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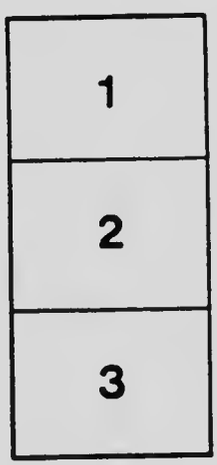

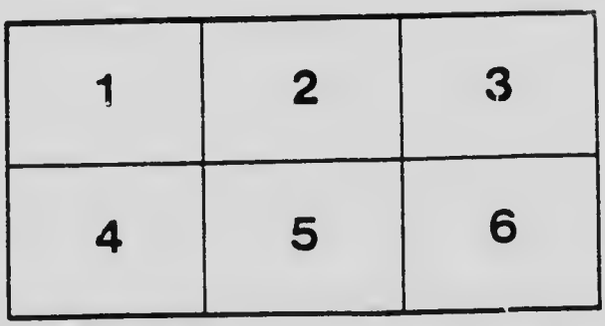

LABORATORY

OF THE

DEPARTMENT OF TRADE AND COMMERCE

OTTAWA, CANADA

BULLETIN No. 414

LARD AND SUBSTITUTES

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NOTES AND COMMENTS.

Under this heading, as occasion arises, the Bulletins issued by this Department will contain, as an appendix, such comment as may seem necessary or advisable upon matters relating to the work of the Department in connection with the administration of the Adulteration Act, the Fertilizers Act, the Feeding Stuffs Act or the Proprietary Medicines Act.

It frequently happens that correspondents ask information regarding the above Acts, of such a nature that the matter in question possesses general interest, and comment upon it would prove acceptable and useful to others than the immediate questioner. In such cases the reply may find a place in these columns. For convenience of reference these notes will be numbered in series.

A. McGILL,
Chief Analyst.

LABORATORY

OF THE

DEPARTMENT OF TRADE AND COMMERCE

OTTAWA, CANADA

BULLETIN No. 414

LARD AND SUBSTITUTES.

October 29, 1918.

F. C. T. O'HARA, Esq.,
Deputy Minister of Trade and Commerce,
Ottawa, Ont.

SIR,—I beg to hand you a report upon certain samples purchased throughout Canada in April and May last, by our inspectors, as Lard and Substitutes for Lard.

Our last report upon this class of food material will be found in Bulletin No. 274, dated January, 1914.

Since that report was published, a very noteworthy increase in the difficulty of procuring normal quantities of edible fats has resulted from war conditions, and in consequence of this, manufacturers have sought to replace lard by fats derived from other sources. This is evidenced by the fact that, in a collection of 243 samples reported in 1914, only 35 per cent were sold as substitutes for lard, while in the present collection of 191 samples 64 per cent are sold as substitutes.

The more recent fats, introduced as food material, are largely of vegetable origin (seed, the soya bean, peanut, etc.) and contrast sharply with the animal fats (e.g. cattle, sheep) heretofore mainly used for food purposes.

A process of hydrogenation (introduction of hydrogen), by which many fats that are liquid at ordinary temperature (and therefore known as Oils) may be changed into hard fats, of the consistency of lard, was developed in 1903, and has, since that time, become important commercially. Of course this has entirely altered the situation as regards substitutes for lard.

From the point of view of the analyst, as well as from that of the manufacturer, and of the intelligent consumer, this subject demands comprehensive treatment and re-consideration. I placed the matter of investigation in the hands of Mr. J. A. Dawson, analyst in charge at the Vancouver sub-laboratory, and his report as furnished herewith, shows a painstaking and intelligent study of the subject. It is, of necessity, much more technical in character than is desirable in publications intended for general perusal, as are our bulletins. Nevertheless, this particular subject is in its nature so complex, and its recent history exhibits so many new features, that I would respectfully advise the printing of the whole. I do not know that anywhere in our literature is to be found so concise, and at the same time, so full a treatment of the question. The novel lines of production of solid fats, which have been so successfully developed in recent years, under the stimulus of war conditions, are by no means yet exhausted as to their possibilities, and it is highly desirable that Canadian manufacturers should have access to a comprehensive statement of what has been already done.

That the general substitution of fats of vegetable origin, for those of animal origin, to which northern nations have been accustomed, will exert some influence upon these nations, is not unlikely. Up to the present, however, we are unable to indicate in what direction such influence may operate. So far as food value is concerned there appears to be no important difference between fats from one source or the other. Olive oil, palm oil and many of the vegetable fats have long been successfully used as food by intertropical peoples, and the selection of food fats of one origin or other, seems rather to be a matter of availability, than of any essential difference in food values.

The following cases of adulteration are included in this report:—

No. 84556. Shortening, sold by A. Raymond, Lachute, Que., on June 11th to Mr. Inspector Costigan. Adulteration consists of excess water, 4·94 per cent.

No. 81958. Sold as Lard, May 17th, to Mr. Inspector Hogan, by James Crawford, Kingston, Ont. The sample is not lard, but a substitute.

No. 79798. Shortening, sold by John Dungan, Winnipeg, to Mr. Inspector Cosgrove, 29th May. Adulterated with excess water, 4·78 per cent.

No. 79820. Sold as Pure Lard, by F. Sagratt, Winnipeg, on 31st May, to Mr. Inspector Cosgrove. Sample contains excess water, 4·01 per cent. The last two samples are stated to be the product of the Western Canada Packing Co., Winnipeg.

I would respectfully recommend publication of the accompanying report as Bulletin No. 414.

