definitely clearcut and good checks are obtained in replicated determinations of a given sample.

Summary

A general reagent applicable to a wide range of thiocyanogen values and capable of reacting with practically all types of fats and oils has been described.

The principal features of the method include rigorous purification of all reagents; replacement of 25% of the volume of glacial acetic acid normally used in preparing the thiocyanogen reagent with an equal volume of carbon tetrachloride; use of finely powdered, dry potassium iodide; increase in the amount of potassium iodide added prior to titration from 1.0 gram to twice the equivalent weight calculated for the volume of standard reagent used; and complete exclusion of water from all reagents and glassware.

The value of the modified reagent is attested by data indicating its improved stability, accuracy when applied to pure unsaturated fatty acids, and its general applicability to a wide variety of fats and fat products.

Acknowledgment

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Soybean Oil

O. H. ALDERKS
(Member, Soybean Research Council)
M. A. & R. Building, Ivorydale, Ohio

SOYBEAN OIL is "coming of age" in the United States. Figure No. 1 shows the relative United States production of the six most important vegtable oils, and Table No. 1 (appended) shows also the annual disappearance of these six oils.

An examination of these data shows that the United States consumed annually over 100,000,000 lbs. soybean oil for five consecutive years during World War I (1916 to 1920, inclusive), reaching a high of 335,000,000 lbs. in 1918. All of this oil was imported, and much of it was of relatively poor quality with the result that United States usage dropped markedly after 1920.

It was not until 1922 that *domestic* soybean oil was produced in marketable quantities. The growth of production was slow at first and then progressed at a more rapid pace, as shown by the solid curve in Figure No. 1, until in 1944 it well exceeded the billion-pound mark and equalled the production of cottonseed oil for the first time.

How much of this record current high domestic production is a result of World War II, brought about because of curtailment of importation of vegetable oils from the Pacific islands regions? How much of this current high production and usage is likely to remain in post-war times? Perhaps an examination of the usage of soybean oil in the past decade will help in part to answer these questions.

Usage of Soybean Oil

The tabulation in Table No. 2 shows the main usage of soybean oil and the relative growth in terms of usage in the various products.

The tabulation shows also the marked increase in usage of soybean oil in recent years for edible purposes, namely, in shortenings, margarine, and salad oils and the relative slower increased usage of soybean oil for "drying oil" purposes.

For example, in 1943 the usage of soybean oil in edible products was 891,000,000 lbs., or about 90% of the total. This was due in part to the allocation of oils in 1943, but even in 1940 and 1936 the respective percentage usage of soybean oil in edible products was 86% and 87%. The main usage of soybean oil in the United States in the past 10 years has been in edible products.

Usage of Soybean Oil and Competing Oils in Products

Table No. 2 lists the various products in which soybean oil has been used and shows the annual amounts thus consumed. The relative importance of

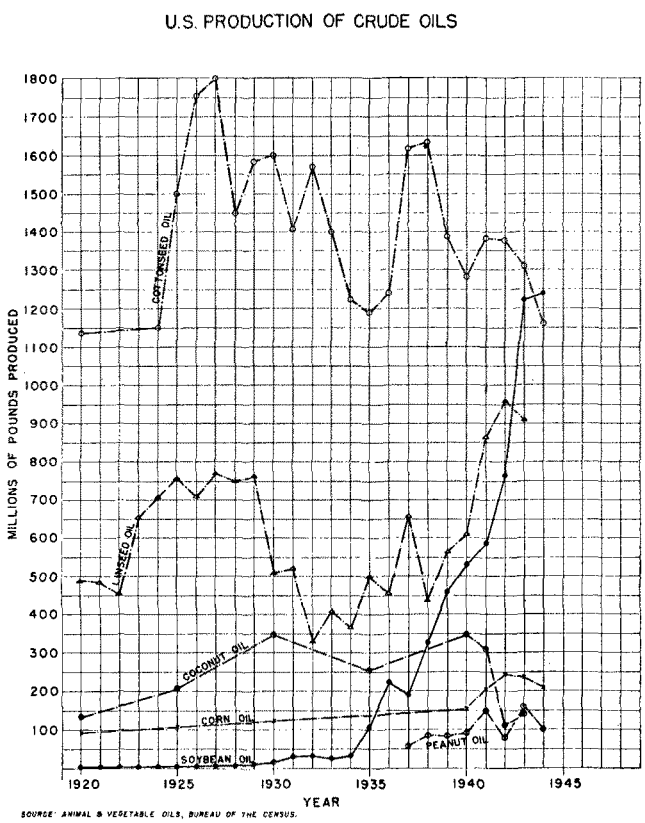

FIG. 1.

soybean oil to other competing oils in these products is interesting.

To show this relative importance, Figure No. 2 and Figure No. 3 have been prepared indicating percentage usage of the competing oils. Above each circle the total oil used in the product is shown. Diagrams for 1936, 1940, and 1943 have been drawn side by side to show the recent trends in soybean oil usage during the past eight years.

