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**THE AMERICAN VEGETABLE-SHORTENING  
INDUSTRY: ITS ORIGIN AND  
DEVELOPMENT**

**FATS AND OILS STUDIES  
OF THE  
FOOD RESEARCH INSTITUTE**

**No. 1. *The Fats and Oils: A General View***  
[February 1928]

**No. 2. *Copra and Coconut Oil***  
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**No. 3. *Inedible Animal Fats in the United States: Considered with Special Reference to Sources of Animal Waste, the Rendering Industry, Municipal Reduction, and Some Effects of Meat Inspection***  
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**FATS AND OILS STUDIES**

**No. 5**     ,     ,     ,     ,     ,     **June 1934**

**THE AMERICAN VEGETABLE-  
SHORTENING INDUSTRY**

*Its Origin and Development*

**By**

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**and**

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**FOOD RESEARCH INSTITUTE**

**STANFORD UNIVERSITY, CALIFORNIA**

**THE FOOD RESEARCH INSTITUTE**

was established at Stanford University, California, in 1921, jointly by the Carnegie Corporation of New York and the Trustees of the Leland Stanford Junior University, for research in the production, distribution, and consumption of food.

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## PREFACE

This book endeavors to trace the economic history of an important and peculiarly American industry. Since the evolution of most industries is largely influenced by technological developments and by inventions, the authors have sought to perform their task with full consideration of these factors. The body of the text has, however, been kept free from technological discussions in order not to break the thread of continuity of the economic treatment. Technological aspects have, so far as possible, been relegated to the appendices. These appendices will interest chemists rather than economists. A glossary of terms, with brief descriptions of the raw materials of the industry, their sources and their principal uses, is presented in Appendix A. Technological and scientific material has been concentrated in Appendices B and C. Most of the statistical material used is concentrated in Appendix F, in tables convenient for reference.

The historical approach has been followed, partly because it seemed the most satisfactory method to place present conditions before the reader, but partly, also, because the history of this industry presents an interesting chapter in the development of industry and technology in the United States.

The authors found information concerning the compound industry both in its early and in its later stages of growth to be widely scattered. For certain periods and on certain points, pertinent information is fragmentary and its reliability unverifiable.

A few of the outstanding men identified with the industry in its infancy are still living. So far as possible, these men were consulted in order to help clarify the be-

ginnings and early life of the industry. Old files of trade journals, notably the *Oil, Paint, and Drug Reporter* and patent and trade-mark literature were relied on heavily.

Some effort was made to obtain records of the activities of the organizations dominant in the industry during the early years, but due to the many changes, these records unfortunately have been largely destroyed.

However, in spite of these various limitations, it is hoped that this volume may prove of interest to those who are, or have been, identified with the industry, as well as to students of American industrial history.

The writers wish to acknowledge their indebtedness to the following men who gave liberally of their time: Mr. W. B. Allbright, Dr. David Wesson, Mr. Henry G. Eckstein, Mr. James Boyce, Mr. Wallace E. McCaw, Mr. T. O. Asbury, Dr. E. E. Chandler, Mr. G. G. Fox, Dr. W. D. Richardson, Professor N. R. Whitney, Mr. J. F. Rogers, Mr. R. F. Crow, Dr. R. H. Kerr, Mr. Louis N. Geldert, Mr. George H. Bennett, Mr. Earl S. Haines, Mr. George S. Templeton.

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# CONTENTS

CHAPTER	PAGE
I. HISTORY OF THE INDUSTRY UP TO 1890 . . . . .	1
The subject—The use of fats for cooking and shortening —Origin of the industry in America—Influence of the margarine industry—Rise of the cottonseed-oil industry —Influence of technical improvements in cottonseed-oil production—Disappearance of independent lard refiners —Early patents for compound—Trade-marked com- pounds and lard substitutes—Emergence of the new industry	
II. EARLY ATTEMPTS TO CONTROL COMPOUND BY LEG- ISLATION . . . . .	34
Widespread food adulteration—The McGeogh case and its aftermath—Early efforts toward state and federal leg- islation—British prosecution of misbranding—Federal investigations of adulteration—Renewed demands for legislation, 1889-90—Other food-control bills—Final ef- forts to secure federal legislation, 1892-93	
III. THE INDUSTRY FROM 1890 TO THE WORLD WAR . . . . .	59
Reasons for paucity of data—Indications of the course of production—Price influences in the 'nineties—Trade- mark and patent developments in the industry—Prin- cipal domestic outlets for compound—Factors affecting expansion around and after 1900—Position of cotton- seed-oil producers in the cooking-fat industry—The rôle of the packers in the industry up to 1914—Volume of output under federal inspection—Economic effects of hydrogenation—Growing independence of compound— Export trade in compound cooking fat—Summary	
IV. WAR-TIME AND POST-WAR DEVELOPMENTS, 1914-32 . . . . .	106
Volume of output—War-time developments—Post-war boom and depression—Types of compound now pro- duced—Raw materials—Production by classes of manu- facturers—Production by class of product—Production costs—Ownership concentration and geographical dis- tribution of production—Present export trade in com- pound—The tariff and compound	

viii *AMERICAN VEGETABLE-SHORTENING INDUSTRY*

CHAPTER	PAGE
V. INTERRELATIONSHIPS OF PRODUCTION, CONSUMPTION, AND PRICES . . . . .	168
Factors in production variation—Seasonal variations: Production, consumption, and prices—Per capita con- sumption of lard and compound—Household as com- pared with commercial consumption—Price relation- ships—The effect of compound on the demand for lard —Packers' efforts to strengthen lard markets	
VI. THE COMPOUND INDUSTRY AND THE NATIONAL ECONOMY . . . . .	213

