Hydrogenated Oil as an Ointment Base. II*

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Several years ago the writer reported that hydrogenated cottonseed oil was satisfactory as an ointment base to replace lard (1). At the present time hydrogenated peanut oil is the official base for several ointments in the Swiss Pharmacopœia (2), and other hydrogenated oils are being employed commercially in the United States in proprietary ointments. Hydrogenated castor oil was found to have characteristics which made it of value for ointments (3), particularly emulsified creams and cosmetics (4). It is the purpose of the present study to compare those hydrogenated oils which are being manufactured commercially at the present time.

Some hydrogenated oils (shortenings) in reality are merely the unhydrogenated oil with sufficient completely hydrogenated oil to give the desired consistency. Obviously, this is more economical, but from the standpoint of rancidity these oils are much more susceptible to deterioration than oils which had been partially hydrogenated. The principal advantage of hydrogenated oil over lard as an ointment base is the fact that, because of partial reduction, it is less susceptible to rancidity, and ointments prepared with it are more stable.

The hydrogenated oils used in this experiment are listed together with certain characteristics in Table I. The writer wishes to acknowledge the coöperation of the following manufacturers for samples and data (except softening point) in this table: Armour and Co., Chicago, Ill.; The Cudahy Packing Co., Chicago, Ill.; Durkee Famous Foods, Elmhurst, N. Y.; Mefford Chemical Co., Los Angeles, Calif.; The Proctor and Gamble Co., Ivorydale, O.; The Southern Cotton Oil Co., Savannah, Ga.; Spencer Kellogg and Sons, Inc., Buffalo, N. Y.; Swift and Co., Chicago, Ill.; Vegetable Oil Products Co., Inc., Wilmington, Calif., and Wilson and Co., Chicago, Ill.

EXPERIMENTAL

Melting points reported in Table I are not of uniform method. From the standpoint of ointments, it was considered that the softening point was more important; this was determined by the A. O. C. S. method (5).

Rancidity.—Samples of the various hydrogenated oils were melted and poured into test-tubes. One series was placed in a south window in direct sunlight (starting in February 1939) and the other series in the dark in an incubator at 36.5° C. From time to time the samples were examined and rancidity determined by the Kreis test (7). The results are indicated in Table II.

The data in Table II do not show a definite relationship between iodine number and rancidity; these samples were obtained from various manufacturers. In order to indicate the relationship between iodine value and rancidity, samples of the same batch of cottonseed oil were hydrogenated to various iodine values.[1] These were exposed to sunlight in the same manner as previous samples, differing, however, in the time of year, being exposed in May and June 1939. The results are shown in Table III.

Table II indicates that Hydrogenated Sesame Oil with an iodine value of 57.7 was by far the most stable of the partially hydrogenated oils. In order to determine if this is due to the relatively low iodine value, or to some inherent features of the oil, samples of the same batch of sesame oil were hydrogenated to various iodine values[1] and treated as above. The data are shown in Table III.

Consistency.—In order to make relative comparisons of the consistency, the hydrogenated oil was placed in a tin-coated, collapsible one-ounce tube with nasal tip and 4-mm. opening. The tubes were uniformly filled with the molten oil, sealed and allowed to cool. They were placed in an apparatus (see Fig. 1) consisting of a lever which compressed the tube while it was held in position by means of a perforated, beveled strip. The relative consistency was determined by the weight of material which would pass through the tip when various weights were added to the pan at the end of the lever for a definite length of time. The results are shown in Table IV.

Relative consistency was also determined by another method dependent upon the resistance of the fat to an object rather than a measure of the fluidity of the fat when compressed. The apparatus (Fig. 2) consisted of a metal disk 1.6 cm. in diameter attached to a 44-cm. vertical rod with a pan upon which weights could be placed. A scale was attached to the rod so that the extent of pene-

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[1] The writer is indebted to the Research Department of Armour and Co., Chicago, for preparing these samples.

tration could be measured. The melted fat was placed in a two-ounce jar and allowed to stand at room temperature for several days. The test was conducted by placing the disk below the surface of the fat (to avoid surface tension) and applying weights to the pan, measuring the extent of penetration after 60 seconds. The data are shown in Table V.