To show *annual* variations in fats and oils usage, three tabulations as follows are appended:

a) Shortening, 1929 to 1943, incl., Table No. 3.
b) Margarine, 1913 to 1943, incl., Table No. 4.
c) Paint, varnish, linoleum, etc., 1912 to 1944, incl., Table No. 5.

The Usage of Soybean Oil in Edible Products

Figure No. 2 shows that the increased usage of soybean oil since 1936 and 1940 has been marked in shortening, margarine, and salad-cooking oils.

In shortening the 1943 usage of soybean oil is equal to that of cottonseed oil. It has replaced considerable cottonseed oil, which has been shifted to other edible products. It has also replaced palm, sesame and other miscellaneous oils not recently available. In shortening soybean oil has the following desirable characteristics: low bleaching costs, whiter products, good consistency behavior and good rancidity behavior. Its undesirable characteristics are: poor flavor stability, particularly of the lower grade oils, and additional cost to hydrogenate.

In margarine the increased soybean oil usage since 1936 has been equally as marked as in shortening. It has replaced all coconut, babassu, and similar oils and accounts for about 40% of margarine fat usage.

The usage of soybean oil in salad and cooking oils was about 22,000,000 lbs. in 1936; in 1943 this usage had increased to 124,000,000 lbs. Here again it replaced the unavailable cocoanut and palm kernel oils.

It is generally well known that all manufacturers of edible products, shortening, margarine, salad-cooking oils, etc., have used soybean oil in their advertised *Quality A Brands.* Generally the percentage used in these Quality Brands has been *limited* because the flavor stability problem has not been completely solved. It can be said, however, that much progress has been made on this problem in recent years, and today all edible fat manufacturers are using much larger quantities of soybean oil without serious quality difficulty than they would have thought safe for their B Brands several years ago. This development means that a large portion of the wartime usage will hold over in the postwar vegetable edible oil industry. This progress has resulted from a rapid stock turnover from grocers' shelves. Also, marked improvement has resulted from improved refining and water washing technique and the development of better subsequent processing, as for example, better selective hydrogenation (1, 2).

Better Farming and Processing Practices Affect Oil Quality

All of the above improvements in factory processing have contributed considerably to making soybean oil a higher quality product. Equally important is the generally improved processing of the entire soybean industry, beginning with the planting of better varieties of beans adapted to the various regions, improved farm practices such as better weed control, better and quicker harvesting of the beans, prompt

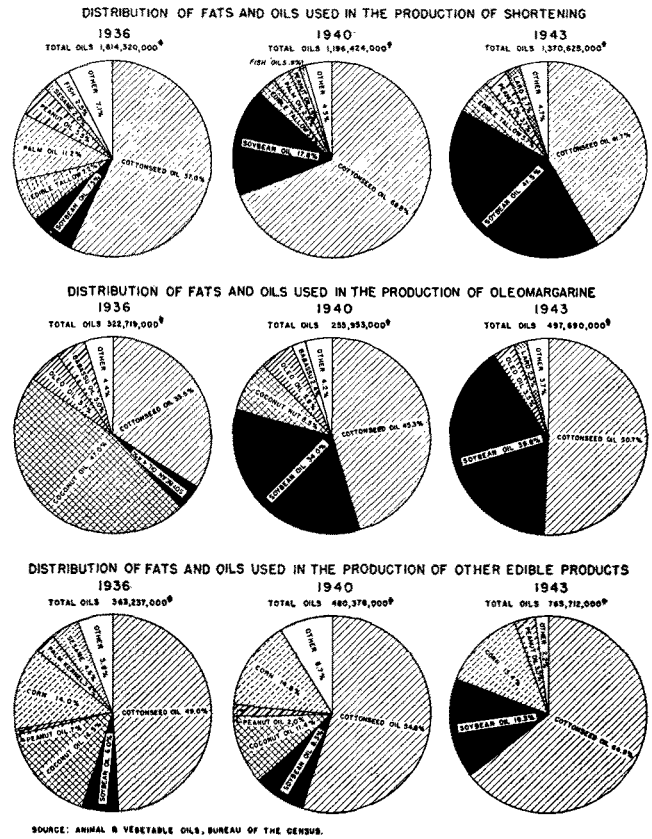

FIG. 2.

