INTERCHANGEABILITY OF OILS AND FATS IN THE SOAP INDUSTRY

Note: But little quantitative information has ever been available on the industrial consumption of oils and fats and particularly on the competitive relation that exists among the different products in their ultimate uses. The soap industry, because of its size and varied production, offers the broadest possibilities for this interchange of raw materials. It is of interest, therefore, to study the consumption statistics in this industry over a considerable period in order to evaluate the factors that determine suitability. Such a study has recently been completed by the United States Tariff Commission in its investigation of vegetable oils under the provisions of the flexible tariff. The following article, abstracted from the commission's preliminary statement of information by Chemical and Metallurgical Engineering, is typical of the economic study that has been made in each of the principal oil-consuming industries.

Any oil or fat may be converted into soap, but the kind of soap produced will vary greatly because of the widely different physical and chemical characteristics of the various oils and fats used. Each kind or grade of soap is made from an oil or combination of oils that will yield a product of the desired properties. When there are considered the many types of toilet soaps and the large variety of soaps that are used in everyday life, as, for example, soap chips, soap powders, laundry, scouring, shaving, shampoo, medicated, liquid, mechanic's textile, and automobile soaps, it will be seen what a wide difference exists in the soaps obtained by the use of various oils and fats and other ingredients and by different methods of manufacture.

Interchangeability in the soap industry does not mean complete substitution of one oil for another. Although this may occur, interchangeability usually involves changes in the relative proportions of the contituent oils and fats, and also substitution of other materials for a portion of one or more of the constituents, as dictated by prevailing prices.

One of the most important factors in buying oils and fats for soap making is the titer of the material, which indicates the hardness of the soap that can be made from it. Manufacturers endeavor to have each brand of soap of a uniform consistency. In making hard soaps, materials of low titer, such as soya-bean, cottonseed, olive, corn, or whale oils, cannot be used exclusively. If they are used they must be mixed with a material of high titer, such as tallow, palm oil, or coconut oil.

The fatty-acid content is important from the soap makers' point of view, inasmuch as the higher the fatty acid, the smaller is the recovery of glycerine—a valuable byproduct. In general, materials of high fatty-acid content do not make satisfactory stock for soaps (including most toilet soaps) which are made by direct treatment of oils and fats in the soap kettle with caustic soda. The free fatty-acid content is of less importance, except for the recovery of glycerine, in oils and fats used for laundry and industrial soaps, which are largely made from fatty acids after being separated from the oil or fat.

The color of an oil or fat is not usually so important in making soaps as it is in the manufacture of edible products. However, white soaps, soap chips, and soap powders must be made from materials which will yield a product of good permanent color. The oils and fats most suitable for white soap are coconut oil, tallow, and white greases. These are not fully interchangeable with each other because of the different properties which they impart to the finished soap. Some soaps are made from oils which give a characteristic color to the product, such as the green of olive-oil foots, and the orange shade of palm oil. Such oils cannot be used in white soaps in amounts which will affect the color.

Yellow laundry soaps are made from lower grade materials the color of which often cannot be removed. Such materials include low-grade tallows, garbage and tankage grease, yellow and brown greases, vegetable-oil foots, fish oils, and offgrade cottonseed oil. Rosin is commonly used in laundry soaps and imparts a yellow color to the soap. White laundry soaps have replaced the yellow to a considerable extent; they are made from better grades of oils and fats, such as coconut oil, tallow, and white greases. The soap used in scouring powders is usually made from vegetable-oil foots, tallows, and greases.

Soaps possessing special characteristics are made from certain individual oils. Pure castile soap should be made from olive oil only. Much of the soap sold in the United States as castile soap, however, is made from oils or fats other than olive oil. Shaving, marine, and hard-water soaps usually contain a large proportion of coconut oil because of the excellent lathering qualities of soap made from it. Certain transparent soaps are made from castor oil. Linseed oil is the basis of some liquid soaps.

Classified by Technical Characteristics

Some of the principal oils and fats used in the manufacture of soap may be divided into three rather broad classes. The grouping shows the titer and the iodine number of each oil or fat. The titer indicates the hardness of the soap resulting from the oil and the iodine number of amount of hydrogen that the oil will combine with when hardened.