CHARTS

CHART	PAGE
1. Cottonseed Oil Production, Exports, and Domestic Re- tention, 1874-75 to 1889-90 . . . . .	14
2. Wholesale Prices of Lard and Cottonseed Oil, Spreads between Them, and Index of Business Activity, Monthly, 1876-90 . . . . .	17
3. Cottonseed Oil Production, and Aspegren Estimates of Domestic Uses, 1889-90 to 1904-05 . . . . .	64
4. Wholesale Prices of Lard and Cottonseed Oil 1890-1904, of Oleostearin 1892-1904, and of Compound 1897- 1904; Price Spread between Lard and Cottonseed Oil; and Index of Business Activity, Monthly, 1890- 1904 . . . . .	68
5. Wholesale Prices of Lard, Cottonseed Oil, Oleostearin, and Compound; Price Spread between Lard and Cot- tonseed Oil; and Index of Business Activity, Monthly, 1904-18 . . . . .	92
6. Exports and Export Prices of Lard and Compound, 1888-89 to 1913-14 . . . . .	99
7. Compound Exports to Principal Destinations, 1896-97 to 1917-18 . . . . .	100
8. Exports of Lard and Compound to Europe, to West In- dies, and to Mexico and Central America, 1900-01 to 1925 . . . . .	102
9. Compound Production, 1908-32, According to Available Data and Estimates . . . . .	107

*CONTENTS*

<b>CHART</b>	<b>PAGE</b>
10. Exports and Average Export Prices of Lard and Compound, Annually, 1908-09 to 1932 . . . . .	109
11. Wholesale Prices of Lard, Cottonseed Oil, Oleostearin, and Compound; Price Spread between Lard and Cottonseed Oil; and Index of Business Activity, Monthly, 1918-32 . . . . .	113
12. Fats and Oils (Other than Cottonseed Oil) Used in Manufacture of Compound, 1912-23 . . . . .	118
13. Course of Production of Cottonseed Oil and Compound, 1922-31 . . . . .	169
14. Lard Production, Exports, and Domestic Retention, 1900-32 . . . . .	171
15. Spreads of Compound and Cottonseed Oil Prices from Lard Prices, and Prices of Compound and Cottonseed Oil as Percentages of Lard Prices, Based on Annual Average Prices Available from 1875 to 1932 . . . . .	172
16. Spread between Prices of Lard and Cottonseed Oil, and Production of Compound, 1922-32 . . . . .	180
17. Seasonal Indexes of Lard, Compound, and Cottonseed Oil Production, 1922-32 . . . . .	181
18. Factory Production of Lard and Compound, Quarterly, 1922-33, with Trends . . . . .	182
19. Estimated Per Capita Consumption of Butter, Lard, Compound, and Margarine, 1900-33 . . . . .	186

**APPENDIX**

<b>APPENDIX</b>	<b>PAGE</b>
A. GLOSSARY . . . . .	223
B. THE HISTORY OF THE TECHNOLOGY OF THE COMPOUND INDUSTRY . . . . .	232
Introduction—The production of hard fats—The production of illuminating oils—The refining of oils—Bleaching oil—Deodorizing oils—Early forms of compound in Europe—Early progress in the manufacture of compound in the United States—Hydrogenation	

**X AMERICAN VEGETABLE-SHORTENING INDUSTRY**

<b>APPENDIX</b>		<b>PAGE</b>
<b>C.</b>	<b>METHOD OF ACTION OF SHORTENINGS . . . . .</b>	<b>275</b>
	Introduction—Shortening—Method of action of shortening—Correlation of flour quality and shortening effect—The effect of shortening upon the leavening process—Effect of shortening on the onset of staleness—The measurement of shortening power—Choice of shortening	
<b>D.</b>	<b>TRADE-MARKS OF COMPOUNDED COOKING FATS REGISTERED IN THE UNITED STATES PATENT OFFICE, TO 1930 . . . . .</b>	<b>284</b>
<b>E.</b>	<b>EXCERPTS FROM THE UNITED STATES FOOD ADMINISTRATION REGULATIONS . . . . .</b>	<b>306</b>
<b>F.</b>	<b>TABLES . . . . .</b>	<b>314</b>