Absorption of Water.—Samples of various hydrogenated oils were added to an equal volume of water and allowed to stand with frequent agitation for 24 hours at a temperature above their melting points. They were then removed from the oven and allowed to stand at room temperature without agitation for 48 hours and then at 5° C for six days, as previously reported for hydrogenated castor oil (3). The fat was separated, adhering water removed and the moisture determined by the toluene-distillation method. The results are shown in Table VI.

TABLE I.—CHARACTERISTICS OF HYDROGENATED OILS USED

Hydrogenated Oil	Sample No.	Softening Point	Iodine Value	Melting Point	Free Fatty Acid (Oleic)	Saponification Value
Cottonseed, soft	1	36.3	66.7	38° C.	0.04%	199
Cottonseed, soft	2	37.2	62.0	45	0.02	197
Cottonseed, soft	3	39.4	66–9	39–40	0.02–0.04	...
Cottonseed, soft	4	29.5	...	38.0	0.01	...
Cottonseed, soft	5	31.3	66.0	...	0.02	196
Cottonseed, soft	6	35.7	62.0	37.2	0.01	...
Cottonseed, soft	7	41.5	62.7	43.3	0.02	...
Cottonseed, soft	8	29.8	70.0	39.0	0.03	198
Cottonseed, soft	9	41.8	57.9	44.0	...	...
Cottonseed, soft[a]	10	38.0	60.5	38.0	...	...
Cottonseed, soft[a]	11	37.7	65.0	41.0	0.03	...
Cottonseed, soft[a]	12	29.7	73.0	39.6	0.03	...
Cottonseed, hard	1	...	5.8	61.0	1.27	194
Cottonseed, hard	2	...	12.0	60.5	0.15	197
Cottonseed, hard	3	...	...	61.0	0.44	...
Cottonseed, hard	4	...	8.3	...	0.04	195
Cottonseed, hard	5	...	37.5	59.0	...	...
Cottonseed, hard	6	...	8.0	52.5	...	195
Untreated Cottonseed Oil, U. S. P.	..	...	105–114	...	...	190–198
Soybean, soft	1	36.8	70.3	39.4	0.04	192
Soybean, soft	2	36.5	72.0	42.0	0.03	192
Soybean, soft	3	35.9	72–6	38–9	0.02–0.04	...
Soybean, soft	4	35.8	74.0	...	0.02	195
Soybean, soft	5	40.8	83.0	46.0	0.05	190
Soybean, hard	1	...	4.4	62.5	0.53	192
Soybean, hard	2	...	9–16	61.0	0.02–0.04	...
Soybean, hard	3	...	10.0	65.5	...	190
Untreated Soybean Oil (6)	..	...	124–143	...	...	190.6–194.3
Coconut Oil	1	...	5.1	44.9	0.06	248
Coconut Oil	2	32.4	4–12	33.0	<0.035	252–260
Coconut Oil	3	43.0	4–12	43.0	<0.035	252–260
Coconut Oil[b]	4	34.4	1.5–3.5	38–9	0.01–0.02	...
Coconut Oil[c]	5	40.4	3.0	49.0	0.07	...
Untreated Coconut Oil (6)	..	...	8–9.6	23–26	...	251–263
Palm Kernel Oil	1	...	0.5–1	47–8	0.01–0.02	...
Palm Kernel Oil	2	...	0.5–1	48.5–9.5	0.01–0.02	...
Untreated Palm Kernel Oil (6)	..	...	...	16–23	24–30	244–255
Palm Oil	..	...	2.0	59.0	0.17	...
Untreated Palm Oil (6)	..	...	48–58	27–50	...	195–205
Peanut Oil, soft	..	40.7	73.3	42.5	0.04	190
Peanut Oil, hard	..	...	24.0	58.5	0.11	190
Untreated Peanut Oil (6)	..	...	83–95	...	...	185–190
Sesame Oil	..	42.7	57.7	45.6	0.04	189
Untreated Sesame Oil, N. F.	..	...	103–115	...	...	188–193
Lard, soft	1	38.0	51.0	44.9	0.06	194
Lard, soft	2	38.1	58–61	47–8.5	<0.03	192–6
Lard, hard	1	...	0.4	60.1	0.12	190
Lard, hard	2	...	< 2.0	61–2	<0.02	192–6
Untreated Lard U. S. P.	..	...	46–70	36–42	...	195–203

[a] A mixture, chiefly cottonseed oil. [b] With lecithin. [c] With a small amount of cottonseed oil.