I have the honour to be, Sir,
Your obedient servant,
A. McGILL,
Chief Analyst.

A. McGILL, Esq., B.A., B.Sc., LL.D., F.R.S.C.,
Chief Analyst,
Ottawa, Ont.

SIR,—I beg to submit herewith the results of the examination of 191 samples of Lard and Lard Substitutes, 68 being sold as Lard and 123 as Lard Substitutes. In the following table a comparison is given with the previous collection reported in Bulletin No. 274 (1914).

	1914.	1918.
Samples sold as Lard	157 (65%)	68 (36%)
" " Substitutes	86 (35%)	123 (64%)
	243	191
Lard found adulterated	5	2
Lard substitutes adulterated	3	2
Total	8 (3·3%)	4 (2·6%)
Brands of Lard substitutes	16	22

From these figures it will be noted that the percentage of adulteration has decreased from 3·3 per cent to 2·6 per cent. Also in the 1914 collection there were about two samples of lard to one of lard substitutes, whereas in the present collection there is only about one of lard to two of lard substitutes.

The standards for Lard and Lard Compound, their composition as well as the different commercial grades will first be detailed after which the methods of inspection and the results will be given, with some suggestions with regard to trade developments.

Lard. "Lard" originally denoted the fat obtained from the leaf i.e., the abdominal fat of the pig. With the development of the packing house industry the fat from any and every part of the hog was included under the designation.

In Canada, Lard is defined by Order in Council of May 3rd, 1912, (G. 1003) as follows:

> "*Lard* is the rendered fat from hogs in good health at the time of slaughter, is clean, free from rancidity and contains, necessarily incorporated in the process of rendering, not more than one (1) per cent of substances other than fatty acids and fat."

Order in Council of October 14, 1910 (G. 931) defines Leaf Lard as follows:—

> "*Leaf Lard* is lard rendered at moderately high temperatures from the internal fat of the abdomen of the hog, excluding that adherent to the intestines, and has an iodine number not greater than sixty-five (65) and contains not more than one (1) per cent of substances o her than fatty acids and fat."

Two samples sold as Lard do not comply with these standards.

> Sample No. 79820 contains four per cent of water.
> " . 81956 contains cottonseed oil.

Lard used for pharmaceutical purposes is defined in greater detail by the British Pharmacopœia (1914):—

> "*Prepared Lard* is the purified internal fat of the hog, *Sus scrofa* (Linn.). A soft, white, homogeneous, unctuous substance. Odour faint but not rancid. Entirely soluble in ether. Acid value not more than 1·2; saponification value 192 to 198; iodine value, 52 to 63; unsaponifiable matter not more than 0·5 per cent; refractive index at 60, 1·4530 to 1·4550." Water, alkalies, chlorides and sesame oil must be absent.

Many of the samples in the present collection, so far as they were examined, would apparently satisfy these conditions.

Commercial Grades of Lard.—In the packing houses of North America five grades of edible lard are produced:—

Name.	Source.	Process.	Use.
(a) Neutral No. 1	Abdomen	40=50°C	Oleomargine
(b) Neutral No. 2 (Imitation Neutral.)	Back	40=50°C	Confectionery and biscuits.
(c) Leaf	Residue (a).	High pressure steam	Domestic consumption
(d) Choice or kettle rendered	Residue (b) and (or) (a).	High pressure steam or kettle.	" "
(e) Prime steam	Miscellaneous	" "	Miscellaneous

Grades (*a*) and (*b*) do not keep so well as the others due to the low temperature of extraction and the consequent action of undestroyed enzymes. Grades (*c*), (*d*) and (*e*) are refined by adding fuller's earth, ærating, filtering and chilling.

Lard Substitutes.- This class of substances includes mixtures of lard with other fats or oils properly described as "Lard Compound" or "Compound Lard," as well as oils or fats which contain no lard. The term "Lard Compound" is applied, however, to all lard substitutes as is indicated by the following definition in Order in Council of October 14, 1910 (G. 931):—

> "*Compound Lard, Lard Compound, etc.*, is a mixture of animal and vegetable fats and oils. It must be free from rancidity, be made from sound and pure materials, and contain not more than one (1) per cent of substances other than fatty acids and fat."

Two samples sold as lard substitutes do not comply with this standard:—

Sample No. 79798 contains 4·78 per cent of water.
" 84556 contains 4·94 per cent of water.

Of the 123 samples of substitutes all but six may be classed as cottonseed oil products and of these there are 22 different brands usually labelled "Shortening." Only one sample was labelled "Compound Lard." Two samples were oleomargarine, two beef fat, one ham fat and one lard with a trace of cottonseed oil.

In Table I a list of the different brands is given. In some cases the name of the brand was not reported. In these cases the identity has been assumed from the manufacturer and the results of analysis.

TABLE I.