TABLE NO. 1

U. S. Production and Disappearance of Fats and Crude Oils

Calendar Year	Coconut Oil		Corn Oil		Cottonseed Oil		Linseed Oil		Peanut Oil		Soybean Oil	
	Prod.	Dis.	Prod.	Dis.	Prod.	Dis.	Prod.	Dis.	Prod.	Dis.	Prod.	Dis.
	Mil. lb.	Mil. lb.	Mil. lb.	Mil. lb.	Mil. lb.	Mil. lb.	Mil. lb.	Mil. lb.	Mil. lb.	Mil. lb.	Mil. lb.	Mil. lb.
1912	39	86	73	50	1,435	1,082	462	461	.5	8	....	25
1914	38	95	92	76	1,790	1,589	507	510	1	8	....	13
1916	100	164	110	101	1,492	1,321	532	526	29	44	....	143
1917	229	390	118	113	1,344	1,198	482	471	50	78	....	261
1918	271	626	111	111	1,284	1,218	375	370	96	164	....	335
1919	216	370	97	91	1,430	1,178	453	458	88	237	....	150
1920	131	341	99	87	1,143	911	485	492	13	97	....	103
1921	113	301	87	73	1,277	1,099	483	520	33	46	....	35
1922	186	382	112	115	935	966	457	640	23	40	1	21
1923	236	439	111	109	974	891	654	678	5	14	1	38
1924	191	409	117	115	1,154	1,053	706	707	7	10	1	14
1925	208	428	104	99	1,511	1,502	764	726	15	18	3	20
1926	261	445	120	115	1,764	1,514	720	714	11	19	3	26
1927	282	534	117	112	1,807	1,553	777	756	11	12	3	13
1928	311	569	124	121	1,460	1,507	751	785	12	17	5	10
1929	353	657	134	137	1,584	1,585	764	789	16	18	11	13
1930	353	655	121	127	1,616	1,584	516	544	25	25	14	18
1931	303	587	113	106	1,417	1,315	521	479	14	21	39	35
1932	264	554	106	107	1,571	1,240	327	358	13	15	39	39
1933	351	574	129	123	1,400	1,295	406	380	13	14	27	32
1934	297	597	115	132	1,224	1,566	371	417	47	26	35	31
1935	253	630	100	131	1,184	1,441	502	470	45	122	105	103
1936	258	640	127	151	1,247	1,340	456	485	70	120	225	222
1937	267	493	127	167	1,626	1,746	665	590	51	109	194	183
1938	287	605	137	149	1,678	1,658	441	490	78	91	323	305
1939	273	600	151	157	1,390	1,414	565	561	73	83	458	455
1940	347	598	158	172	1,274	1,378	606	590	84	62	533	499
1941	318	726	203	174	1,392	1,566	868	816	150	146	586	556
1942	111	202	248	264	1,386	1,402	960	832	77	93	762	718
1943	143	197	239	239	1,313	1,321	917	793	152	121	1,234	1,127
1944			210		1,160			725	105		1,240	

From—The Fats and Oils Situation.
FOS-29—July 14, 1939.

drying of the beans when necessary, better storage of the beans and improved methods of oil recovery. Each of these items plays an important role, more than is generally realized, in producing a high quality stable oil.

Oil of the highest quality can be obtained only from clean, fully matured, sound, fairly dry, yellow soybeans. Any deviation in bean quality results in extra processing and generally poorer flavor stability. The degree of damage may vary considerably. For example, green bean oil produced from frost-bitten beans in which full maturity of the bean was arrested will produce, after thorough bleaching, a final oil of fairly good quality and stability. However, field-damaged soybeans, in which the beans have become discolored and partially decayed by weathering, produce a definitely inferior quality oil of poor flavor stability (3). Beans of damaged quality can be blended with prime beans at processing plants in order to maintain plant processing capacity and so "lose" the darker oil by blending with prime oil, but in so doing a large quantity of contaminated oil with poorer keeping quality, namely, poorer flavor stability, is obtained.

The manner of processing soybeans is also important. It is generally agreed that soybean oil produced by the usual hydraulic pressing equipment is slightly inferior in quality to normal quality expeller oil or to solvent extracted oil which is generally of the highest quality.

In the case of the production of hydraulic soybean oil it has been reported that humidification of the soybeans above 12.0% will generally increase the yield of crude oil obtainable but at the expense of oil quality as measured by flavor stability (4). From a flavor stability point of view, soybeans to be processed in hydraulic equipment should be dried to about 10 to 11% moisture content.

The soybean oil usage data presented above show that approximately 86 to 95% of the oil produced in recent years has been used in the edible oil industry. This oil has commanded the same price whether it had

TABLE NO. 2

Usage of Soybean Oil in Various Products
(1,000 #)

	Shortening	Oleomargarine	Other** Edible Products	Soap	Paint and Varnish	Linoleum and Oilcloth	Printing Inks
1929	82	11	.....	6,396	5,815	3,229	71
1930	.....	.....	.....	5,000	.....	.....	....
1931	10,869	623	.....	3,816	6,256	2,612	33
1932	4,889	3	180	5,571	7,485	4,061	47
1933	489	7	460	4,235	8,568	5,641	65
1934	2,735	24	509	1,354	10,451	2,843	59
1935	52,452	1,740	9,421	2,549	13,003	4,816	52
1936	113,897	14,262	21,598	5,023	14,471	2,886	62
1937	90,798	31,793	15,530	10,274	16,143	934	80
1938	137,133	39,885	11,280	10,897	15,183	3,605	59
1939	201,599	70,822	32,345	11,177	21,720	6,438	62
1940	212,317	87,106	39,980	17,612	29,828	7,254	82
1941	215,967	75,634	47,976	24,737	41,594	7,666	255
1942	335,555	133,346	60,857	31,510	25,307	421	141
1943	568,405	198,020	124,562	15,428	20,462	273	48
1944*	449,643	157,176	133,903	2,436	14,558	40	18

* First *three* quarters, 1944.
** Mainly cooking, frying and salad oils.
U. S. Dept. of Commerce, Animal and Vegetable Fats and Oils.