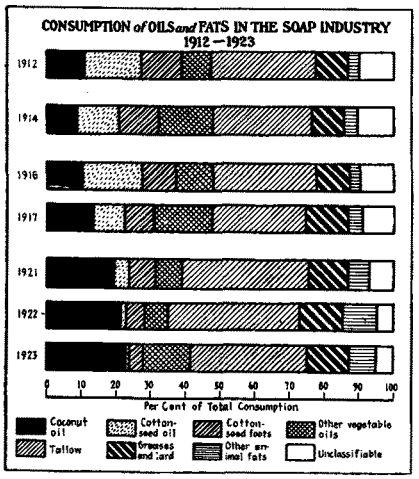
Table I.—Titer and Iodine Number of Typical Soap Oils

	Titer	Iodine Number
Group I:		
Tallow	38—48	35—41
Palm oil	36—45	53.3
Group II:		
Coconut oil	22.5—25	8. 4— 9.3
Palm kernel oil	20.5—25.5	12
Group III:		
Cottonseed oil and foots	32—35	111—115
Soya-bean	21.2	138—142
Peanut oil	29.2	95—104
Corn oil	19	119.5
Olive oil foots	17—26	86—90

Table II.—Oils and Fats Used by the U. S. Soap Industry (in thousand pounds)

Consumption of—	1912	1914	1916	1917	1919	1921[1]	1922[1]	1923[1]
Vegetable oils:								
Coconut	78,816	77,959	111,084	168,602	182,613	194,417	237,702	267,982
Corn	9,822	11,368	12,821	15,997	2,405	2,405	4,941	5,617
Cottonseed	132,312	119,254	194,916	126,390	56,130	47,935	19,759	10,824
Olive-oil foots	5,457	7,298	9,411	10,500	3,964	15,842	20,688	27,324
Olive-oil, inedible	690	748	1,184	1,731	935	767	1,047	1,317
Palm	7,546	[2]71,896	14,938	27,345	17,268	24,386	30,389	102,323
Palm kernel	20,579	31,376	5,804	4,762	4,551	593	685	3,287
Peanut	31	76	1,181	15,126	3,055	10,983	6,711	6,905
Soya-bean	1,182	4,499	57,373	124,058	58,401	10,756	2,307	3,266
Cottonseed foots	89,127	108,141	112,178	115,942	108,389	76,018	61,966	52,676
Miscellaneous	20,142	17,831	21,604	25,694	20,328	11,807	9,952	10,477
Total	365,704	450,446	542,594	636,147	457,769	395,909	396,147	491,998
Animal fats and oils:								
Bone grease	17,526	16,632	19,535	37,032	([3])	839	2,107	1,308
Garbage grease	12,619	13,627	28,719	63,118	([3])	19,104	22,010	15,493
Lard	8,469	10,484	8,294	7,481	([3])	([4])	([4])	([4])
Recovered grease	2,858	10,627	8,531	12,680	([3])	([4])	([4])	([4])
Tankage grease	28,566	31,822	35,769	38,303	([3])	247	1,427	173
Tallow	238,685	270,713	338,931	362,297	([3])	373,223	429,966	401,926
White grease	([4])	([4])	([4])	([4])	([3])	31,489	36,902	42,669
Yellow grease	([4])	([4])	([4])	([4])	([3])	32,009	36,872	39,352
Brown grease	([4])	([4])	([4])	([4])	([3])	30,461	42,667	41,170
Red oil	8,723	10,275	10,230	12,812	24,205	13,149	10,431	12,233
Herring and sardine oil	56	10,339	2,705	4,104	([3])	}		
Menhaden	116	882	330	2,279	([3])	} 32,592	29,689	31,941
Whale oil	9,927	4,023	8,126	5,732	([3])	5,021	60,816	41,328
Miscellaneous	7,272	13,202	18,860	30,919	406,412	12,241	9,217	11,857
Total	334,817	392,826	480,030	576,757	430,617	550,375	682,104	639,450
Unclassifiable:								
Fatty acids, acidulated and misc. soap stock	74,635	92,917	107,388	124,601	30,653	71,039	53,808	57,328
Grand total	775,156	936,189	1,129,812	1,337,505	919,039	1,017,323	1,132,059	1,188,776

[1] Estimated from data submitted to Tariff Commission. [2] Bulletin 769, U. S. Department of Agriculture, Supplement, p. 6, reported 71,896,000 pounds of palm oil consumed in soap in 1914. This figure is apparently an error, since it exceeds imports of palm oil in either 1913, 1914, or 1915 by about 20,000,000 pounds. [3] Included in miscellaneous animal fats and oils. [4] Included in other specified animal fats and oils.