Manufacturer.	Brand.	Samples.
(a) *Cottonseed Oil Products.*		
Procter & Gamble Mfg. Co., Hamilton, Ont.	Crisco	20
" " "	Flake White	3
" " "	Invincible	2
Harris Abattoir Co., Ltd., Toronto, Ont.	Domestic	19
Swift Canadian Co., Toronto, Ont., etc.	Cotosuet	14
" "	Jewel	3
" "	Delico	2
Gunns Ltd., Toronto, Ont.	Easifirst	13
Matthews Blackwell, Ltd., Toronto, Ont., etc.	Snowflake	7
Wm. Davies Co., Ltd., Toronto, Ont.	Peerless	5
P. Burns & Co., Ltd., Calgary, Alta., etc	Tisgood	4
" "	White Carnation	1
F. W. Fearman Co., Ltd., Hamilton, Ont.	Star	3
Gordon Ironside & Fares Co., Ltd., Winnipeg, Man	Gifco	3
" "	Reliance	3
N. K. Fairbanks Co., Montreal, Que.	Boar's Head	5
" "	Cottelene	1
Armour & Co., Hamilton, Ont.	White Cloud	1
F. A. Lallemand & Co., Montreal, Que.	Beaver Head	1
Gallagher, Holman, La France Co., Winnipeg, Man	(Compound Lard)	1
Western Packing Co., Winnipeg, Man	Regal	1
Whyte Packing Co., Ltd., Toronto, Ont.	Household	1
Arnold & Co. (vendors), Toronto, Ont	(Lard Substitute)	1
Southern Cotton Oil Co., New Orleans, U.S.A., etc.	Wesson Oil	1
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(b) *Miscellaneous Products.*		
Harris Abattoir Co., Ltd., Toronto, Ont.	Oleomargarine	1
" "	Lard Compound	1
Swift & Co., Chicago, Ill.	Oleomargarine	1
J. W. Soper, North Battlefield, Sask.	Beef Fat	1
Don France, Prince Albert, Sask	Beef Fat	1
L. Baller & Son, Quebec, Que.	Ham Fat	1
		6

Composition.—Fatty oils and fats of animal or vegetable origin consists principally of triglycerides. These are neutral compounds of the fatty acids with the trihydric alcohol glycerol (glycerine). In the liquid state the triglycerides form a mutual solution which on cooling becomes an eutectic-mixture. More or less free fatty acids and a small proportion of other substances are also present in fats. Vegetable oils and fats all contain the solid alcohol phytosterol while animal oils and fats contain similar alcohol cholestorol. By testing for the presence of these alcohols, the fat under examination may be classified.

The French chemist Chevreul in a series of classic researches published 1815 to 1823, first established that fats consist principally of neutral triglycerides of various fatty acids. It is a remarkable fact that now, over one hundred years later, we do not know accurately the composition of a single fat. That the glyceride tristearin does not occur in lard was not known until about 1912. Based on this fact, it has been proposed to work out a method of detecting the presence of beef or mutton fat and of hydrogenated oils in lard. (J. Assoc. Off. Agr. Chem., Vol. 2, p. 237).

Lard contains the glycerides of lauric, myristic, palmitic, oleic and stearic acids with small proportions of linolic and possibly linolenic acids. The unsaponifiable matter amounts to less than 0·5 per cent, mostly cholesterol.

Beef and mutton fats consist almost exclusively of the glycerides of palmitic, oleic and stearic acids. Linolenic acid in small proportion also is present. By repeated crystallization from various solvents the following glycerides have been separated: oleo-dipalmitin, stearo-dipalmitin, oleo-palmito-stearin, palmito-distearin and tristearin.

Whale Oil has not been thoroughly examined yet as to its composition. Volatile fatty acids are absent. The "stearine" consists largely of palmitin. About 8 per cent of the unsaturated acids, clupanodonic, is present. The fishy odour is said to be due to the presence of this acid or to indol. The unsaponifiable matter varies from 0·5 to 3·5 per cent.

Cottonseed oil contains the glycerides of palmitic, oleic and linolic acids with a small proportion of arachidic acid. The unsaponifiable matter varies from 0·7 to 1·6 per cent consisting of phytosterol with colouring matter.

Cocoanut oil contains large proportions of trimyristin and trilaurin with some tripalmitin, tristearin and triolein and the glycerides of the volatile acids caproic, caprylic and capric. It is free from butyric acid. The unsaponifiable matter varies from 0·2 to 0·3 per cent.

The proportions of the fatty acids in lard vary within rather wide limits according to climate, soil, race, breed, food, part of the animal, process of manufacture, age and exposure to light, heat and air in the presence of moisture and catalyzers. Animals fed on vegetable oils in the form of oil cake, etc., will yield lard whose analytical constants approach those of the oil and will even contain characteristic chromogenetic substances derived from the oil. These conditions make the detection of the presence of small proportions of these oils in lard most difficult. Also by the process of hydrogenation, liquid oils can be converted into solid fats resembling lard so closely in appearance and in analytical "constants" that it requires refined methods and extended experience to detect their presence in mixture with lard.

Lard Compounds consist of mixtures of lard with beef fat, cottonseed oil, cocoanut oil, etc., or with the "stearine" derived from these.

Lard Substitutes proper, contain no lard. They usually consist of (1) cottonseed oil, soya bean oil, etc., with up to 20 per cent of beef or other "stearine"; (2) similar mixtures with hardened cottonseed or cocoanut oil; (3) hardened oils of varying consistency, usually cottonseed with 10 per cent or more of cocoanut oil; (4) pure fats or oils such as beef fat, cottonseed oil, etc., or mixtures of these such as oleomargarine. The latter of course often contains lard "oleo."

Methods of Inspection and Results.—The methods of the Association of Official Agricultural Chemists (1916 edition, p. 299) as outlined for fats and oils were followed in general except as noted below.

Samples for Comparison.—In order to become somewhat familiar with the characteristics of various common oils that might occur in lard or in lard substitutes, a

number of samples were obtained through the kindness of a number of importers in Vancouver, B.C. With the exception of whale oil, these represent commercial samples of edible oils. These are listed in Table II with certain of their analytical constants.

TABLE II.