TABLE NO. 3

Materials Used in Manufacture of Shortening

Calendar Year	Cotton-seed Oil	Soybean Oil	Peanut Oil	Coconut Oil	Corn Oil	Palm Kernel Oil	Rapeseed Oil	Linseed Oil	Palm Oil	Sesame Oil	Other Vegetable Oils	Lard	Edible Animal Stearin	Oleo Oil	Tallow Edible	Fish Oils	Marine Animal Oils
1929	1,161,848	82	3,586	72,145	25,459	11,824	138	....	1,191	5,215	102	23,123	44,138	7,553	25,556	14,921	....
1931	928,489	10,869	5,960	34,132	6,616	158	....	....	34,536	33,817	18,549	8,860	27,220	10,004	69,548	16,676	2,708
1932	834,367	4,889	3,502	8,332	3,067	....	....	....	22,126	7,797	957	5,636	17,357	1,134	45,708	11,520	2,185
1933	852,843	489	3,330	7,117	1,128	....	....	....	21,116	7,371	2,469	3,171	17,105	294	46,437	106,247	46,110
1934	1,058,733	2,735	8,837	9,045	1,895	....	122	....	16,717	4,720	2,527	2,635	21,517	764	73,416	10,775	304
1935	985,798	52,452	90,900	44,034	2,815	825	15,575	57	114,362	34,967	23,790	2,252	27,026	126	120,384	27,671	427
1936	918,866	113,897	88,470	38,427	430	627	30,572	....	168,808	33,120	21,216	4,503	36,358	1,839	116,908	36,649	....
1937	1,209,596	90,798	58,141	12,531	1,611	47	5,203	1,522	123,677	29,269	997	915	29,664	242	66,278	21,284	66
1938	1,040,162	143,318	52,402	26,199	399	614	297	6	115,033	5,435	1,645	2,825	32,845	291	74,251	16,529	48
1939	904,950	201,599	51,713	20,659	1,453	288	37	....	113,078	724	506	7,398	25,574	470	56,671	20,321	12
1940	823,359	212,317	22,516	17,576	746	1,146	....	....	33,224	24	381	16,786	16,940	880	39,595	10,902	....
1941	888,733	215,967	81,905	22,069	62	4	....	....	86,486	24	....[3]	50,787	23,103	1,282	41,227	6,165	....
1942	639,564	335,555	37,817	4,961	4,093[1]	1,179	....	....	29,303	2	50[3]	61,632	30,701	663	55,777	5,750	....
1943	572,208	568,405	50,886	3	6,356[1]	91	....	7,084	852	4	1[3]	36,407	29,726	2,660	78,552	12,584	....

[1] Includes muru-kernel and tucum kernel oil.
[3] Includes rendered pork fat, which was not classified separately before 1941.
From—Oil and Fats Statistics.

TABLE NO. 4

Fats and Oils Used in the Manufacture of Margarine
Year beg. July 1913-29.
Cal. years 1930-43.