TABLE II.—RANCIDITY OF HYDROGENATED OILS

Hydrogenated Oil	Sample No.	Iodine Value	Kreis Test 5 Weeks A	5 Weeks B	10 Weeks A	10 Weeks B	15 Weeks A	15 Weeks B
Cottonseed	1	66.7	0	0	4	0	7	0
Cottonseed	2	62.0	0	0	1	0	7	0
Cottonseed	3	66–9	1	0	2	0	7	0
Cottonseed	4	...	0	0	1	0	2	0
Cottonseed	6	62.0	T	0	2	0	7	0
Cottonseed	7	62.7	T	0	3	0	6	0
Cottonseed	8	70.0	0	0	2	0	7	0
Cottonseed	9	57.9	T	0	2	0	4	0
Cottonseed	10	60.5	1	0	3	0	6	0
Cottonseed	11	65.0	1	T	4	T	7	T
Cottonseed	12	73.0	T	T	2	T	7	T
Cottonseed, hard	1	5.8	1	0	1	T	4	T
Cottonseed, hard	5	37.5	2	0	4	0	6	T
Soybean	1	70.3	0	0	0	0	3	0
Soybean	2	72.0	T	0	3	0	6	0
Soybean	3	72–6	T	0	1	0	7	0
Soybean	5	83.0	T	0	2	0	7	0
Soybean, hard	2	9–16	0	0	T	0	4	T
Soybean, hard	4	...	0	0	T	0	T	0
Coconut	1	5.1	1	0	2	0	4	0
Coconut	2	4–12	1	0	2	0	7	0
Coconut	3	4–12	1	0	2	0	5	0
Coconut	4	1.5–3.5	2	0	5	0	7	0
Palm Kernel	1	0.5–1	.	.	.	.	.	.
Palm Kernel	2	0.5–1	T	.	1	T	1	T
Palm	..	2.0	T	T	T	T	T	T
Peanut, soft	..	73.3	1	0	5	0	7	0
Peanut, hard	..	24.0	T	0	T	0	T	0
Sesame	..	57.7	0	0	0	0	1	0
Lard, soft	1	51.0	2	1	3	2	7	4
Lard, soft	2	58–61	2	1	3	2	7	4
Lard, hard	1	0.4	T	0	1	0	1	0
Lard, hard	2	...	.	.	.	.	.	.
Control (untreated lard)	..	...	3	1	7	2	7	4

Legend: 0 = not rancid; T = trace of color; color of Kreis test indicated numbers varying from pink (1) to wine red (7).

TABLE III.—RANCIDITY IN OILS HYDROGENATED TO VARIOUS IODINE VALUES

Hydrogenated Oil	Iodine Value	Kreis Test 10 Days	20 Days	30 Days
Cottonseed Oil	74.9	1	3	5
Cottonseed Oil	70.7	1	3	5
Cottonseed Oil	65.9	0	1	3
Cottonseed Oil	59.5	0	0	1
Cottonseed Oil	53.3	0	0	1
Sesame Oil	78.9	0	T	1
Sesame Oil	73.3	0	0	T
Sesame Oil	69.8	0	0	0
Sesame Oil	65.5	0	0	0
Sesame Oil	61.5	0	0	0

