Hydrogenation Standardizes Quality of Lard*

Stabilization of Packers' Product by Light Treatment with Hydrogen Corrects Shortcomings of Inferior Grades

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QUOTING E. G. Montgomery, Chief Foodstuffs Division, U. S. Dept. Commerce in November, 1930 "Food Industries," "an increase of about 10 lbs. per capita in the consumption of vegetable oils is one of the most striking changes in food consumption that has taken place in the past 30 years. Nor has this gain been at the expense of other edible fats. Consumption of butter has declined a small amount but lard consumption has remained practically the same; about 14 lbs. per capita per year during the 30 year period. The average consumption of fats and oils, both vegetable and animal, has reached about 44 lbs. per capita in recent years.

"Vegetable oils, such as olive oil, corn oil and cottonseed oil, were used in a limited way for salad dressings and cooking purposes at the close of the 19th century, but the total consumption at that time was probably not more than about 2 lbs. per capita. With the discovery of methods for hardening vegetable oils, however, new uses were soon found, particularly in the manufacture of shortening compounds and margarines that use vegetable oils as part or all of the raw materials. The principal use is in the shortening compounds, which now amounts to about 8 lbs. per capita."

Certainly a large factor here in the increase of consumption of vegetable fats was the paralleling quality improvement. Note, too, that this increase in the consumption of vegetable oils has until perhaps very recently not affected the consumption of lard in this country. The increase in total fat consumption here is negligible compared to the increase in that of sugar in the last two decades.

Our point is that if saturation in fat consumption has not been reached, (and who would dare say so in view of the extremely important new biologic functions of lipins being daily uncovered) the lard producers have an open field on this continent alone perhaps for their full production, provided that they standardize their quality.

Can improvement of the lower grades of lard be expected from rendering technic? We believe every one will agree that this art has been advanced nearly to its practical limit.

The principal limitations to a more general use of low-grade lard at present are:

1. Its pronounced animal flavor
2. Its lack of adaptability to hot and deep frying arising from its free fatty acid content
3. Its only moderate resistance to rancidity
4. Its softness, giving poor creaming characteristics

We will take up these disadvantages in a little more detail beginning with the flavor.

The decrease in hard manual labor in this country we believe quite a factor in a corresponding decrease of relish of this strong animal taste. The change may or may not be good, but the fact of the change remains.

The smoking point of a fat decreases approximately logarithmically with the fatty acid content which means that the first small increment in a nearly neutral fat is as objectionable as a great increment in a fat of high free fatty acid. Free acid is not the only factor in reducing smoke point, neutral coconut oil (high saponification value) smokes at a comparatively low temperature, as does an ordinary rancid but neutral fat. Free fatty acids have another disadvantage, viz., their pronounced corrosion of iron cooking vessels, rapidly darkening and otherwise damaging the containing fat.

Instability to oxygen in some lards is the resultant of quite a number of well-known factors. The linoleic acid content is generally considerable. A recent article[1] described a fatty acid yielding an octobromide as a nor-

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[1] Journal Am. Chem. Soc. 152; p. 1135.

mal constituent of lard; viz., more than 0.3%. This is equivalent to 1% of a fish oil. Linseed-meal-fed hogs have been said to yield a linoleic acid in their lard. Again the free fatty acids and the often concurrent metal content which acts as a metallic drier are potent factors in rapid induction of rancidity. These remarks especially apply to the lower grades of lard and ham fats.

Last but not least, much lard is not only too soft for effective creaming but is quite variable in this property. Different feeds, different sections of the country, different portions of the animal produce different consistencies of fat. Large production of course may modulate this disadvantage through extensive mixing.

There is being produced at present more and more ham fat which is unusually soft, i.e., with a titer below 26° C. Some producers have such an excess that they are unable to work this off by mixing in their regular production. The use of the paper carton, too, is precarious with unhardened lard.

The difficulties noted herein have been specifically corrected in practice as follows:

(1) Flavor removal by refining and deodorization.

(2) Free fatty acid removal by neutralization.

(3) Potential and to some extent actual rancidity removal by hydrogenation.

(4) Softness by hydrogenation.

Since refining and deodorization are normal adjuncts to hydrogenation, it is logical to include this latter step if at all economically practicable. By the ordinary powder or batch method, however, this cost, exclusive of hydrogen, approaches that of the refining and deodorizing. By the metal base catalyst or continuous method (the Bolton & Lush Patents) the cost is definitely fractional.