Year Beginning July	Butter	Lard Neutral[1]	Oleo Oil	Oleo-stearine	Oleo Stock	Coconut	Cottonseed	Soybean	Peanut	All Other Fats and Oils	Total Fats and Oils
	1,000 #	1,000 #	1,000 #	1,000 #	1,000 #	1,000 #	1,000 #	1,000 #	1,000 #	1,000 #	1,000 #
1913	6,123	23,287	57,549	1,698	....	322	23,206	715	4,214	4,871	121,985
1914	4,694	24,904	55,615	1,764	5	300	26,556	369	2,850	3,737	120,794
1915	2,152	33,445	68,986	2,036	397	563	49,959	2,123	5,335	2,907	167,903
1916	3,316	42,415	95,933	2,459	3,458	19,614	63,497	6,570	10,493	3,373	251,128
1917	4,548	45,702	96,378	3,427	7,526	61,773	36,454	....	21,593	60	277,461
1918	5,680	45,764	97,464	2,456	6,342	69,640	37,846	....	38,764	40	303,996
1919	6,845	38,456	89,842	2,132	5,804	80,784	39,450	....	48,346	35	311,694
1920	1,499	39,268	49,676	4,858	2,065	103,112	18,533	461	16,332	7,828	233,632
1921	1,107	27,057	40,980	4,574	2,143	57,394	15,420	....	11,625	....	160,300
1922	1,576	29,568	46,645	4,815	2,322	65,656	18,757	....	6,922	....	176,261
1923	1,900	32,210	52,265	5,317	2,756	83,059	20,640	....	5,656	893	204,696
1924	1,509	25,674	44,102	5,250	3,183	79,449	20,966	....	4,392	964	185,489
1925	2,330	25,172	47,418	5,314	3,082	98,307	25,608	1	5,257	1,616	214,105
1926	2,070	24,872	48,741	5,145	2,552	107,654	23,372	33	4,872	1,293	220,603
1927	2,484	25,036	45,477	5,532	1,738	141,000	24,801	....	5,459	1,288	252,815
1928	2,611	24,189	47,185	5,834	1,294	171,411	28,173	....	6,617	1,402	288,716
1929	2,616	19,632	45,322	6,269	1,189	185,066	30,214	619	5,714	1,170	297,811
Calendar Year											
1930	1,687	14,905	38,914	6,024	1,278	177,989	27,445	2,257	5,785	1,121	277,405
1931	331	9,665	18,785	4,883	816	133,117	16,027	623	4,598	2,768	191,613
1932	38	9,413	12,454	3,684	469	123,219	15,096	3	2,518	320	167,214
1933	7	8,959	15,095	3,120	829	150,096	17,997	7	2,635	885	199,630
1934	11	7,486	21,872	3,478	1,454	123,678	54,778	24	2,744	71	215,596
1935	2	3,005	18,226	2,612	2,389	174,314	99,505	1,740	4,368	2,514	308,675
1936	....	2,199	18,330	3,550	1,930	150,465	108,106	14,261	4,140	21,307	324,648
1937	....	1,748	12,278	3,375	1,318	73,806	173,617	31,791	2,880	25, 413	326,226
1938	....	1,464	13,411	3,282	1,532	89,420	142,858	39,885	3,593	96,725	312,500
1939	....	1,355	11,866	3,067	1,042	38,519	98,656	70,822	2,445	14,986	242,758
1940	....	5,100	14,332	3,386	1,260	21,780	115,946	87,103	1,730	6,752	257,389
1941	....	8,300	18,415	3,058	1,919	29,786	149,930	75,634	2,210	8,933	297,185
1942	3	8,133	22,495	2,919	3,940	3,491	166,444	133,346	920	4,860	346,551
1943	....	10,694	17,236	3,448	2,819	....	252,109	198,020	4,564	11,304	500,194

[1] Quoted as "lard and neutral lard," 1913-14.
From—Oleomargarine—U. S. Dept. of Agriculture. August 1936.

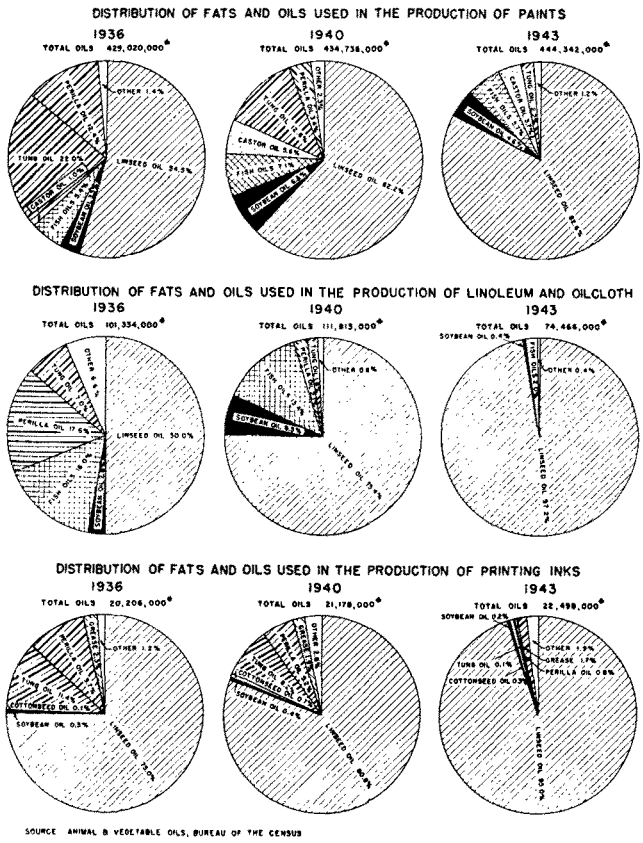

FIG. 3.

the best or poorest quality with respect to those properties in which the "edible fat" food processor is interested. Perhaps the soybean industry would serve itself best if an oil grading scale were adopted which would reflect the quality of the oil to the food processor and which would pay a premium to the crude oil processor for producing oil of highest quality. This is particularly important in the post-war period when soybean oil will have to compete with a variety of bland oils. By producing and segregating the highest quality soybean oils (premium oil) perhaps a very sizable quantity of soybean oil now used in quality brands can be retained there.

There are compelling reasons why edible fat manufacturers would prefer the usage of *domestic* soybean oil in their products. However, the American public appears to prefer edible products which have a "bland" flavor, and it is, therefore, important to the soybean industry that the work at the Northern Regional Laboratory and in other laboratories on improving the flavor stability of soybean oil be continued actively. This is undoubtedly the most important problem facing the continued usage of soybean oil in some edible products in the post-war period.