**APPENDIX TABLES**

<b>TABLE</b>		<b>PAGE</b>
<b>I.</b>	<b>Cottonseed Produced and Crushed, Crude Oil Produced, and Oil Exported, Annually, from 1874-75 . . . . .</b>	<b>314</b>
<b>I A.</b>	<b>Exports of Cottonseed Oil, Crude and Refined, 1922-33 . . . . .</b>	<b>316</b>
<b>II.</b>	<b>Aspegren Estimates of Domestic Uses of Cottonseed Oil, Annually from 1874-75 to 1911-12 . . . . .</b>	<b>317</b>
<b>III.</b>	<b>Aspegren Estimates of Uses of Exported Cottonseed Oil, Annually from 1874-75 to 1911-12 . . . . .</b>	<b>318</b>
<b>IV.</b>	<b>Classification of Trade-Mark Registrations of Compound, 1868-1930 . . . . .</b>	<b>319</b>
<b>V.</b>	<b>Exports of Compound, Annually from 1892-93, and of Lard, Annually from 1873-74 . . . . .</b>	<b>320</b>
<b>VI.</b>	<b>Exports of Compound to Principal Areas of Reported Destination, Annually from 1896-97 . . . . .</b>	<b>322</b>
<b>VI A.</b>	<b>Exports of Compound to Principal European Countries of Reported Destination, Annually from 1896-97 . . . . .</b>	<b>323</b>

*CONTENTS*

xi

<b>TABLE</b>	<b>PAGE</b>
VI B. Exports of Compound to Principal ex-European Countries of Reported Destination, Annually from 1896-97 . . . . .	325
VII. Shipments of Compound and Lard to Possessions, Annually from 1896-97 . . . . .	326
VIII. Factory Production of Lard, Compound, and Cottonseed Oil, Quarterly, 1922-33 . . . . .	327
IX. Lard Production, Exports, and Apparent Domestic Consumption, 1900-32 . . . . .	328
X. Compound Production, 1908-33, According to Available Data and Estimates . . . . .	330
XI. Compound and Lard Production in the Meat-Packing Industry, Compared with Total Output of the Industry, Census Years 1899-1931 . . . . .	331
XII. Census of Manufactures Data on Production of Compound, 1914-31 . . . . .	332
XIII. Census of Manufactures Classified Data on Compound Produced in the Shortenings (Other than Lard) Industry, 1925-31 . . . . .	334
XIV. Shortening Materials Used in the Commercial Baking Industry, Census Years 1923-31 . . . . .	335
XV. Cost of Principal Materials Used in the Commercial Baking Industry, Census Years 1923-31 . . . . .	336
XVI. Relative Importance of Vegetable Oil Compounds and Compounds Containing Animal Fats in Exports, 1922-32, and in Production in Part of the Industry, Census Years 1925-31 . . . . .	337
XVII. Raw Materials Used in Manufacture of Compound, in Specified Years, 1912-33 . . . . .	338
XVIII. Animal and Vegetable Fats and Oils (Other than Cottonseed Oil) Used in Manufacture of Compound, in Specified Years, 1912-33 . . . . .	339
XIX. Tariff Duties on Fats and Oils and Their Food Products, 1883-1932 . . . . .	341
XX. Approximate per Capita Consumption of Lard, Compound, Butter, and Margarine, Annually, 1900-32 . . . . .	342

**xii AMERICAN VEGETABLE-SHORTENING INDUSTRY**

<b>TABLE</b>	<b>PAGE</b>
<b>XXI. Wholesale Prices of Lard, New York, Monthly, 1875-1933 . . . . .</b>	<b>343</b>
<b>XXII. Wholesale Prices of Cottonseed Oil (Prime Summer Yellow), New York, Monthly, 1875-1933 . . . . .</b>	<b>345</b>
<b>XXIII. Wholesale Prices of Compound, New York, Monthly, 1897-1933 . . . . .</b>	<b>347</b>
<b>XXIV. Wholesale Prices of Oleostearin, New York, Monthly, 1892-1933 . . . . .</b>	<b>348</b>
<b>XXV. Excess of Lard Prices over Prices of Cottonseed Oil and Compound, Annual Averages, 1875-1933 . . . . .</b>	<b>349</b>
<b>XXVI. Prices of Cottonseed Oil and of Compound, Expressed as Percentages of Lard Prices, Annual Averages, 1875-1933 . . . . .</b>	<b>350</b>

**INDEX**

<b>INDEX . . . . .</b>	<b>351</b>
------------------------	------------

# APPENDIX

## APPENDIX A GLOSSARY

- Annatto** A yellowish-red dye obtained from the pulp inclosing the seeds of the annatto tree of Central America. It has been widely used to color butter and margarine, but is now in part replaced in this use by anilin dyes.
- Bleaching** See Appendix B, pp. 253 ff.
- Camphene** A popular term, formerly applied to essential resinous oils, such as the purified or distilled spirits of turpentine.
- Catalyst** A substance which alters the rate of a reaction without itself becoming permanently changed. Its action is known as catalysis. Commonly the rate of reaction is accelerated, but retardation is also possible.
- Caustic soda** A compound of one atom each of the metal sodium and the gases oxygen and hydrogen. Its formula is NaOH; its proper scientific name is sodium hydroxid. It is also known as soda lye, or simply as lye. It is very alkalin and corrosive.
- Coconut oil** The fat obtained from the meats of the coconut, the seed of the coconut palm, *Cocos nucifera* L. Commercially, the fat is not obtained from fresh nuts, but by pressing (*q.v.*) copra, as the dried meats are termed. However, natives in the tropics often prepare the oil in the household from fresh meats. The meats are grated into water, the suspension heated, and the oil skimmed off. Such oil is of superior quality but is not a factor in world trade. Coconut oil has a melting-point of 23°–27° C.; it is, therefore, solid in temperate climates.
- Colza oil** A term formerly applied to oil expressed from fine French seed of *Brassica napus*; as now used, it is practically synonymous with rape oil.
- Cottonseed oil** The oil expressed from the seed of different species of the cotton plant (*Gossypium*). The seeds of the Egyptian, Sea Island, Jamaican, and Brazilian sorts are hairless or naked after the removal of the fiber, but other varieties re-