Chart, Based on Table II, Showing Relative Percentages of the Different Oils Used in the Manufacture of Soap.

In general, it may be said that in the manufacture of soap the substitution of one oil for another is made within the limits of each group. It is, of course, possible to make an oil in Groups II or III comparable with tallow and palm oil in Group I by the process of hydrogenation or hardening. Unless a soap company is also engaged in the manufacture of lard substitutes, which require the hardening of vegetable oils, it is not ordinarily equipped to harden oils for exclusive use in the manufacture of soap. Such companies therefore depend largely upon oils and fats that produce hard soaps, such as tallow and palm oil, since they prefer not to buy hardened oils from competing companies.

Palm oil and tallow are not so closely related that one can completely replace the other, but palm oil may in part replace tallow in soap.

In Group II, coconut and palm-kernel oils are practically equivalent, and a difference in price of one-eighth to one-quarter cent per pound may cause a shift from one to the other oil. The oils and fats in Group III make softer soaps than those in Group I and II. These oils are generally used to reduce the titer or hardness of soap made from tallow and palm oil. In this group cottonseed, peanut, and corn oils, except foots and off grades, are ordinarily too high priced to be used for soap. Corn oil when used in the manufacture of soap oxidizes and thereby tends to darken the finished product; it also develops an unpleasant odor in the soap. Cottonseed oil not only is too expensive for the cheaper grades of soap, but when used in the finer grades of toilet soaps causes them to deteriorate.

Soap makers who specialize in trade-marked brands of soap which are widely advertised are more conservative in shifting from one oil to another. They will not risk the loss in sales which might result from modification of their soap formulas to an extent noticeable by consumers of their products. Olive-oil foots and palm oil produce colored soaps. Obviously such oils cannot be used in white soaps in appreciable amounts.

So numerous are the factors entering into the making of a soap that it is not possible to state definitely the exact degree of interchangeability which exists between the various oils and fats. The extent to which interchangeability or substitution is possible depends not only on the soap

maker but on the kind of soap produced. Therefore, only the above generalizations can be made, and emphasis laid on the more important factors, such as titer, color, odor, fatty acid. brands and trade-marks, and price, which affect interchangeability.

Table II shows the consumption of oils and fats by the domestic soap industry from 1912 to 1923, inclusive, except the years 1913, 1915, 1918, and 1920. The estimated consumption for 1921 to 1924, inclusive, is based on returns to the Tariff Commission from 74 companies producing about 90 per cent of the total soap production. The accompanying chart, based on the figures on Table II, indicates the relative percentages of the different oils and fats used by the soap industry in seven typical years since 1912.

In 1923, 56 per cent of all the oils and fats used by the reporting companies in the soap industry was made up of tallow and cocoanut oil, 34 and 22 per cent, respectively, of all oils and fats. If other animal greases are added the total would represent more than two-thirds of the oils consumed in the manufacture of soap. Among the other oils and fats consumed by the soap industry are palm oil (8.6 per cent of all oils and fats), fish oils, including whale oil (6.2 per cent), and cottonseed foots (4.4 per cent).

Coconut oil is now the most important vegetable oil used in soap manufacture, making up 23 per cent of the total of oleaginous materials. The use of this oil has steadily increased and is now more than twice as great, in relation to all oils, as in 1912 and 1914, and the actual quantity consumed is more than three times as much. The import duty of 2 cents a pound on coconut oil does not apply to shipments from the Philippines, which are about 96 per cent of the total quantity entering the United States. Nor is there a duty on imports of copra, whatever the origin. More than 99 per cent of the coconut oil used by soap manufacturers since 1921, including the oil produced in this country from imported copra, was exempt from import duty.