Development of Soybean Varieties Containing Better Quality Oil

In connection with the production of soybean oils of better quality for edible usage it is gratifying to report that current efforts of some plant agronomists are being directed not only to increasing the oil yield

TABLE NO. 5

Oils Used in the Manufacture of Paint, Varnish, Linoleum, Oilcloth and Printing Inks
(1912-44)

Year	Linseed Oil Used in Paint, Varnish, Linoleum, Oilcloth, and Printing Inks	Linseed Oil Used in Other Products	Total Apparent Disappearance of Linseed Oil	Tung Oil	Perilla Oil	Oiticica Oil	Castor Oil[1]	Fish Oil	Soybean Oil
	1,000 #	1,000 #	1,000 #	1,000 #	1,000 #	1,000 #	1,000 #	1,000 #	1,000 #
1912	.....	.....	460,639	42,707	.....	.....	.....	.....	.....
1913	.....	.....	603,259	42,405	76	.....	.....	.....	.....
1914	.....	.....	509,777	30,031	42	.....	.....	.....	.....
1915	.....	.....	502,206	33,867	79	.....	.....	.....	.....
1916	.....	.....	526,117	57,517	168	.....	.....	.....	.....
1917	.....	.....	471,347	40,847	976	.....	.....	.....	.....
1918	.....	.....	369,842	41,613	922	.....	.....	.....	.....
1919	.....	.....	457,752	51,360	4,743	.....	.....	.....	.....
1920	.....	.....	492,400	59,440	7,582	.....	.....	.....	.....
1921	.....	.....	519,875	37,623	652	.....	.....	.....	.....
1922	.....	.....	640,069	67,694	2,208	.....	.....	.....	.....
1923	.....	.....	677,700	82,491	6,441	.....	.....	.....	.....
1924	.....	.....	706,968	78,036	3,016	.....	.....	.....	.....
1925	.....	.....	726,085	86,705	6,017	.....	.....	.....	.....
1926	.....	.....	714,188	92,278	7,401	.....	.....	.....	.....
1927	.....	.....	755,516	84,668	5,358	.....	.....	.....	.....
1928	.....	.....	785,482	95,367	2,011	.....	.....	.....	.....
1929	.....	.....	788,506	109,530	5,574	.....	.....	.....	.....
1930	.....	.....	544,292	99,581	8,838	.....	.....	.....	.....
1931	471,318	7,497	478,815	91,160	12,353	.....	1,936	26,989	8,901
1932	353,989	4,477	358,466	75,081	12,071	.....	1,608	19,616	11,593
1933	375,923	4,488	380,411	103,709	26,522	.....	2,466	22,089	14,274
1934	408,886	8,026	416,912	114,965	24,889	.....	2,678	25,039	13,353
1935	465,021	5,463	470,484	127,622	64,257	.....	3,858	32,470	17,871
1936	478,026	6,946	484,972	118,896	112,400	2,622	4,794	39,636	17,419
1937	570,788	19,543	590,331	148,157	39,732	3,284	7,722	44,340	17,157
1938	479,813	9,714	489,527	90,295	41,894	3,969	6,043	29,781	18,847
1939	548,876	12,461	561,337	105,596	52,159	17,172	11,844	42,570	28,220
1940	575,524	14,616	590,140	66,937	19,415	14,510	24,857	45,967	37,164
1941	784,481	31,834	816,315	68,515	8,575	26,785	46,295	55,514	49,515
1942	775,748	55,831	831,579	10,636	3,712	9,172	52,432	26,113	25,928
1943	698,231	75,253	773,484	8,228	1,990	1,658	16,913	26,754	20,783
1944	650,000	75,000	725,000	10,000	400	15,000	80,000	.....	14,616*

Use of linseed oil in the drying oil industries represents total apparent disappearance minus use in "other products" reported by Bureau of the Census. Apparent disappearance of linseed, tung, perilla, and oiticica oils computed from data on production, trade and stocks, from reports of the U. S. Department of Commerce, and U. S. Dept. of Agri.

[1] Utilization in paint, varnish, linoleum, oilcloth and printing inks, Bureau of the Census. In recent years, this has consisted of dehydrated castor oil, but small quantities of No. 1 and No. 3 castor oil also are used.

* 9 mos.

From—The Fats and Oils Situation. FOS-93. Nov. 1944.

but also to reducing the linolenic acid content in soybean oil.

The tabulation in Table No. 6 shows the composition of peanut, cottonseed, corn, soybean, and linseed oils. Soybean oil owes its "drying" properties to the presence of 2.2 to 8.1% linolenic acid. In linseed oil this fraction is present from 25.7 to 58.3%. It is generally agreed by various investigators that the difficulty in maintaining flavor stability of soybean oil is associated with the presence of this unsaturated material. The "bland" flavored peanut, cottonseed, and corn oils do not contain linolenic acid.