The halving of this hydrogenation cost in the medium size units should not be difficult to understand. By the powder method, it is almost as troublesome to completely harden as to perform a slight hydrogenation. In addition to the cost advantage the absence of kiesulguhr, the very low contact time under heat and reaction (15 minutes) offers a group of important aids to quality.

The free fatty acid decreases rather than increases as in the powder method. The hydrogenation flavor is much less requiring less deodorization with a noticeably less loss. Whereas we have not measured the sterol content before and after a continuous metallic base catalyst hydrogenation, earths including kiesulguhr under the conditions present in batch process hydrogenation have been shown to resinify and adsorb such bodies, which are said to have antioxidant properties.

Below is the average of several analyses on samples we have hardened on a semi-commercial scale, continuously. We were unable to find out how long the catalyst would last without reactivation. At the end of two weeks, the rate of production was still over 90% of the original:

FFA	015%
Iodine Value	55.
Saturated Solid Acids	36%
Solid Unsaturated Acids	2.5%
Liquid Acids	Remainder
I. V. of liquid acids	89
I. V. of the lards before hydrogenation	62 - 64

We wish to point out the unusual degree of selectivity indicated in the low content of solid unsaturated acids. At all but the lowest temperatures, this product was still slightly softer than the present all-hydrogenated cotton seed oil shortenings. If necessary this is correctible by carrying the reaction slightly further.

Summary

HYDROGENATION and its complemental processes not only open new outlets for lard, but offer unusual flexibility of plant processing and handling. The low grade lards have been transformed into products of more utility than the best hitherto produced by the usual methods. The continuous hydrogenation procedure is extremely simple, automatic and as near foolproof as such a chemical process might be. The difficulties of catalyst preparation are completely overcome as well as the necessity for a constant renewal of the supply of catalyst materials.

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A manufacturer of mayonnaise in the South has recently introduced variegated colors for his product, packing it in pink, green and orange tints, for use in decorative effects for salads and sandwiches. There is not yet available a report on the response of the buying public to this innovation, but it seems likely to be favorable.

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At the first Conference of the new International Society for the Testing of Materials held at Zurich, Switzerland from Sept. 9th to 11th, the second meeting of the International Commission for the Study of Oils and Fats was also held. Among other things, the Commission has undertaken the task of clearing up those doubtful cases where, in the oils and fats trades, unscientific or unauthorized methods of examination are used.

Determination of Unsaponifiable Matter

Considerable difficulty is often experienced and much time wasted in the estimation of unsaponified matter in soaps and unsaponifiable matter in oils owing to the formation of troublesome emulsions. Inaccurate results are frequently obtained due to the lack of a definite separation between the ether and the soap solution layers.

It has been found that a simple treatment of the emulsion formed eliminates these difficulties.

Procedure: Dissolve 5 to 10 grams of soap in 100 cc. of water. In the case of unsaponifiable matter in an oil, saponify the sample by refluxing for several hours with 50 cc. of 0.5 N alcoholic potassium hydroxide, evaporate to dryness and dissolve in 100 cc. of water. Extract the cold soap solution by thoroughly shaking in a separatory funnel with 50 cc. of ether. In many cases a homogeneous emulsion is formed which separates very slowly, if at all.

To avoid this add 3 cc. of alcohol carefully and gently down the sides of the separatory funnel. This is most conveniently handled from a wash bottle. The emulsion will immediately break and complete separation occur within a few minutes. Sometimes it is advantageous to impart a slight whirling motion to the separatory funnel. On no account should the mixture be vigorously or even moderately shaken after addition of the alcohol. Draw off the soap solution layer into another separatory funnel and repeat the process twice more, using 50 cc. portions of ether each time.

Wash the combined ether layers three times with successive amounts of 20 cc. of water. After careful draining and separation of the water evaporate the ether from a weighed flask. Dry for 1 hour at 105° C., or, preferably, in vacuo at 60° C., and weigh.

The above method, if carried out with proper attention to detail, has always given satisfactory results. By its use ether-soap solution emulsions which are difficult to separate by other means are quickly broken, allowing of a rapid and accurate determination of unsaponified and unsaponifiable matter.—Frank N. Biffen in *The Chemist-Analyst,* 20, No. 4, p. 8 (1931).

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The usual method of determining free alkalinity or acidity in soaps by extraction with alcohol is said to yield erroneous results, as a determination after extracting all free acid with ether still showed 0.5 per cent free fatty acids by the alcohol method. *Chem. Umschau Fette, Oele, Wechse Harze* 38, 110-2 (1931).