Palm oil, which is not dutiable, was unimportant in 1912, supplying less than 1 per cent of the total consumption of oils and fats used in soap factories. In no year between 1912 and 1917, inclusive, did the consumption of palm oil exceed 2 per cent of the total. In 1921 and 1922 palm oil supplied about 2.5 per cent of the total consumption, and in 1923 about 9 per cent (102,323,000 pounds). The consumption of inedible olive oil, including olive-oil foots—also nondutiable—has also shown a significant increase, although still a small part of the total. In 1923, the consumption was 28,641,000 pounds, or between four and five times the pre-war figure, but represented only 2.3 per cent of all oils and fats. Palm-kernel oil, which is a substitute for coconut oil, has declined greatly, not only in

actual quantity but in relation to all oils consumed. The consumption in 1923 was only one-tenth of that in 1912 and 1914 and was only three-tenths of 1 per cent of all oils used. Although a desirable oil and exempt from duty, British control of the trade in and crushing of palm kernels, prevents its extensive use in the United States. Palm-kernel oil is one of the most important oils used for soap making in England.

The increase in the use of soya-bean oil by the soap industry from 1,000,000 pounds in 1912 to 124,000,000 pounds in 1917, and the subsequent decline to less than 3,500,000 pounds in 1923, is one of the striking changes that have occurred in the consumption of oils by the soap industry. But in relation to the total consumption of oils and fats in soap, soya-bean oil has never been of major importance. At the peak of consumption, in 1917, under abnormal conditions of demand for all oils and fats, it supplied only 9 per cent of the total. (See Tables II and III.)

Table III.—Relative Consumption of Oils and Fats by the Soap Industry in the United States: 1912, 1914, 1916, 1918 and 1921-23

(Percentage of total oils and fats consumed)

Consumption of—	1912	1914	1916	1917	1921	1922	1923
Vegetable oils:							
Coconut	10.2	8.3	9.9	12.6	19.1	21.0	22.5
Corn	1.3	1.2	1.1	1.0	.2	.4	.5
Cottonseed	17.1	12.3	17.3	9.5	4.7	1.7	.9
Olive-oil foots	.7	.8	.8	.8	1.6	1.8	2.3
Palm	1.0	17.7	1.3	2.0	2.4	2.7	8.6
Palm kernel	2.6	3.3	.5	.4	(2)	(2)	.3
Peanut	(2)	(2)	(2)	1.1	1.1	.6	.6
Soya-bean	(2)	.5	5.1	9.3	1.1	.2	.3
Cottonseed foots	11.5	11.5	9.9	8.7	7.5	5.5	4.4
Miscellaneous	2.9	2.5	2.1	1.9	1.2	1.1	1.0
Total	47.2	48.1	48.0	47.3	38.9	35.0	41.4

Table IV.—Comparison of Consumption of Cottonseed Oils, Cottonseed Foots, and Soya-Bean Oil in Soaps, 1912-1923

	Cottonseed Oil		Cottonseed Foots		Soya-bean Oil	
Year	1,000 Pounds	Per Cent of Total Oils Used	1,000 Pounds	Per Cent of Total Oils Used	1,000 Pounds	Per Cent of Total Oils Used
1912	132,312	17.1	89,127	11.5	1,182	0.2
1914	119,254	12.7	108,141	11.6	4,499	.5
1916	194,916	17.3	112,178	9.9	57,373	5.1
1917	126,390	9.5	115,942	8.7	124,058	9.3
1919	56,130	6.0	108,389	12.0	58,401	6.0
1921	47,935	4.7	76,018	7.5	10,756	1.1
1922	19,759	1.7	61,966	5.5	2,307	.2
1923	10,824	.9	52,676	4.4	3,266	.3

Cottonseed oil in pre-war days was an important soap material, supplying (together with the foots) between 200 and 300 million pounds

annually, or 25 and 30 per cent of the total oils and fats consumed in the industry. After 1916 there was a steady decline in the utilization of cottonseed oil, until in 1923 it constituted less than 1 per cent of all oils and fats used in soap. The consumption of cottonseed oil and foots by the soap industry in 1923 was 63.5 million pounds, or less than 6 per cent of the total consumption of all oils and fats. Table IV gives comparative figures for cottonseed oil and foots and soya-bean oil used in the manufacture of soap.

The figures in Table IV indicate that since 1917 American soap makers have not found it practicable to replace soya-bean oil with cottonseed oil. The consumption of both has declined greatly since that year. The explanation is found in the rising price of cottonseed oil relative to other oils, which removes it from the soap-maker's market and restricts its use to edible products, such as lard compound.

In the last 12 years neither peanut oil nor corn oil has furnished as much as 1.5 per cent of all the oils used in soap making. The use of both of these oils for edible purposes has tended to remove them from the soap-maker's market.