TABLE NO. 6

Composition and Properties of Oils

	Peanut	Cotton-seed	Corn	Soybean	Linseed
Oleic	50.6-71.5	22.9-33.15	45.4-48.8	21.0-33.6	21.7-37.6
Linoleic	13.0-26.0	39.35-47.8	34.0-40.9	49.3-58.8	3.3-23.1
Linolenic	.....	.....	.....	2.2-8.1	25.7-58.3
Myristic	.....	.3-2.1	1.7	.....	.....
Palmitic	6.0-8.5	19.1-23.4	7.7-11.0	6.5-9.7	3.8-6.9
Stearic	2.6-6.0	1.1-2.9	2.9-3.5	2.4-4.4	2.2-4.8
Arachidic	2.6-4.9	0.1-1.3	0.4	.7-.9	.22-.86
Lignoceric	2.5-3.0	.....	0.2	.1	0-.36
Unsap. Mat.	.2-.3	0.9	1.7	.6	0.6-1.6
Smoke Pt.	464°F.	508	440	492	320
Fire Pt.	692	644	678	673	680
Flash Pt.	632	582	618	618	588
Iodine Value	83-95	103-115	116-130	103-152	170-204
Normal I.V.	90	109	126	130	180

From
"Vegetable Fats and Oils," George S. Jamieson (Reinhold Publishing Corporation, New York, 2nd Edition, 1943).
"Smoke, Flash and Fire Points for Commercial Oils," Oil & Soap, *9*, 69 (1932).
"A Short Hand-book of Oil Analysis," Augustus H. Gill (J. B. Lippincott Company, Philadelphia, 11th Edition, 1927), p. 266.

In the past agronomists have centered their attention on trying to improve the "drying" properties of soybean oil by increasing the linolenic acid content of soybean oil. Since 86 to 95% of soybean oil usage in the past eight years has found its outlet in edible products, attention should be directed at improving those properties, which will make it a more desirable oil for edible usage. Work should be directed at reducing the linolenic acid content to the lowest possible level.

The Usage of Soybean Oil in the Drying Industry

Important developments have been made in recent years for improving the quality of soybean oil both as an "edible" oil and as a "drying" oil by the separation of the saturated from the unsaturated glycerides. These processes, both the separation of glycerides and of the fatty acids, have been covered by numerous United States patents and other publications. A few typical references are listed and these will indicate others (5 to 13).

The purpose of all these processes is to separate oils, soybean oil for example, into two or more fractions, one composed of mostly saturated tri-glycerides having improved flavor and rancidity stability and other desirable characteristics for various food usage and a second fraction containing mostly unsaturated triglycerides having desirable "drying" properties.

Commercial units are in operation, processing considerable quantities of linseed, soybean, and some other oils. Edibility results on some samples of soybean and linseed oil raffinates which the writer has seen showed that the soybean raffinate was equal in flavor quality to regular soybean oil. The flavor quality of the linseed raffinate was not satisfactory for edible purposes.

No doubt, further development of these processes will improve the quality of some raffinates for edible usage. However, unless these fractions are definitely superior, they will not be able to carry any of the additional processing cost and these costs will have to be added to the unsaturated fractions. The unsaturated fractions are reported to have definitely desirable characteristics for various uses in the drying oil industry. These synthetic drying oils, whether the segregated oil or fatty acid (re-esterified), or alkyd resin, or conjugated oil type, have specific desirable characteristics which add to their value. With further development, increased usage of soybean oil may be expected for "drying" purposes.

Price of Soybean Oil Compared with Other U. S. Produced Vegetable Oils

Table No. 7 shows the average annual price per pound of the six U. S. vegetable oils discussed above for the period 1910-1944. The prices are shown in cents per pound in tank cars.

TABLE NO. 7

Average Annual Price of Crude Oils
(Price per pound tank cars—cents)

	Coconut Oil	Corn Oil	Cotton-seed Oil	Linseed Oil*	Peanut Oil	Soybean Oil
1910			6.66			
1911			5.04			
1912			5.13			
1913			5.87			
1914			5.72			
1915			5.67			
1916			9.34			
1917			14.03		15.0	
1918			17.50		18.1	
1919	15.3		18.63		20.3	
1920	14.6		13.20		.....	
1921	8.1		6.23		6.9	
1922	7.3		8.60		11.2	
1923	8.3		9.80		14.6	
1924	8.6	10.3	9.15		11.8	
1925	9.8	9.9	9.33		10.7	
1926	9.2	10.0	9.44	10.4	12.2	
1927	8.3	8.5	8.29	9.7	11.3	
1928	8.1	9.0	8.36	9.1	9.6	
1929	7.1	8.3	8.08	11.6	9.0	
1930	5.9	7.4	6.86	11.8	7.2	8.6
1931	3.9	5.8	5.29	7.8	6.2	5.5
1932	3.2	3.5	3.10	5.7	3.7	3.1
1933	3.0	4.1	3.66	8.5	4.1	5.4
1934	4.6†	5.9	5.57	9.0	6.0	6.0
1935	7.4	9.6	9.22	8.8	9.6	8.1
1936	8.0	8.9	8.6	9.5	8.8	7.5
1937	9.0	8.4	8.0	10.3	8.6	8.1
1938	6.1	7.1	6.71	8.74	6.9	5.59
1939	6.1	5.9	5.6	8.8	5.9	4.8
1940	5.6	5.7	5.3	9.0	5.7	4.8
1941	8.4	10.0	9.5	9.7	9.7	8.5
1942	10.9‡	12.7	12.7	12.2	13.0	11.6
1943	11.0‡‡	12.8	12.8	14.4	13.0	11.8
1944	11.0‡‡‡	12.8	12.8	14.3	13.0	11.8

* Linseed oil; raw, average price per lb., in tank carlots, Minneapolis.
† Includes excise tax of 3 cents beginning May 10, 1934.
‡ Ave. 11 mos.
‡‡ Ave. 7 mos.
‡‡‡ Ave. 7 mos.
From
U. S. Dept. of Agr. Stat. Bull. No. 59.
Fats and Oils Situation, Bur. of Agr. Ec. Monthly Bulletin 1937-44.