TABLE IV.—CONSISTENCY OF HYDROGENATED OILS. GRAMS EXUDED BY COMPRESSION

Hydrogenated Oil	Sample No.	S. P.	0 Gm.	50 Gm.	100 Gm.	200 Gm.	300 Gm.	400 Gm.	500 Gm.	1000 Gm.	Total
Cottonseed	1	36.3	T	T	0.05	0.10	0.15	0.15	0.15	1.60	2.20
Cottonseed	2	37.2	0.10	0.15	0.20	0.25	0.30	0.50	0.80	5.50	7.80
Cottonseed	3	39.4	0	0	0	0	0	T	T	T	T
Cottonseed	4	29.5	0.25	0.45	0.50	0.80	0.85	0.80	0.90	1.15	5.70
Cottonseed	6	35.7	0	0	0	0	0	T	T	T	T

TABLE IV.—CONSISTENCY OF HYDROGENATED OILS. GRAMS EXUDED BY COMPRESSION

(*Continued from page 20.*)

Hydrogenated Oil	Sample No.	S. P.	0 Gm.	50 Gm.	100 Gm.	200 Gm.	300 Gm.	400 Gm.	500 Gm.	1000 Gm.	Total
Cottonseed	7	41.5	0	0	0	0	0	0	0	0	0
Cottonseed	8	29.8	0.25	0.30	0.40	0.80	0.80	0.80	0.85	1.25	5.45
Cottonseed	9	41.8	0	0	0	0	0	0	0	0	0
Cottonseed	10	38.5	0	0	0	0	T	T	T	T	T
Cottonseed	11	37.7	0.40	0.50	0.50	0.65	0.70	0.90	1.50	1.90	7.05
Cottonseed	12	29.7	0.80	1.05	1.30	1.80	1.10	0.65	0.35	1.30	9.35
Soy Bean	1	30.8	0	0	0	0	0	0	0	0	0
Soy Bean	2	36.5	1.20	1.40	1.60	2.30	1.60	1.30	1.30	5.20	14.30
Soy Bean	3	35.9	0	T	T	T	T	T	0.05	0.05	0.10
Soy Bean	5	40.8	0.05	0.05	0.05	0.05	0.10	0.10	0.10	6.50	7.00
Peanut	..	40.7	0	0.95	1.10	2.05	2.25	2.45	2.45	7.80	19.05
Lard	1	38.0	0	0	0	0	0	0	0	0	0
Lard	2	38.1	0	0	0	0	0	0	0	T	T
Coconut with lecithin	..	34.4	0.30	0.30	0.35	0.40	0.50	0.60	0.65	9.00	12.10
Petrolatum	..	..	0	T	T	0.05	0.10	0.15	0.20	1.35	1.85
Wool Fat	..	..	T	T	0.10	0.20	0.25	0.70	0.75	2.85	4.85
Lard	..	..	0.70	0.70	0.95	2.90	2.10	2.10	1.10	2.40	10.85

TABLE V.—CONSISTENCY OF HYDROGENATED OILS. EXTENT OF PENETRATION

Hydrogenated Oil	Sample No.	S. P.	100 Gm.	200 Gm.	300 Gm.	400 Gm.	500 Gm.	1000 Gm.	500[a] Gm.	1000[a] Gm.
Cottonseed	1	36.3	0.4	21.5	+	...	...	...	...	...
Cottonseed	2	37.2	2.0	4.0	+	...	...	...	...	...
Cottonseed	3	39.4	0.1	0.9	3.3	2.7	2.3	+	...	...
Cottonseed	4	29.5	1.0	1.0	1.5	2.5	+	...	...	...
Cottonseed	5	31.3	0.9	2.8	13.2	+	...	...	...	...
Cottonseed	6	35.7	—	—	—	—	—	2.5	3.0	+
Cottonseed	7	41.5	—	—	—	—	—	1.0	1.0	+
Cottonseed	8	29.8	1.5	7.5	9.0	9.0	8.0	+	...	...
Cottonseed	9	41.8	—	—	—	—	—	0.1	—	1
Cottonseed	10	38.0	5.5	7.0	8.0	4.0	2.5	+	...	...
Cottonseed	11	37.7	0.2	0.5	0.5	1.9	2.0	+	...	...
Cottonseed	12	29.9	+	...	...	...	...	...	...	...
Soy Bean	1	36.8	—	—	—	—	—	—	—	4
Soy Bean	2	36.5	2.25	+	...	...	...	...	...	...
Soy Bean	3	35.9	1.0	2.0	4.0	5.0	6.5	+	...	...
Soy Bean	4	35.8	0.1	0.1	0.1	0.4	0.4	...	...	...
Soy Bean	5	40.8	0.5	1.0	2.0	5.0	+	...	...	...
Peanut	..	40.7	+	...	...	...	...	...	...	...
Sesame	..	42.7	—	—	—	—	—	0.5	—	0.5
Lard	1	38.0	—	—	—	—	—	0.2	0.3	1.0
Lard	2	38.1	0.9	+	...	...	...	...	...	...
Coconut	..	32.4	—	—	—	—	—	—	—	2.0
Petrolatum		...	5	+	...	...	...	...	...	...
Wool Fat		...	19	+	...	...	...	...	...	...
Lard		...	9	+	...	...	...	...	...	...