Name.	Origin.	Iodine No.	Butyro-refractometer 40° C.	Saponification No.
No. 1 Refined Whale Oil	Canada	129	62	188
Soya Bean Oil	Japan	136	64	191
Corn Oil	United States	125	62	192
Cottonseed Oil	United States	113	59	192
Sesame Oil	India	105	59	190
Peanut Oil	China	96	56	195
Cocoanut Oil	Australasia	9	35	257
Hardened Cocoanut Oil	(Chicago, U.S.)	0.5	35	258

Sampling.—The outer portions of a sample of lard, etc., have often been exposed to conditions which bring about a change in composition. These samples are originally of a homogeneous composition usually having been prepared by melting. For these reasons the whole sample was not remelted but small portions were taken from the interior and melted. However, in case the moisture exceeded 0·5 per cent the whole sample was melted while sealed at 40 — 45° C. and then shaken till cool. Where necessary the fat was filtered.

Sense Tests.—Examination was made as to colour, transpareney, consisteney and odour both before and after melting. In special eases the taste of the original sample was examined. All samples were found to be clean and free from starch, gums, etc.

Rancidity.—This condition can be detected by odour and taste when it has advaneed to a considerable stage. In its incipient stages it is indieated by colour tests, whieh are of speeial value in the presence of oils having a strong natural flavour. According to Kerr (J. Ind. Eng. Chem. 1918, p. 471), a modification of the Kreis test is most useful, and may be applied quantitatively. It depends upon the development of a pink or red colour when a raneid fat is shaken with hydrochloric aeid and 1 per cent phloroglucinol in ether. The test is also given by aldehydes, ketones, most essential oils and some unrefined vegetable oils, as crudo cotton oil. The test is of value in determining the incipient stages of raneidity some time before this becomes evident to the senses, so that the produet may be conserved by early use.

Aeeording to Lewkowitseh (Oils, Fats and Waxes, vol. 1, p. 51), raneidity is primarily due to soluble ferments acting in the presence of moisture. These ferments are absorbed from the tissues adjaeent to the fat so long as they are left in contaet. The glyeerides are hydrolyzed giving free glyeerol and fatty acids which in the presenee of oxygen of the air under tho influence of heat and light, yield aldehydes and ketones of eharaeteristie odour and taste. Theso produets may be distilled off with steam or extracted with hot water and determined by titration with permanganate. Based on this, Issoglio has defined an "oxidizability value" as a measure of rancidity. (See J. Ind. Eng. Chem., 1918, p. 474). Although free fatty aeids are developed in some forms of rancidity, there would seem to be no definite relationship.

It appears to be well established that rancidity will not develop unless oxygen is present. The rate of development is accelerated by light, heat, moisture and catalyzers. Holland *et al.* have investigated the influence of air, light and moisture on the stability of olive oil. As a result of six years investigation they conclude that light alone eauses a slow development of rancidity which becomes rapid in the presence of

air with further acceleration in the presence of moisture. (J. Agr. Research, 1918, 13, 353-366). Rogers has shown that traces of iron and of copper produce decided deterioration in cold storage butter. (U. S. Bur. Animal Industry, Bull. 162). Moulds and bacteria will not live in pure oils or fats.

Each sample was examined for rancidity but in no case had this developed to a serious extent. Samples which had been shipped considerable distance in the hot weather gave the strongest indications. All samples received in original tins or in cardboard packages with a first wrapper of waxed paper were in excellent condition and remained so indefinitely. Upon standing for some time certain substitutes containing considerable oil developed a sticky film indicating the semi-drying nature of the oil.

Moisture and Volatile Matter.—In the absence of any A. O. A. C. method for the determination of water in fats and oils, the alternative method suggested for routine control analysis of commercial fats and oils as described in J. Ind. Eng. Chem. Nov. 1917, p. 1067), was adopted. Where more than 0·5 per cent of moisture was indicated, the determination was repeated on the thoroughly mixed sample using the standard method. (Loc. cit. Apr. 1918, 317). With oleomargarine, asbestus was used to prevent the curd and salt settling to the bottom and retaining the water.

Many samples of lard gained up to 0·05 per cent in weight after heating for one hour at 105-110° C. The solubility of water in Lard is very low being only 0·15 per cent at 42° C. (average melting point). Except for one sample adulterated with 4 per cent of water only 3 samples of lard exceeded 0·15 per cent. Of the 69 samples of lard, 41 contained no water. Nearly all the substitutes showed a slight loss usually less than 0·05 per cent which may be attributed to the presence of a volatile constituent. Two samples were adulterated with 4·5 per cent added water.

Ash.—Only in the case of two samples of oleomargarine, each about 10 per cent ash and ham fat 0·5 per cent, was any weighable ash obtained from 10 grams of the sample. An attempt was made to detect nickel in the ignited material but this was not found practicable on account of the very small proportion present and it was also found difficult to dissolve out the traces of nickel alloyed with the platinum so that interference with subsequent tests arose. Quartz dishes would be best for this purpose.

Iodine Number of the Filtered Fat.—For this determination 25cc. of the Hanus solution was used on 0·25 gram of fat, with N/5 thiosulphate. For weighing the sample, small tared watch glasses of 2·5 cm. diameter were found most useful.

The iodine number of genuine American lards ranges from 46 to 66 in most cases. The iodine number varies with the character of the food supply. The iodine number of lard from hogs fed on copra has been found to range from 32 to 42. Lard from the fat of the back of Japanese and Chinese hogs possibly fed on soya bean cake, have given iodine values from 79 to 102. A sample of lard of Chinese origin passing through Customs at Vancouver, B.C., July, 1918, was found to have an iodine number of 63. From the foregoing it is evident that the iodine number is of limited use in identifying the purity of lard. This is especially true since the advent of hardened oils, the iodine values of which can be adjusted to any point below that of the oil.