The average last 10-year price of these oils was as follows:

(1935-1944)

Crude Linseed	$.1057/lb.
Crude Peanut Oil	$.0942/lb.
Crude Corn Oil	$.0939/lb.
Crude Cottonseed Oil	$.0912/lb.
Crude Cocoanut Oil	$.0835/lb.*
Crude Soybean Oil	$.0826/lb.

* Includes $.03/lb. excise tax.

Soybean oil is at the foot of the class and fluctuates about one-half cent to one cent per pound lower

than cottonseed oil. This average lower price is due to soybean oil being a substitute oil for cottonseed, peanut, and corn oil in the edible field, requiring additional processing to make it usable. Similarly in the drying oil field soybean oil is classed as a "semi-drying" oil and therefore sells at a discount to linseed oil.

This "substitute" character will continue until research work eliminates the flavor stability problem in the edible field or until the separation of the oil into "fractions" makes them more valuable for edible and drying oil uses.

Postwar Soybean Oil Usage

What is the outlook for increased soybean oil usage in the United States in the post-war period? In the drying oil field some recent observations have been quite optimistic and others have indicated that an abundance of various drying oils will be available (14, 15, 16).

Reference to Figure No. 2 and Table No. 5 shows that soybean oil has not been a vital factor in the drying industry in the past. In 1941 its steady slow growth reached a usage just short of 50,000,000 lbs. a year (about 5% of the total oil usage in the "drying oil" industry). During the past three years due to restrictions this annual usage has dropped to somewhat less than half this quantity. It should be possible to recapture this lost ground and perhaps extend it, but the competition will be severe, particularly from such new products of research as dehydrated castor oil which will challenge the recognized advantage of soybean oil alkyds as a non-yellowing interior finish.

In the edible field the post-war competition of other oils will also be intense, but the picture for domestic soybean oil appears fairly bright for the following reasons: it is unlikely that the cotton crop will be increased hence the available cottonseed oil will remain near its present level. Similarly, the supply of peanut oil from domestic sources is not likely to expand under less controlled post-war conditions. It follows then that large supplies of other oils will be needed to furnish the oil for a 2.2 to 2.6 billion pound vegetable edible oils market. We know that soybean oil has had public acceptance in all types of edible products of good quality in these war years.

There are no other domestic oils available in large volume, and competition will come mostly from coconut and similar oils for usage in margarine and salad-cooking oils. For margarine there is considerable "legislative" advantage in using oils from domestic farms to compete with butter fat from the same and other domestic farms. All of these factors favor continued usage of soybean oil in the edible field.

The war has given soybean oil an enviable opportunity in the edible fats and oils industry. It is up to the soybean industry to continue actively an enlightened program to improve the quality of crude soybean oil by all methods—agronomic improvement of varieties, improved growing, harvesting, cleaning and storing of beans, improved oil processing with rewards for superior quality, continued research to improve its flavor stability, and continued development of "fractionated" soybean oil.

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Solidification Points of Binary Mixtures of Caprylic and Capric Acids[1]

H. A. SCHUETTE and H. A. VOGEL[2]
University of Wisconsin, Madison, Wis.

ON several occasions in the past progress reports (3) have been made from this laboratory on studies centering around the solidification points of binary mixtures of adjacent pairs of the saturated fatty acids of even number carbon atom content. Extension of these studies beyond the C_{32}-C_{34} pair has been temporarily halted because the probable present limit appears to have been reached in the practical application of the solidification-point diagrams of straight-chain acids to problems in fatty oil and wax analysis. Still unreported are pertinent data for the C_8-C_{10} pair, acids lying in the zone between those members of this homologous series whose solidification points are determinable by the procedure already described (3a) and those whose physical state requires modification of procedure for the determination of this constant. To complete the record (Table 2) on those even acids whose behavior has been to date studied is the object of this communication.

TABLE I

Properties of Saturated Fatty Acids

Acid	Molecular Weight		Melting Point °C.		Solidification Point °C.	
	Found	Theory	Found	Reported	Found	Reported
Caprylic	144.8	144.2	16.4	15-16	16.05	.....
Capric	172.0	172.3	31.6	30.8-31.5	31.60	.....

Because of their availability as distilled, natural products it was not deemed necessary to synthesize

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[2] Present address: Pittsburgh Plate Glass Co., Milwaukee, Wisconsin.