Numbers indicate penetration in mm. after 60 seconds—using 1.6-cm. disk.

\+ Indicates rapid penetration to the bottom of the jar in less than 60 seconds.

[a] Mm. penetration after 60 seconds, using 1.1-cm. disk.

TABLE VI.—ABSORPTION OF WATER BY HYDROGENATED OILS

Hydrogenated Oil	Sample No.	Iodine Value	M. P.	Moisture Content %
Cottonseed, soft	2	62.0	45.0	2.00
Cottonseed, soft	3	66–9	39–40	4.35
Cottonseed, soft	4	...	38.0	0.50
Cottonseed, soft	6	62.0	37.2	3.00
Cottonseed, soft	7	62.7	43.3	4.50

TABLE VI.—ABSORPTION OF WATER BY HYDROGENATED OILS. (*Continued from page 21.*)

Hydrogenated Oil	Sample No.	Iodine Value	M. P.	Moisture Content %
Cottonseed, soft	8	70.0	39.0	1.00
Cottonseed, soft	9	57.9	44.0	3.00
Cottonseed, soft	10	60.5	38.0	2.75
Cottonseed, soft	11	65.0	41.0	2.40
Cottonseed, soft	12	73.0	39.6	3.50
Cottonseed, hard	1	5.8	61.0	3.00
Cottonseed, hard	3	...	61.0	5.00
Cottonseed, hard	5	37.5	59.0	2.80
Cottonseed, hard	6	8.0	63.0	0.75
Soy Bean, soft	1	70.3	39.4	4.50
Soy Bean, soft	2	72.0	42.0	1.00
Soy Bean, soft	5	83.0	46.0	5.00
Soy Bean, hard	1	4.4	62.5	0.55
Soy Bean, hard	3	10.0	65.5	1.25
Soy Bean, hard	4	29.5	...	3.50
Coconut	1	5.1	44.9	2.25
Coconut	2	4–12	33.0	3.25
Coconut	4[a]	1.5–3.5	38–39	15.00
Coconut	5[b]	3.0	49.0	0.60
Palm Kernel	1	0.5–1	47–8	trace
Palm Kernel	2	0.5–1	48.5–49.5	0.05
Peanut, soft		73.3	42.5	1.60
Sesame		57.7	45.6	0.70
Lard, soft	1	51.0	44.9	2.40
Lard, soft	2	58–61	47–48.5	8.00
Lard, hard	1	0.4	60.1	trace
Lard, hard	2	<2.0	61–2	1.65
Palm		2.0	59.0	2.40
Castor (3)		70.8	40.0	5.00
Castor (3)		16.6	82.0	8.50
Untreated Lard (3)		...	...	3.70
Untreated Petrolatum (3)		...	...	1.70

[a] With lecithin.
[b] With 6% cottonseed oil.