main covered with a fine fuzz or lint. In preparing oil from the naked varieties, the seed is crushed or ground, heated, and the oil expressed in hydraulic presses. Other varieties are first delinted and decorticated in special machines before they are ground, cooked, and pressed. The oil (crude oil) as it runs from the presses is deeply colored, red to almost black.

**Cottonseed-oil stearin** The stearin obtained in winterizing (*q.v.*) cottonseed oil.

**Crushing** (of oilseeds, also known as pressing). A process for separating oils from solids with which they are mixed. It is the method used in the production of vegetable oils from oilseeds; it is the counterpart of rendering (*q.v.*), the method used in producing animal fats. Briefly, the method is as follows: The seeds are cracked, shelled, or hulled (*i.e.*, decorticated), when this is necessary. They are then crushed or ground. The ground material is then subjected to pressure, either cold or hot. If no heat is used, the oil is known as cold-pressed oil. If pressed hot, the seeds are cooked, usually with steam, before being subjected to pressure. The expression of the oil is practiced either with hydraulic, screw, or wedge presses, or with special machines known as expellers. These are built on the same principle as the ordinary meat-chopper or sausage machine, which nowadays is to be found in most kitchens. The oil-bearing material is fed into one end of a cylinder within which a power-driven worm conveyor forces the material to the other end of the cylinder and out against resistance, exactly as though it were sausage meat. The pressure exerted in the process squeezes out the oil.

The residue left after the expression of the oil, whether this has been done in a press or in an expeller, is known as oil cake, press cake, pressed cake, or simply as cake. It is used for feed or fertilizer.

Pressing in presses is also employed to some extent in rendering animal fats. After heating the tissues and removing the melted fat, the residue is sometimes subjected to pressure to recover the melted fat that is retained in the material.

Pressing is also employed in the manufacture of oleo oil, stearin, tallow oil, grease oil, and lard oil. The process is described in some detail in Appendix B, pp. 235 ff.

**Decolorizing** See Appendix B, pp. 253 ff.

**Deodorizing** See Appendix B, pp. 258 ff.

**Diglycerid** A substance formed by the chemical union of two



molecules of fatty acids with one molecule of glycerin, two molecules of water being eliminated in the process.

**Drying oil** An oil that absorbs oxygen readily. When exposed to the atmosphere in a thin film, these oils are gradually converted into a solid elastic waterproof resin; it is this property of forming tough films that causes drying oils to be used in paints and varnishes.

**Edible tallow** Choice tallow (*q.v.*) fit for food. See also *Oleo stock*.

**Ester** A substance formed by the chemical union of an alcohol, for example ordinary alcohol or glycerin, with an acid, water being eliminated in the process. Glycerids are, therefore, esters.

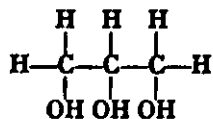
**Fatty acids** A term originally applied to the acids separated chemically from fats and oils. The term is now applied by chemists to any organic acid in which the carbon atoms are linked together without ring formation.

**Filter press** A device to separate a solid from a liquid in which it is suspended. In its most usual form, it is an assemblage of square screens of canvas all of the same size. They are placed on a horizontal rack like books on a shelf. Thus, a series of thin, flat compartments is formed, very much as though one were to stack upright along a shelf a series of ordinary square window screens, in which the wire netting had been replaced by canvas. The canvas is usually backed by a corrugated metal plate, so that it will not burst under pressure. In the filter press, the frames are pressed so tightly together by means of a powerful screw that liquid cannot escape between them. The frames of the screens are perforated with a set of holes placed so as to form a continuous tube reaching from one end of the stack to the other when the screens are assembled. This tube opens into every other compartment. Through this tube, the liquid is pumped into these compartments and forced through their canvas walls into the adjacent compartments, which do not communicate with the tube. The canvas holds back the fuller's earth or other suspended material and permits only clear oil to ooze into the adjacent compartments. The latter are provided with channels which permit the clear oil to escape to the outside, where it runs into storage tanks.

**Foots** See *Refining*.

**Fuller's earth** See Appendix B, p. 255.

**Glycerin** A white, somewhat viscous, sweet liquid. Chemically, it is an alcohol and has the formula,  $C_3H_8O_3$ , which is represented graphically thus:



It is found in fats and oils in which it is combined with fatty acids. It is obtained commercially as a by-product in the manufacture of soap. See also *Stearin*, *Saponification*.

**Graining** See Appendix B, p. 235.

**Grease** Any fat of a soft-solid consistency which, for any reason, is regarded as inedible. In packing-house parlance, grease is merely inedible lard.

