STILLINGIA OIL*

By G. S. JAMIESON and R. S. McKINNEY
CARBOHYDRATE RESEARCH DIVISION, BUREAU OF CHEMISTRY AND SOILS, U. S. DEPARTMENT OF AGRICULTURE.

Abstract

Results of an investigation made in 1929 on the oil expressed from combined samples of stillingia seed from California, Florida and Texas are given, along with those recently obtained from an imported sample of stillingia oil. The American oil gave an iodine number of 176.1, a saponification value of 211.7, and a thiocyanogen value of 102.7, and was found to contain the following percentages of acids: Oleic 7.7, linoleic 56.3, linolenic 24.6, palmitic 4.42, stearic 1.43 and arachidic acid 0.34. The sample of Chinese oil gave an iodine number of 169.0, a saponification value of 206.2, and a thiocyanogen value of 100.7, and was found to contain the following percentages of acids: Oleic 10.4, linoleic 49.9, linolenic 25.4, palmitic 5.89, stearic 2.64 and arachidic acid 0.14. From the characteristics and composition of these samples, it would appear that stillingia is suitable for use in the manufacture of paints and varnishes.

STILLINGIA OIL is obtained from the seeds of the tree Sapium sebiferum belonging to the Euphorbiacae. It will be recalled that from the mesocarp of the fruit the Chinese vegetable tallow of commerce is obtained.

Many years ago, the tree was introduced into this country by the Foreign Plant Introduction Division of the Bureau of Plant Industry, Department of Agriculture, and shortly afterwards seedlings were distributed for planting in our southern states. In the vicinity of Jacksonville, Florida, a sizable planting was made with a view to the production of fat for the local manufacture of soap, but this undertaking failed. This was due largely, if not entirely, to the prohibitive cost of harvesting the fruits from the trees. In this region, it was found necessary to collect the fruits as they reached maturity, because they were quickly attacked by a fungus growth which seriously injured the tallow.

During 1929 samples of sound fruits were received from California, Florida, and Texas. The vegetable tallow extracted from the fruits of the combined samples was examined by T. P. Hilditch and J. Priestman.[1] The oil was expressed from the seeds by means of the oil expeller. The results of our investigation of this oil will be given along with those recently obtained from a sizable sample Chinese stillingia oil received last May and for which we are indebted to Dr. E. Schnelke and the Murray Oil Products Company.

An examination of the literature showed that no comprehensive study of the oil had previously been undertaken. The published analyses included only the chemical and physical characteristics of several samples of the oil and the insoluble mixed fatty acids.

From the data presented in this paper, it would appear that the most important use for this oil would be in the manufacture of paints, varnishes, and similar products. The characteristics of the two samples of oil are given in Table I.

TABLE I
The Chemical and Physical Characteristics of Stillingia Oil.

	Chinese Oil	American Oil
Refractive index at 25° C.	1.4817	1.4830
Iodine number (Hanus)	169.0	176.1
Thiocyanogen value	100.7	102.7
Saponification value	206.2	211.7
Acid value	3.7	3.1
Acetyl value (Andre-Cook)	...	8.5
Reichert-Meissl value	1.64	0.6
Polenske number	0.97	0.6
Unsaponifiable matter	0.78%	0.61%
Saturated acids (Bertram)	8.67%	6.19%
Unsaturated acids	85.70%	88.60%
Total neutral oil	97.5	97.6

Unsaturated Acids

The percentages of oleic, linoleic and linolenic acids in each case were calculated in the customary way from the iodine and thiocyanogen values and the quantity of unsaturated acids present in the oil. The calculated quantities of each of these unsaturated acids are given in Table II.

TABLE II—UNSATURATED ACIDS

Acids	Chinese Oil Per cent	Chinese Per cent in Oil	American Per cent in Oil
Oleic	12.2	10.4	7.7
Linoleic	58.2	49.9	56.3
Linolenic	29.6	25.4	24.6
	100.0	85.7	88.6

Saturated Acids

The saturated acids separated from the saponified oil by the lead-salt ether method were esterified with anhydrous ethyl alcohol in the presence of dry hydrogen chloride.[2] The esters, which amounted to 65.3 grams after being freed from solvent and moisture, were fractionally distilled under diminished pressure. Each fraction in turn was redistilled in the usual manner under a pressure of 1 mm. Five fractions were obtained and the composition of each one was determined by methods which have been previously described.[3] The final results which were calculated from the analytical data, including the acids obtained from the undistilled residue, are given in Table III.

TABLE III—SATURATED ACIDS

Acids	Chinese Oil Per cent	Chinese Per cent in Oil	American Per cent in Oil
Palmitic	68.00	5.89	4.42
Stearic	30.50	2.64	1.43
Arachidic	1.50	0.14	.34
	100.00	8.67	6.19

*Presented at the Twelfth Fall Meeting of the American Oil Chemists' Society, Chicago, Oct. 6th and 7th, 1938.