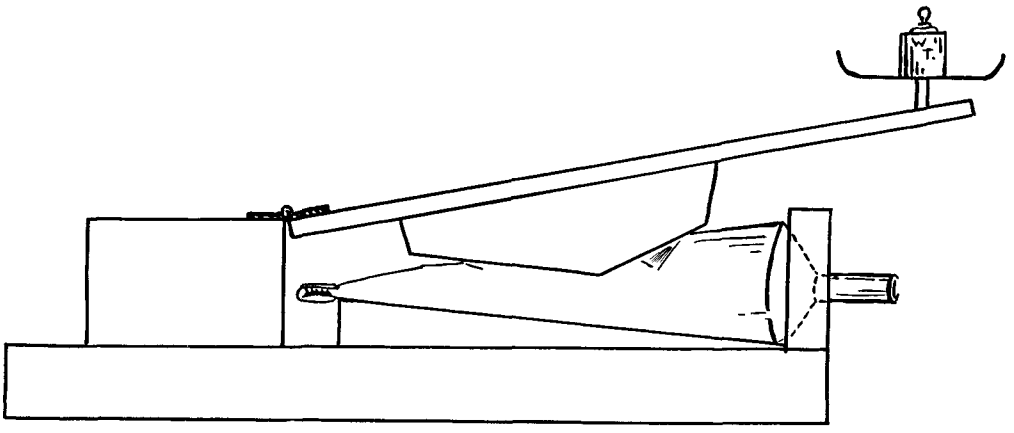

Fig. 1.—Compression-Consistency Apparatus.

SUMMARY

Commercial hydrogenated oils were studied to determine their suitability for ointments as far as stability to rancidity, consistency and water retention was concerned. None of the samples of hydrogenated vegetable oils developed more than a trace of rancidity when kept at body temperature in the dark in unstoppered glass tubes. Lard and partially hydrogenated lard, however, became distinctly rancid under the same conditions.

In sunlight all of the partially hydrogenated (I. V., more than 50) oils developed rancidity to some degree, but less rapid than lard. Hard hydrogenated oils (I. V., less than 10) did not develop rancidity as rapidly as partially hydrogenated oils. Hydrogenated oils of different manufacturers did not deteriorate exactly in proportion with the iodine value, but hydrogenated cottonseed oils of various iodine values prepared from the same batch of oil deteriorated in relationship to the iodine value, the lower iodine value oils being more stable.

Of all of the commercial partially hydrogenated oils, sesame oil was superior from the standpoint of rancidity. Samples of the same batch of oil hydrogenated to various degrees indicated that it was much more stable than hydrogenated cottonseed oil of the same iodine value.

Two pieces of apparatus are described for determining the relative consistency of fats. It was found that, in the main, the consistency varied with the softening point. The softening point of the same kind of oil from different manufacturers did not, as one would expect, vary with the iodine values, probably due to the differences in hydrogenating temperatures, differences in original oils, etc.

The data on water retention showed lack of uniformity with samples of different manufacturers. None of them retained as much water as hard hydrogenated castor oil with the exception of coconut oil containing lecithin which retained about five times as much as other coconut oils without lecithin. With the exception of partially hydrogenated lard, none of the partially hydrogenated oils retained as much water as partially hydrogenated castor oil.

Subsequent studies will be made to determine the relative value of various hydrogenated oils as bases for official ointments.

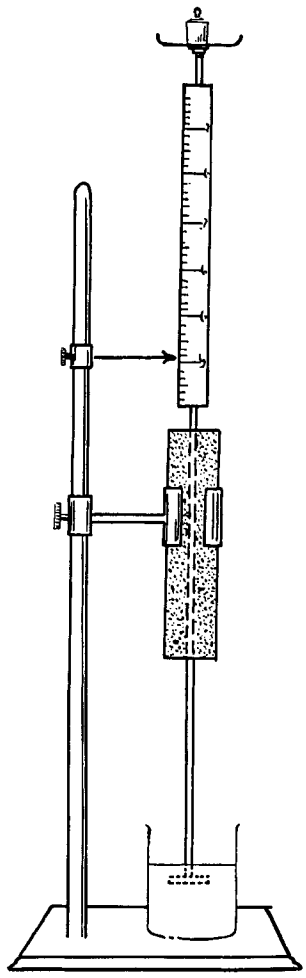

Fig. 2.—Penetration-Consistency Apparatus.

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