**Grease oil** The oil obtained in manufacturing stearin from grease by pressing.

**Hydrogenation** See Appendix B, pp. 264 ff.

**Iodin number** The percentage by weight of iodine absorbed by a fat in the natural state. It is an index to the degree of unsaturation of a fat. See also *Unsaturated fatty acids*.

**Lard** (French, *saïndoux*, *graisse de porc*; German, *Schweinefett*, *Schmalz*; Italian, *strutto*, *lardo*, *grasso di porco*). Originally, the fat rendered from the leaf of the pig, i.e. the fat from the kidneys and bowels. For some decades, however, it has meant in America the fat taken from any and every part of the hog; and is so recognized in the regulations for the enforcement of the United States Meat Inspection Act.

**Lard oil** An oil obtained in preparing stearin from lard by pressing (*q.v.*) by the method described in Appendix B, p. 235.

**Lard stearin** Stearin prepared from lard by pressing.

**Leaf fat** The fat from the omentum or leaf of animals. The omentum is a sheet of tissue attached to the stomach and intestines. The ruffle (kidney) fat is also usually included with that from the leaf.

**Linseed oil** Flaxseed oil. The oil obtained from flaxseed, *Linum usitatissimum*. It is a drying oil.

**Margarine** A butter substitute. It is made by emulsifying in milk, whole or skim, bland, flavorless, odorless fats mixed in such proportions as to have a melting-point of about 26° to 27.5° C.,

inoculating this emulsion with cultures of certain milk-souring bacteria in order to impart the flavor of butter, and then, by rapid chilling, separating the fat from the excess of liquid in which it is emulsified. This solid-fat emulsion is then worked and handled like butter. The most important fats employed in its manufacture are neutral lard, oleo stock, oleo oil, coconut oil, palm kernel oil, peanut oil, oleostearin, lard stearin, cottonseed oil, and sesame oil.

**Mixed glycerid** A glycerid (see also *Triglycerid*) which contains in its molecule more than one kind of fatty acid.

**Monoglycerid** A substance formed by the chemical union of one molecule of a fatty acid (*q.v.*) with one molecule of glycerin, one molecule of water being eliminated in the process.

**Neutral lard** See chapter i, p. 10.

**Oil cake** See *Crushing*.

**Oleic acid** An acid forming a component of certain triglycerids (see *Olein*). It is a liquid, and has the formula  $\text{CH}_3(\text{CH}_2)_n(\text{CH})_1\text{COOH}$ , or  $\text{C}_{2n}\text{H}_{4n}\text{O}_2$ . It will be noted that it has the same formula as stearic acid (*q.v.*), except that it contains two atoms less of hydrogen. It is, therefore, an unsaturated acid (*q.v.*).

**Olein** A common constituent of fats and oils. It is a triglycerid, like stearin (*q.v.*), but differs from it in that it contains three molecules of oleic acid (*q.v.*), instead of stearic acid. It is a viscous liquid, congealing to a solid at a temperature of 4° to 5° C., i.e. a temperature a little above the freezing-point of water.

**Oleomargarine** In America, the statutory designation for margarine and all other butter substitutes. In the trade, the term is sometimes used to designate margarine (*q.v.*) containing animal fats to distinguish this type of butter substitute from margarine consisting wholly of vegetable oils. Originally, in France, the term was used to designate the fat now known in America as oleo oil (*q.v.*).

**Oleo oil** See chapter i, p. 11.

**Oleostearin** A solid fat obtained from oleo stock (*q.v.*) as a by-product in the manufacture of oleo oil (*q.v.*). The method of manufacture is described in Appendix B, p. 235. Its composition and properties vary with the method of preparation. Most commonly, it has a melting-point of 50° to 54° C.

**Oleo stock** A choice grade of edible tallow made by chilling caul and ruffle fats and the fats obtained from trimming the viscera immediately after slaughter, then hashing them, and rendering with water at low temperatures not exceeding 76° to 77° C. Sometimes the best grades of cutting fats from the cutting and boning operations are also used. In Europe, it is also known as *premier jus*. It is the counterpart of neutral lard (*q.v.*). It is used primarily for the manufacture of oleo oil (*q.v.*).

**Organic compound** Any substance, the molecules of which contain carbon.

**Palmitic acid** An acid forming a component of certain triglycerides (see also *Palmitin*). It forms tufts of fine crystalline needles, melting at 62.6° C. Its chemical formula is  $\text{CH}_3(\text{CH}_2)_{14}\text{COOH}$ , or  $\text{C}_{16}\text{H}_{32}\text{O}_2$ .

**Palmitin** A common constituent of fats and oils. It is a triglycerid, like stearin (*q.v.*), but differs from it in that it contains three molecules of palmitic acid (*q.v.*), instead of stearic acid. It is softer than stearin and melts at 63° to 65° C.

**Palm kernel oil** The fat obtained from the seeds of the oil palm (see *Palm oil*). The seeds or kernels are cracked and the fat is expressed from the meats. Palm kernel oil closely resembles coconut oil. Its melting-point is 23° to 30° C.; it is solid like coconut oil in temperate climates.