Of the samples of lard deemed genuine the iodine numbers ranged from 54 to 66. Of these 25 were 54 to 59, 42 were from 60 to 66, one adulterated was 63 and another 96.

Of the samples of lard substitutes, the iodine values ranged from 42 for beef fat to 113 for cottonseed oil. In Table III the various brands are listed in decreasing order of their average iodine numbers. In the case of the two brands Cotosuet and Jewel both of the Swift Canadian Co., it was found that each of these included two products apparently differentiated by the presence or absence of cocoanut oil, with a corresponding difference in the iodine and saponification numbers.

TABLE III

(*a*) *Cottonseed Oil Products.*

Sample.	Name.	Average Iodine No.	Range Iodine No.	Average Butyro refractometer reading.	Saponification No. One sample.
1	Wesson Oil	113	113	59·0	192·2
1	Beaver Head	99	99	57·3	195·7
2	Jewel (part)	98·5	98—99	56·5	.....
2	Invincible	98·5	98—99	57·0	193·6
19	Domestic	97·4	93—103	56·9	195·0
1	Household	97	97	56·3	192·9
5	Boar's Head	96·6	94—99	56·8	195·7
13	Easiürst	96·4	91—100	56·6	191·4
3	Flake White	95·7	94—97	56·9	195·7
9	Cotosuet (part)	95·2	91—97	56·2	193·6
1	Cottelene	94	94	56·2	197·5
1	White Cloud	91	91	55·5	191·4
6	Peerless	89·2	81—94	54·9	196·3
7	Snowflake	85·4	82—99	54·7	193·6
3	Star	82·3	79—89	53·5	195·0
1	White Carnation	82	82	53·8	197·1
20	Crisco	78·6	77—80	53·0	194·3
5	Cotosuet (part)	77·8	71—83	52·7	211·8
4	Tingood	77·5	74—81	53·4	195·7
1	(Lard Substitute) No. 84066	77	77	52·5	.....
1	Jewel (part)	74	74	52·0	197·1
1	Compound Lard No. 79797	74	74	51·6	198·5
1	Regal	73	73	51·3	192·9
3	Gifco	70·7	70—72	51·6	195·7
3	Reliance	64·3	59—69	51·4	195·0
2	Delico	63·5	63—64	50·2	197·8
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(*b*) *Miscellaneous Products.*

1	Swift's Oleomargarine	65	65	50·1	204·8
1	Ham Fat	64	64	50·6	.....
1	Harris Lard Compound	61	61	50·3	.....
1	" Oleomargarine	58	58	49·4	220·3
2	Beef Fat	42·5	42—43	46·1	.....
6					

Butyro-refractometer Reading.—This was determined at 40° C., using a small portion which had been melted before applying to the prism. A solution of potassium bichromate was interposed in front of the mirror to prevent dispersion at the line of demarcation. For samples of genuine lard, the readings vary from 48 to 51·7. The average readings for the lard substitutes are given in Table III in which it may be noted that with the iodine number ranging from 42 to 113 the butyro readings vary respectively from 46 to 59. The butyro reading is hence of value in confirming the iodine number.

Saponification Number.—In Bulletin No. 396 of this series dated March 11th, 1918, on Salad Oils, there were 31 out of a total of 59 samples sold as cottonseed oil that contained up to 50 per cent of mineral oil. Among the present samples of lard substitutes there were many which resembled vaseline on account of their translucent appearance. Accordingly the saponification number was determined on a few samples of lard and on one sample of each brand of substitute. The results for the latter are given in Table III. The saponification number of lard runs, 193 to 199, cottonseed

oil 192 to 196, cocoanut oil 250 to 260, beef fat 193 to 198. The saponification number is not affected by hydrogenation to any extent. The addition of neutral mineral oil will lower the saponification value of a fat about two points for each per cent of oil present. The absence of mineral oil is indicated by the results obtained. Two samples having values of 211·8 and 220·3 probably contain cocoanut oil.

Halphen Test for Cottonseed Oil.—In the hydrogenation of cottonseed oil the chromogenetic substance responsible for this reaction appears to be destroyed. Gastaldi has improved the test to some degree by substituting pyridine for amyl alcohol. Bolton and Revis (Allen, IX. p. 154) state that 0·2 per cent of ordinary cottonseed oil products can be detected by this improvement.

Of the 68 samples of lard, one gave decided Halphen reactions and the presence of cottonseed oil was confirmed by other evidence. Eight samples gave a pink colour probably indicating feeding with cottonseed meal or oil cake. The tedious phytosterol acetate test is the last resort for such doubtful cases. Of the 123 substitutes all but 24 responded to the test and 20 of the 24 were samples of "Crisco". The colour of melted "Crisco", as well as the odour and the nitric acid test indicate however that this is a partially hydrogenated product of cottonseed oil (See Hydrogenation of Oils, Carleton Ellis, 1916, ed. p. 16).