The acids were recovered from portions of the ester fractions and the undistilled residue by saponifying them with alcoholic potash and decomposing the soaps with hydrochloric acid. The acids were collected and completely separated from potassium chloride and any free hydrochloric acid by remelting them with hot distilled water in the usual manner, and in each case they were subjected to fractional crystallization from ethyl alcohol. Ararchidic acid was found only in the undistilled residue, which also contained a small quantity of stearic acid. On account of the rather high saponification value of the oil, it was expected that some myristic or lauric acid might be present, but none was found in the two samples of oil examined. This high value is probably due, in part if not entirely, to the presence of volatile acids which are indicated by the Reichert-Meissl and Polenska values. The acids from the ester fractions, which were isolated and identified in each case, confirmed the deductions previously made from the mean molecular weights of the esters of the saturated acids.

The composition of the oils in terms of glycerides is given in Table IV.

TABLE IV—GLYCERIDES OF

Acids	Chinese Per cent in Oil	American Per cent in Oil
Oleic	10.9	8.0
Linoleic	51.9	58.5
Linolenic	26.4	25.5
Palmitic	6.2	4.6
Stearic	2.8	1.5
Arachidic	0.15	.35

REFERENCE LIST

(1) J. Soc. Chem. Ind., **49**, 497T (1930).
(2) J. Amer. Chem. Soc., **42**, 1200 (1920).
(3) J. Amer. Chem. Soc., **46**, 775 (1924).

WHAT THE BAKER WANTS IN A SHORTENING

WILLIAM H. CATHCART
(RESEARCH DEPT., AMERICAN INSTITUTE OF BAKING, CHICAGO, ILL.)

THE remarks in this short paper will be limited to shortenings for yeast raised products. Although the purpose of this paper is to enumerate what the baker wants in a shortening, it is felt that it is necessry first to discuss briefly the different types, the amounts used, and the effects.

Common Types of Shortenings:*

The common types of shortenings used in yeast raised products are as follows:

1. Open kettle rendered pure lard
2. Steam rendered pure lard
3. Vegetable oil compound type shortenings
4. Vegetable oil-animal fat blended type shortenings
5. Hydrogenated shortenings
6. Butter
7. Oleomargarine
8. Oleo oil
9. "Dry shortening"

It might be well to point out that types 1 through 5 are most commonly used. The only exception to this would be Danish pastry, where much of the oleomargarine type shortening is used.

Amounts of Shortening Used in Various Products:

The percentage of shortenings used in various yeast raised products varies considerably as is shown in the following table. The figures given are average ones, and the percentage shortening for any one type of product will vary from baker to baker. For instance, in bread today bakers use varying amounts, ranging from 2 to 10 per cent, with the majority using possibly 4 per cent when based on the flour weight. It is interesting to note how this majority figure has increased since 1928 (see Table I).

TABLE I*

Type of Yeast Raised Product	Average % Shortening Based on Flour as 100%
French bread	None
Pan bread 1928	2
Pan bread 1938	4
Soft rolls	8
Sweet rolls	12-15
Special breads	15
Danish pastry	50-65

The Effects of Shortening:

Considering the average amounts of shortening used in bread (4 per cent) and the way in which it is used, the primary effect of shortening in bread is a lubricating one. One can picture this as the lubrication of the individual gluten strands and starch particles; thus enabling them to slide over each other more easily. The results of this action are as follows:

(1) The fermentation period is slightly shortened in amounts up to approximately 3%.
(2) The crust is more tender due to "shortness": i.e., it has better eating qualities.
(3) The volume of the loaf is improved in amounts up to approximately 3%.
(4) The symmetry of form is improved.
(5) The grain of the bread is improved.
(6) The texture becomes finer and more silky.
(7) The crumb becomes "shorter," softer, and the development of crumbliness is delayed.
(8) The life of the bread is increased. This is probably due to a delay in the loss of moisture due to the coating of shortening around the individual particles.

*At the Fall Meeting (1938) of the American Oil Chemists' Society, William Walmsley presented a paper on "The Procedure of Bread Making" as an introduction to the present paper. The common types of shortenings used and the amounts in which they are used were included in Walmsley's remarks.

Now, there are some effects which are simply due to the presence of the shortening. These are:

(1) The crust has more lustre.
(2) The crumb color is more brilliant.
(3) The energy value of bread is increased since fats or oils yield 2¼ times as much energy as carbohydrates.
(4) The flavor and taste are improved.

The above effects apply specifically to bread; however, they can be applied with modification to all yeast raised products in which larger percentages of shortening are used, such as coffee cakes and sweet rolls.

Effects of Too Much Shortening:

The effects of too much shortening are:

(1) Loss of volume resulting in a compact, soggy loaf.
(2) Greasy grain and texture.
(3) Greasy taste.

It must be pointed out here that these characteristics do not become pronounced unless very large quantities of shortening are used.

Shortening in Relation to Flavor:

In the percentage of shortening normally used in bread, the average consumer is not able to tell whether the loaf they are using contains lard, hydrogenated shortening, dry shortening, or in many cases even butter. Some bakers believe that there are definite flavor differences between bread produced say with lard and hydrogenated shortening.