, 1978) that the addition of 2% of a lightly acid-activated clay (Tonsil L-80) to degummed soya oil reduced its phosphorous content from 520 ppm to 5 ppm at atmospheric pressure and under a nitrogen blanket. At the same time, the photometric color came down from 21.6 to 2.4. This coincides with results from Fahn (SME and AIME Convention, Tucson, 1978), who reported that soya oil needs only a clay activated with 560 m vol/HCl/100 g of clay against 800-1,000 m vol/HCl for palm oil and others to obtain maximum decoloration.

Besides this proposed use of activated clay after degumming, it is not uncommon to add reduced amounts of specially prepared clays directly into the degumming stage, where the clay helps to eliminate, e.g., phospholipids and unstable proteins, thus giving a more uniform oil for further refining.

Besides the reduction of phosphorous compounds in the oil by means of an adsorptive clay, other traces of undesirable elements can be eliminated. Romero et al. conducted a study of crude fish oil (AOCS meeting, New York, 1980) with AAS, treating the oil with different amounts of various activated clays. The sulfur content decreased drastically, from 2.60 to 0.85 and 0.88 to 0.02 ppm in two different crudes. Iron and copper sometimes dissolve into the crude oil when it has a high free fatty acid (FFA) content and is in contact with these metals either in the storage tank with defective lining, pipes or valves. The iron content could be reduced from 5.24 to 2.58 ppm and the copper content from 0.264 to 0.096 ppm by treatment with 2% of a hydrochloric-activated clay.

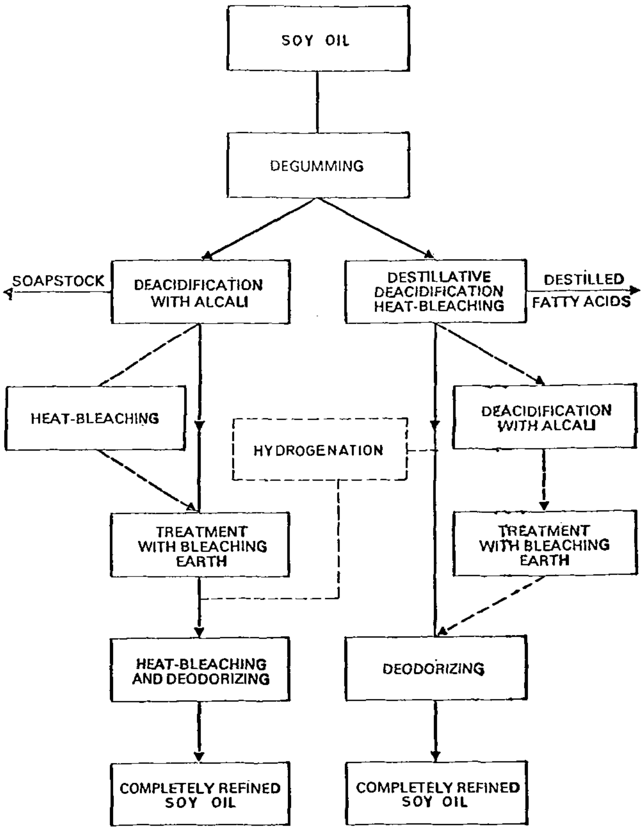

FIG. 1. Processing of soy oil.

The use of a nitrogen blanket, as already mentioned, is getting more popular to prevent oxidation of the oil during the refining process, which always causes deepening of color and sometimes causes serious bleaching problems. The same can be said about mechanical devices such as double valves, which feed the clay into the agitators. They prevent air intake and make the bleaching clay more effective.

PRETREATMENTS FOR HYDROGENATION

We recently had a very stimulating symposium on hydrogenation (Nov. 1979, Mexico City) with participants from 15 countries. All the experts agreed that sophisticated, selective hydrogenation can only be successful with properly prepared oils, so that pretreatment with clay is sometimes indispensable.

Table I shows, in a study by Fahn, our Research Director, the effect of this pretreatment on a crude tallow, which was hydrogenated without pretreatment. We see that tallow, with FFA of 12.1% and iodine value (IV) of 49, could not be hydrogenated below IV 43 without pretreatment. In contrast, with the addition of 3% of a highly activated clay, the IV was reduced to 1 within 40 min. Even though soya oil has FFA of only 3-4% max., and the IV has to decrease from only ca. 125 to 70 or 80, the benefit of pretreatment with clay before hydrogenation can be the same.

TREATMENT AFTER HYDROGENATION

Originally, this treatment was called "postbleach" and has as its main objective to "polish" the oil, i.e., to reduce its color to its desired standard. However it was soon established, that specially activated clays like Tonsil P can be used in this process, in order to retain traces of catalyst which either increase oxidation, or are poisons or both.

As an example, by treating a hydrogenated soya oil with 0.5% Tonsil P, its nickel content came down from 1.3 ppm, copper from 0.55 ppm and chromium from 0.04 to 0.02 ppm or less (0.02 being the detectable limit for AAS). These special clays can readily replace more expensive sequestering agents.

Heat treatment does not eliminate trace metals, although it normally decreases the color of an oil. Modern refining of soya oil has a definite tendency toward heat treatment. Clay treatment is no longer restricted to a decolorizing function but as outlined here and shown in Table II, has its place in the preparation of an oil for processing and also its posttreatment after hydrogenation.

TABLE I

Influence of Bleaching on Hydrogenation of Tallow

		with % Tonsil optimum →		
A) Bleaching: at 110 C; 30 min				
Color				
Lub 5' 1/4"	–	0.5	2	3
Red	21	23	10.4	8.7
Yellow	70	70	70	70
Blue	6.2	4.8	0.2	0.1
White	1.0	1.0	1.0	1.0
B) Hydrogenation at 6 bar; 180 C; 0.1 NI-G53				
iv	49	49	49	49
min				
10	45	39.5	30.5	22
20	44	38	24.5	10
30	43	37.5	18	5
40	43	37	14	1
50	43	36.5	10	
60		36.5	7.5	
70			4	
80			2.0	
90				

Base: crude tallow; FFA 12.1%; IV 49

As the spent clay contains retained oil, some proteins, chlorophyll and other valuable compounds, its use as an animal food or food pelletizer seemed possible. However, these compounds are very unstable and deteriorate easily. Together with the adsorption of toxic matters by the clay, this application is out! So is the reactivation of the clay, because its cost is higher than buying a new product. Hundreds of attempts in this direction have already failed.

Solvent extraction in order to reclaim the retained oil and transform it into some cheap product is commercially possible, but it still leaves the disposal of the extracted clay to the plant operator.

TABLE II

Adsorption Treatment for Refining Soya Oil with Clay

Treatment	Function	Type of clay	Normal doses (%)
Prebleach	Degumming aid, elimination of unstable proteins, phosphor compounds, trace metals, toxic matter	Mildly acid-activated clay (Tonsil-P)	0.5-1
Main bleach	Decolorizing	Highly acid activated clay (Tonsil optimum)	0.5-2
Postbleach	Polishing, elimination of catalyst traces	Mildly acid-activated clay (Tonsil-P)	0.5-1