Nitric Acid Test.—This test appears to be of value in detecting cotton-seed oil that does not respond to the Halphen test. (Lewkowitsch, vol. 2, p. 204). In the present collection of lard it was found that the majority of samples gave a more or less dark brown colour when shaken with nitric acid, slightly above their melting point. Lewkowitsch (loc. cit. p. 722) states that lard from hogs fed on cotton cake gives a brown colour. The writer has found also that lard which does not give more than a slight colour change, will give a very much deeper colour if heated considerably above its melting point, then cooled and the test applied. It is therefore evident that the nitric acid test is of very little value in detecting with certainty, the presence of cottonseed oil in lard, etc., which may contain traces of albuminoid substances or such foreign material. Lewkowitsch (Vol. 1, p. 494) refers to a serious mistake that was made in declaring an imperfectly purified tallow as adulterated, because it gave with nitric acid a brown colouration which was judged to be due to the presence of cottonseed stearine. Other cases indicating the limitations of the test are given by Allen. (Vol. 2, p. 139).

Nickel.—In 1896 the French chemists, Sabatier and Senderens commenced their historical investigations on metallic catalyzers which led to the discovery that in the presence of finely divided nickel at the proper temperature, unsaturated compounds could be readily converted into the saturated condition. In 1903 the English chemist, Norman, first applied this process to oils thus converting liquid oils into solid fats. A rapidly expanding industry has resulted from the discoveries of these chemists.

Hydrogenation alters the physical and chemical properties of oils to such a degree that the usual tests lose their value for the purposes of identification. The saponification value is only slightly affected. Evidence as to the presence of hardened oils has been based on the presence of traces of nickel, which pass the filter presses in the form of a nickel soap. Many manufacturers however are washing out practically all traces of nickel by means of hydrochloric acid. Formerly the nickel content of hardened oils ranged from 1 to 5 parts per million and the presence of nickel gave rise to debate as to the limits permissible on account of the poisonous nature of nickel salts. (Ellis, Hydrogenation of oils, 1914, ed. p. 147). It has been shown that the nickel content of certain samples of hardened oils is about one-thousandth part of that found in certain foods prepared in nickel vessels. When fats and oils containing free fatty acids are refined in nickel plated vessels, traces of nickel will be dissolved. Then, in the preparation of hardened oils some plants use palladium instead of nickel as catalyzer. The presence or absence of traces of nickel has therefore little significance in indicating the presence of hardened oils.

The method suited for routine determination of nickel is that of Prall as modified by Kerr. (J. Ind. Eng. Chem., 1914, p. 207). Where the content is less than one part per million, the ignition of 200 grams or more in silica is recommended.

The work of detecting and estimating nickel, I entrusted to Mr. W. H. Hill, who investigated and modified Prall's method in considerable detail in order to make a quantitative estimation. On account of the limited quantity of sample and the exceedingly faint traces of nickel present, it was found impossible to obtain definite results. The chief difficulty is caused by the rapid fading of the rose colouration. (See Allen, vol. 9 p. 173) Knapp's suggestion (loc. cit. p. 125) of using ammonium sulphide was tried with no more success, due to the fugitive nature of the colour. The description of this test given in Allen omits the important detail of removing any iron present by treating with ammonia and filtering before adding ammonium sulphide.

Of the 68 samples sold as lard, 17 gave fugitive pink or rose colourations with dimethylglyoxime added to the oxidized evaporated extract. All but four of the substitutes reacted similarly. No difficulty was experienced in obtaining a permanent colouration with a solution of a nickel salt indicating one part of nickel in five million. It is therefore apparent that the proportion of nickel present in no case approaches this limit.

Marine Animal Oils.

During the last few years in certain European countries, particularly in Germany, whale and fish oils have been introduced into oleomargarine, lard substitutes, etc. The fishy flavour of these oils is said to be almost entirely removed by hardening.

About two years ago, W. P. Schuck obtained a patent in United States (No. 1260072) on a process by which he claims that fish oils, castor oil, soya bean oil, garbage grease, etc., can be rendered practically neutral, bland and palatable simply by passing hydrogen through the heated oil without any catalyzer. (Met. Chem. Eng., June 1, 1918, p. 608.)

In the Monthly Review of the U.S. Bureau of Chemistry, (Vol. 2, p. 9, April, 1918) the following appears under the heading "Ediblo Products from Fish Oils":

> "The attention of the Bureau has recently been called to a sample of lard substitute produced by the hydrogenation of fish oils. This product was of good colour and consistency and free from disagreeable flavours. This product was manufactured by the owner of a United States Patent for the deodorizing of fish oils by means of hydrogen without the aid of a catalyst. It is interesting to note in this connection that a sample of deodorized herring oil manufactured under this patent, which has been in the Bureau for two years and has been exposed to light during this period, is today sufficiently sweet in flavour and odour to make a fair grade of food oil."

Whale meat is being canned at the whale oil stations on the Pacific coast and during the last year fresh whale meat has been sold at butcher stores. It is hence possible that deodorized whale or fish oils may be used in Canada for the manufacture of food products.

The advisability of using whale oil for human food has been discussed at some length, especially in Europe. Apart from the fishy flavour, it is contented that whale carcasses frequently rot in the sun before rendering the blubber and that the sanitary conditions at the whaling stations are far from those in a beef or pork packing house. These criticisms are met by the declaration that modern whaling boats and stations are so equipped that the oil is rendered with the greatest expedition in order to obtain the best grade of oil and the highest price. (Lewkowitsch, vol. 2, p. 409.) The medicinal and food value of cod liver oil is also referred to, and it is claimed that all marine animal oils contain glycerides of unsaturated acids, e.g., clupanodonic acid, which are readily hydrolyzed and digested, and which have been shown to occur in the phosphatides of the heart muscles and the liver of various animals. (Lewkowitsch.

vol. 1, p. 40.) E. Madson of Copenhagen has recently stated that the mysterious benefit from cod liver oil may be due to an exceptional vitamin content. (Am. J. Pharm. Sept., 1918, p. 667.)