**Palm oil** The oil obtained from the flesh of the fruit of the oil palm *Elaeis guineënsis*, a native of West Africa. It should not be confused with palm kernel oil, obtained from the hard seeds, inclosed within the flesh of the same fruit. Palm oil is orange-colored. It is imported principally from West Africa, but a smaller volume of very pure oil is now also exported from Sumatra, where the palm has been introduced by planters. Palm oil is used in soap, in foodstuffs, and in the manufacture of tin plate to prevent oxidation of the sheets during the process of tinning.

**Pearl ash** A term formerly applied to commercial potassium hydroxid or caustic potash, KOH (see also *Potassium hydroxid*). It was made by leaching wood ashes with water, boiling off the water, and causticizing the residue.

**Potassium hydroxid** Caustic potash. It is a compound of one atom each of the soft white metal, potassium, and the gases, oxygen and hydrogen. Its formula is, therefore, KOH. It is very alkalin and corrosive.

**Pressing** See *Crushing*.

**Rape oil** The oil obtained from the seed of various members of the mustard family, principally *Brassica campestris*, L.

**Red oil** The commercial name of an impure oleic acid, obtained as a by-product in the manufacture of stearic acid. It is extensively used, combined with alkali, as a detergent in the textile trade and also as a soap material.

**Refining** (See also Appendix B, p. 251). The removal of free fatty acids and other objectionable substances—principally nitrogenous and mucilaginous matters from oils and foots. The oil or melted fat is treated with a little more than the requisite amount of strong aqueous caustic soda (*q.v.*) solution to convert the free fatty acid present into soap. The oil and the alkali solution are thoroughly stirred together and sometimes warmed. The mixture is then allowed to separate. The result is that the oil, freed from fatty acid, floats on top of a layer of soap-alkali solution and other impurities which are drawn off. The oil is then washed with water to remove soap, alkali, and other impurities, when it is ready for the decolorizing or deodorizing process. There are other methods of refining, but this is the one most commonly used in America. The under layer of soap and other impurities, which is drawn off from the oil, consists of solid matter mixed with some alkaline water. It is known as foots, probably because it collects at the foot of the tank. It is used to manufacture soap or washing powder.

**Rendering** The process of separating fats or oils from animal tissues by heating dry or in the presence of moisture. See Appendix B, pp. 244 ff.

**Saponification** The chemical process by which a triglycerid (see also *Stearin*) is split into its components, glycerin and fatty acid. In the process, three molecules of water are taken up. The process of splitting a substance whereby water is taken up is known to chemists as hydrolysis, a word which is the Greek for cleavage by water. It was first observed to take place in the manufacture of soap. The term saponification (instead of the more exact term hydrolysis) is, however, applied indiscriminately and inappropriately to any chemical change of this nature, whether or not soap is formed.

**Sesame oil** The oil obtained from the seeds of *Sesamum indicum* and *Sesamum orientale*.

**Shortening** Any fat used in making baked products to modify the texture so as to render such products more tender, crumbly, or flaky. See also Appendix C.

230 AMERICAN VEGETABLE-SHORTENING INDUSTRY

**Simple glycerid** A glycerid (see also *Triglycerid*) which contains in its molecules only one kind of fatty acid.

**Soap** A combination of a fatty acid with a metal, i.e. a salt of a fatty acid.

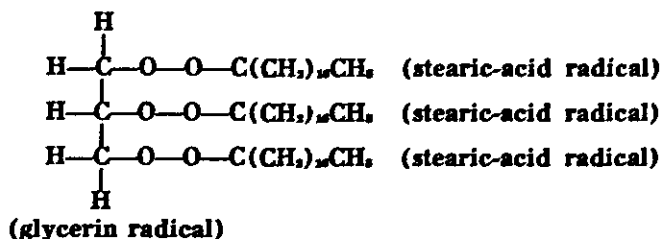
**Sperm oil** Oil obtained from the head cavities and blubber of the sperm whale. See also *Spermaceti*.

**Spermaceti** A kind of animal wax from the head of the sperm whale (French, *cachelot*; German, *Pottfisch*), particularly *Physter macrocephalus*.

**Steam lard** Lard rendered with steam under pressure. See also Appendix B, pp. 244 ff.

**Stearic acid** An acid forming a component of the molecule of certain triglycerids (see also *Stearin*). It is a hard, white solid with crystalline fracture. Its chemical formula is  $\text{CH}_3(\text{CH}_2)_{16}\text{COOH}$ , or  $\text{C}_{18}\text{H}_{36}\text{O}_2$ . The stearic acid of commerce is never the pure acid; it is a mixture of stearic with other acids, such as palmitic acid. See also *Palmitin*.

**Stearin** A common constituent of fats and oils. It is the triglycerid of stearic acid, i.e. it is formed by the chemical union of one molecule of glycerin with three molecules of stearic acid, three molecules of water being eliminated in the process. Its formula may be represented schematically thus:



It is not known to occur in the pure form in nature and is always associated with other triglycerids in fats and oils. It is extremely difficult to separate completely from associated triglycerids. The stearin, so-called, of commerce is always a mixture of stearin with a certain amount of other triglycerids. Pure stearin is a white, crystalline solid, greasy to the touch, and practically tasteless and odorless. It melts ordinarily at about 72° C.