Of the five different grades of whale oil produced, the best quality known in commerce as "Whale Oil No. O" is of a pale yellow colour and has but a faintly fishy smell. At present this "water white" brand is used as a burning oil and in soap making. Through the kindness of Mr. J. H. Hamilton, Secretary of the Canadian Pacific Section of the Society of Chemical Industry, I obtained a sample of "No. 1 Refined" whale oil produced at the station of the Victoria Whaling Co., at Kyuquot on Vancouver Island. This sample had very little colour and only a slightly fishy odour, and taste. When mixed with 3 to 4 parts of a lard having a strongly "scorched" flavour it was difficult to detect the flavour of the whale oil. Mixture of one per cent. of this oil with lard, however, could be detected by the insoluble bromide test particularly by the darkening when heated in boiling water.

All samples were submitted to the marine animal oil test and such oils as well a. linseed oil, etc., were in no case indicated. Hydrogenated marine animal oils fail to respond to the bromide test and various colour reactions have been described for their detection. (Allen, 9, p. 124.). Sulphuric acid containing a trace of iodine is stated to give a violet-red colour with hardened whale oil. This test applied to various samples of lard and of lard substitutes gave a black colour in all cases. The test would seem to be of very little value when applied to mixtures of most fats, on account of the charring action of the sulphuric acid on the organic matter.

Glycerides Crystallized from Ether.—This test has been found to be of value in detecting beef fat as well as others including hardened oils when mixed with lard. The method as worked out by Emery (U.S. Bureau of Animal Industry. Circular 132) has been tried out by a collaborative test and found capable of detecting 5 per cent of beef tallow in lard or 2½ per cent of hydrogenated oil. (J. Assoc. Off. Agr. Chem., vol. 1, p. 183). Boemer has also worked out a somewhat similar method. (Allan, vol. 9, p. 178)

Nine samples sold as lard were examined according to Emery's method and compared with results obtained on pure lard and mixture of 10 per cent of beef fat and lard. Crystals obtained from pure lard in ether at 16—18°C melted at 63.4°C. Those from 10 per cent beef fat mixture melted at 62°C. In 8 of the 9 samples examined the crystals melted at 63.3 to 64.0°C. The other sample yielded crystals melting at 61.5°C., and under the miscroscope the crystal habit was decidedly different from those of the other 8 which showed the chisel shaped ends, etc., of the crystals from pure lard. The phytostrol acetate test was applied to the suspected sample and after the third crystallization a melting point of 125° C was observed which with the Halphen test established the presence of cottonseed oil, although the iodine number was only 63.

Food Value.—The calorific values of different fats and oils whether of vegetable or animal origin show only minor variations. (see McGill, Bull. 377 of this series on Human Food). Oils are more readily digested than fats, and the ease of oxidation increases with the proportion of unsaturated fatty acids present, i.e., according to the increase of the iodine number. The fats of the liver, kidneys and heart muscles of various animals have been examined and by their iodine numbers, it is found that they contain considerably more unsaturated acids than is found in the fat from the connective tissues. It is apparent that these easily oxidized substances are constituents of those organs of the body which are the centre of the greatest metabolic activity. (Lewkowitsch, 1, 40).

Every ounce of fat digested produces 264 calories of energy as compared with 116 calories produced by the digestion of an ounce of proteid or of carbohydrate.

With regard to the digestibility of hardened fats, it has been pointed out that some samples melt above 50°C., and that fats that melt much above 37°C. (body temperature), are not suitable especially for persons affected with derangements of the

digestive organs. Small proportions of hardened fats of high melting point cannot be objected to when mixed with oils or fats of low melting point.

The fat-soluble vitamine content of various fats has been studied by Halliburton, and Drummond, (J. Physiol., 51, (1917) 235-251). The following are the conclusions of their investigations:

> "The fat-soluble accessory growth substance is present in beef-fat and 'oleo-oil' and is present in margarins prepared upon such a basis. Such margarins are nutritively the equivalent of butter.
>
> "Cocoanut oil, cottonseed oil, arachis oil and hydrogenated vegetable oils contain little or none of this accessory substance, hence margarins prepared with a basis of these fats have not an equal nutritive value to that of butter. Nut butters prepared from crushed nuts and vegetable fats are similarly not equal to butter.
>
> "Lard substitutes prepared from vegetable oils are equal to lard in their nutritive value, both alike being destitute of the fat-soluble accessory substance."

It thus appears that lard substitutes are equal to lard in calorific and in nutritive value but that neither of them are equal to butter or beef fat as nutriments.

In view of the foregoing facts, the claims involved in the following instructions printed on the containers of certain brands of substitutes, are obviously absurd:

> Use a quarter less Domestic Shortening than lard or butter.
>
> Wesson Oil--for shortening use about one-third less Wesson Oil than butter.
>
> Snowflake brand Shortening. Use one-third less than recipe calls for.
>
> Use one-quarter to one-third less Easifirst than your recipe calls for Lard or Butter. Easifirst is 100 per cent. shortening and contains no water or salt, hence the smaller amount required.

Conclusions.

With the rapidly increasing sale of lard substitutes and of oleomargarine containing oils and fats from various sources and of different nutritive value, it has been recommended that manufacturers should declare on the label of the product, the original source and character of the oils and fats that enter into the product. In the case of mixtures the proportion of each constituent should be stated. This regulation has already been proposed for Salad Oils. (Bulletin 396 of this series). Certain oils and fats no matter how carefully refined or treated should not be allowed to enter into any food product. Some oils are of such a nature that they will even poison the catalyzer when an attempt is made to treat them.

As given in the Canada Year Book, 1916-17 of the Department of Trade and Commerce, the imports of Lard and Lard Compound, etc., in 1916 amounted to almost 8,000,000 pounds valued at $666,000. The exports of Lard amounted to only 25,000 pounds valued at $2,980. No lard substitutes are listed as being exported. The importation of vegetable oils (1916) was over 5,000,000 gallons valued at some $3,000,000. No vegetable oils appear to have been exported. In fact the only oils produced in Canada in quantity are linseed oil and fish and whale oils.

There is undoubtedly a need for the introduction of oil producing plants in Canada so that we may become self supporting. Aside from the possibilities of utilizing linseed or fish oils by improved methods of production and treatment, there are other sources of oil such as the seeds of tomato, peach, mustard, etc., which should be utilized. In 1834 an English traveler wrote regarding the cotton culture in United States as follows:

> "In many places it is usual to manure the fields with the seed not used for sowing." (See Wesson, Contributions of the Chemist to the Cottonseed Oil Industry, J. Ind. Eng. Chem., 1915, p. 276). The cottonseed products of United States are valued at some $125,000,000 per year, now.

Cotton plants do not thrive in Canada but there are other plants yielding seed of considerable oil content that might be introduced with profit. The soya bean grown extensively in Manchuria, China and Japan has been introduced into other countries, during recent years. Varieties suitable for growth in Canada are being studied at the Experimental Farms. The oil content of soya beans is about 20 per cent. and the protein about 40 per cent as compared with 2 per cent of fat and 20 per cent protein in common beans. The protein of soya bean is closely allied to casein being very easily digested. Soya bean cake contains no poisonous glucoside as does linseed cake nor any toxic principle like gossypol in cottonseed cake. Cows fed on soya cake yield milk richer in fat than when cottonseed or even linseed cake is used. The edible varieties are much superior to common beans, both in food value and in flavour. Lewkowitsch (Vol. 2, p. 118) states that soya bean oil from fresh beans yields a cheap edible oil which has to a large extent replaced cottonseed oil, and is therefore sold as such or in admixture with cottonseed oil as an edible oil. The colour is similar to that of cottonseed oil and the flavour is rather pleasant. The oil contains palmitic, oleic, linolic and linolenic acids. No stearin is deposited on standing. It is used largely for soap making and as a paint oil.

Professor Klinck of the University of British Columbia has developed two edible varieties of soya beans which mature readily in Quebec, Ontario and in the interior of British Columbia. The yield is about 16 bushels per acre. Field tests were started in 1906. Professor Zavitz of the Ontario Agricultural College has also developed two varieties each of which yielded about 14 to 15 bushels per acre in 1916. The plant thrives on poor soil and does not need much attention. The plant being a legume increases the nitrogen content of the soil.

With regard to the enormous trade in cocoanut oil formerly in the hands of the Germans much of this has passed into the hands of San Francisco operators who have recently completed at Tahiti the largest crushing plant in the Southern Pacific. The San Francisco Harbour Board and the State of California are bearing a portion of the cost of machinery and installation.

The composition of cocoanut oil resembles that of butter fat more closely than does any other common vegetable oil. It is hence used largely in the manufacture of oleomargarine and in other butter substitutes. Hardened cocoanut oils of different melting points are used in the manufacture of lard substitutes, also in confectionery and in baking.

Cocoanut oil is produced in large quantities within the British Empire. With the advent of the manufacture of oleomargarine in Canada and with the increasing use of lard and butter substitutes, in many brands of which products cocoanut oil is an important constituent, it is highly desirable that Canada should import necessary supplies directly from other parts of the Empire. At the plants where oxygen is being produced for oxy-acetylene welding, large quantities of hydrogen are going to waste that might be utilized for purposes of hydrogenation.

SUMMARY.

(1) Of 68 samples sold as lard, one was adulterated, being cottonseed oil product, while a second sample contained excess water. Two of the 123 samples of lard substitutes were adulterated with water. Mineral oils, whale oil and fish oils were absent from all samples. The content of nickel when present was less than one part in five million. The percentage adulteration has decreased from 3·3 per cent in 1914 to 2·6 per cent in 1918.

(2) In 1914 there were two samples of lard to one of lard substitute. In 1918 the condition is reversed, there being 2 samples of substitute to one of lard. Of the 123 samples of substitutes in the present collection. all but six were cottonseed oil products. A list of the various brands is given.

(3) Lard and lard substitutes are discussed under the headings, composition, rancidity, methods of inspection, improvements in tests and results.

(4) The calorific and nutritive values of lard and vegetable fats are equal but both are inferior in nutritive value to butter or beef fat. Suggested claims of certain brands of lard substitutes being superior to lard or butter are shown to be without foundation.

(5) The arguments for and against the use of whale oil, etc., as human food are quoted.

(6) The suggestion is made that the source of oils and fats used in manufacturing lard compounds, oleomargarine, etc., should be declared on the label, as is the case when cottonseed oil is sold as salad oil.

(7) The unequal balance in Canadian trade with regard to Lard and Lard Compounds as well as Vegetable Oils is shown from statistics. The necessity of introducing and developing new sources of edible oils is emphasised, and the possibilities of the soya bean are detailed. The trade in cocoanut oil is also discussed.

Yours very truly,

(Signed) J. A. DAWSON,
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