**Stearin from cottonseed oil** Stearin obtained from cottonseed oil in winterizing (*q.v.*).

**Tallow** (French, *suif*; German, *Talg*). The fat obtained from cattle, sheep, and goats. It is solid at ordinary temperatures, its melting-point ranging from about 43° C. to about 54° C.

**Tallow oil** The more liquid portion of tallow obtained in producing stearin by pressing (*q.v.*).

**Tallow stearin** The stearin (*q.v.*) made from tallow by pressing.

**Triglycerids** See *Stearin*.

**Unsaturated compound** See *Unsaturated fatty acid*.

**Unsaturated fatty acid** A fatty acid (*q.v.*), the molecule of which contains less than the maximum of hydrogen possible. It is unsaturated with respect to hydrogen. The term unsaturated is applied to any organic compound exhibiting this characteristic. Oleic acid (*q.v.*) is such an unsaturated acid. Most unsaturated fatty acids are liquids at ordinary temperatures. By chemical means, these acids may be made to take up (i.e. combine with) hydrogen. This process is known as hydrogenation. It converts a more unsaturated fatty acid into a less unsaturated one; or, if the hydrogenation is carried to completion, into a saturated fatty acid, i.e. into one which contains the maximum possible of hydrogen. Saturated fatty acids are usually solid. Thus by hydrogenation, oleic acid, a liquid, is converted into the saturated acid, stearic acid, a solid. Similarly, linoleic ( $C_{18}H_{28}O_2$ ) and linolenic acids, which are more unsaturated, are first converted into oleic and finally into stearic acid.

**Winterizing** (also known as demargarinating) A process to which oil is subjected to prevent it from congealing in cold weather or depositing stearin when chilled. It consists in slowly cooling the oil and filtering off the stearin that separates. Such an oil is known as a winter oil. Conversely, an oil that has not been winterized is known as a summer oil.

## APPENDIX B

# THE HISTORY OF THE TECHNOLOGY OF THE COMPOUND INDUSTRY

### INTRODUCTION

In the main body of the text reference has been made to the effects of technological developments upon the economic evolution of the compound industry, but neither the details of processes nor their history have been presented there. To have included either in the main body of the text would have entailed many digressions and disturbed the orderly presentation of the economic evolution of the industry. Yet the history of the technology employed is an essential part of the history of the industry. It is, therefore, presented in this appendix where it may be examined by those interested in the history of the application of science and invention to industry rather than in the history of the economic factors that served to shape this particular industry.

It has been pointed out (p. 5) that, in cookery, consistency of oleaginous material is important only when it is to be used for shortening. For technical purposes, on the contrary, consistency may be the factor that determines the choice of a particular fat or oil. To be burned in lamps in winter, for example, or to be used in the ancient practice of dressing wool, the fat must be fluid. In candles, the fat must be as hard as possible. Early progress in producing and refining fats and oils was stimulated by technological requirements, such as these, rather than by demand for food purposes. The most active period of progress in this field began with the end of the eighteenth century and continued into the middle of the nineteenth century. This was due in part to the fact that in this period the science of chemistry developed and with it the application of science to many industries became possible for the first time. An even more important stimulus was the growing demand for fats and oils in general, which has been discussed in the main body of the text (chapter v). Many factors were active toward the end of the eighteenth century to encourage progress in fats and oils technology. The most important forward steps were taken in the manufacture of soap, lubricants, cloth, and leather, and in illumination. Discoveries made in these industries were utilized in later times in the manufacture of food fats when such manufacture became neces-



sary. The processes developed in connection with illumination ultimately became especially important for the food-fat industries. Therefore, to search out the origins of the technical processes of these industries it is necessary to inquire into the history of the production of hard fats for candle making, of the production of permanently fluid oils for lamps, of the refining of oils, of the deodorizing of illuminating oils, and of the methods of bleaching fats, especially for candle making.

#### THE PRODUCTION OF HARD FATS

Originally, candles were made of beeswax or tallow. In the thirteenth century, they were still considered a luxury.<sup>1</sup> Spermaceti began to be used only in the first half of the eighteenth century.<sup>2</sup> It was known in medieval Europe, but was used as a medicine, records of such use going back at least as far as 1471.<sup>3</sup> It was obviously a rare and precious substance, and any such substance in those days was liable to be put to medicinal use. According to Goode,<sup>4</sup> sperm whales were not often taken before 1720-30 because they were too fierce. Spermaceti remained comparatively scarce even after commercial whale fishing had developed, because the sperm whale is a denizen of tropical and subtropical seas, though it does range into colder waters. Scammon<sup>5</sup> states that specimens have been taken as far south as latitude 56° and in the Pacific as far north as 56° 12'. It is, however, not one of the commoner species of northern waters; hence in the early days it could not have been taken frequently. Spermaceti was, therefore, not a cheap material. It became relatively so only after the southern fishery was begun by British colonists in America in the second decade of the eighteenth century,<sup>6</sup> for only then were sperm whales taken regularly and in numbers.

<sup>1</sup> According to J. Lewkowitsch (*Chemical Technology and Analysis of Oils, Fats, and Waxes* [London, Macmillan, 1922, 3 vols., 6th edition], III, 262), "the Dominican monk Flamma reports, in the beginning of the thirteenth century tallow candles were still considered a luxury."

<sup>2</sup> Chamber's *Cyclopaedia* in 1738 stated that "Spermaceti candles are of modern manufacture, . . . superior to the finest wax candles." Quoted in *A New English Dictionary* . . . , edited by J. A. H. Murray, et al. (Oxford, Clarendon Press, 10 vols., 1919), Vol. IX, Part 1, p. 578; K. Kamarsch, *Geschichte der Technologie seit Mitte des Achtzehnten Jahrhunderts* (Munich, R. Oldenbourg, 1872), p. 843.

<sup>3</sup> Murray, et al., *loc. cit.*

<sup>4</sup> G. B. Goode, et al., *The Fisheries and Fishery Industries of the United States* (Washington, Government Printing Office, 1884-87), Section V, II, 64.

<sup>5</sup> C. M. Scammon, *The Marine Mammals of the North-Western Coast of North America together with an Account of the American Whale-Fishery* (San Francisco, John H. Carmany & Co., 1874), p. 77.

<sup>6</sup> W. S. Tower, *A History of the American Whale Fishery* (Philadelphia, Publications of the University of Pennsylvania, 1907), p. 100.

Just when sperm candles were first made in the American colonies of Great Britain it is impossible to say. In the report made in 1730-31 by the Board of Trade and Plantations to the British House of Commons "with respect to laws made, manufactures set up, or trade carried on in the Colonies, detrimental to the trade, navigation, or manufactures of Great Britain," no mention seems to be made of candle manufacture.<sup>1</sup> However, sperm-candle making must have become established rapidly, for as early as 1748 spermaceti candles were advertised in the *Boston Gazette*<sup>2</sup> as though they were newly introduced. Franklin,<sup>3</sup> in 1758, mentions an extinguisher "for spermaceti candles only." By 1760 there were eight sperm-candle factories in New England and one in Philadelphia.<sup>4</sup> By 1770 the export of sperm candles alone amounted to nearly 380,000 pounds, valued at over £23,500.<sup>5</sup>

Toward the end of the eighteenth century, the demand for candles better than those made of tallow but cheaper than those made from beeswax<sup>6</sup> or spermaceti became great enough to stimulate the search for substitutes.

The earliest process used to furnish hard fats as substitutes for beeswax and spermaceti is a mechanical one. It depends upon the fact that tallow, like most other fats and oils, is a mere physical mixture of closely related chemical individuals known as triglycerids. The most important of these are stearin, palmitin, and olein. At ordinary temperatures, stearin is a fairly hard, white solid; palmitin, a softer solid; and olein, a liquid. The fats of common domesticated animals consist predominantly of mixtures of these three, and their proportions determine the consistency. If stearin predominates, the fat is hard, like tallow; if olein predominates, it is soft and oily, like chicken fat.

<sup>1</sup> Cf. Timothy Pitkin, *A Statistical View of the Commerce of the United States of America* . . . (New York, James Eastburn & Co., 2d edition), 4 ff.

<sup>2</sup> G. F. Dow, *The Arts and Crafts in New England, 1704-1775; Gleanings from Boston Newspapers* . . . (Topsfield, Mass., Wayside Press, 1927).

<sup>3</sup> *The Life and Writings of Benjamin Franklin*, edited by A. H. Smyth (New York, Macmillan, 10 vols., 1905), III, 433.

<sup>4</sup> Tower, *op. cit.*, 111.

<sup>5</sup> Pitkin, *op. cit.*, 21.

<sup>6</sup> Before the middle of the nineteenth century, beeswax had been displaced almost completely in the United States as a candle-making material, except for sacramental purposes, though, as late as 1816, over 7,000 pounds of wax were still exported, and though beeswax continued to be exported for a long time. No beeswax candles were manufactured in this country, and those imported from France cost 100 per cent more than stearic-acid candles. Cf. Campbell Morfit, *Chemistry Applied to the Manufacture of Soap and Candles* . . . (Philadelphia, Carey and Hart, 1847), p. 478; also the review of this book in the *Journal of the Franklin Institute*, February 1848, Third series, XV, 122.

If stearin or palmitin be melted and then cooled, and the temperature at which the liquid congeals be noted, it is found that stearin congeals at a considerably higher temperature than palmitin and that both have set to solids at temperatures much higher than that at which olein solidifies. Furthermore, as would be expected, if a mixture of the three is melted and then slowly cooled, it is observed that first most of the stearin congeals out of the mixture, most of the palmitin and olein remaining in liquid form. The solidified stearin can be separated by merely straining and draining, if precautions are taken not to let the mass cool off further. It is a procedure exactly similar to the freezing of water out of hard cider in order to make the cider more alcoholic than it naturally is. If a barrel of cider is exposed outdoors in winter, everyone knows it is the water that congeals, not the alcohol. This is because water congeals at a much higher temperature than alcohol. Thus, it is possible to freeze or congeal out much of the water and to drain off the rest, which, therefore, contains the alcohol in more concentrated form than in the original hard cider.

Because stearin, and also palmitin, congeal at a higher temperature than olein, it is possible to perform a similar separation exactly analogous to the well-known concentration of the alcohol content of cider by freezing. The fat is melted and allowed to cool slowly to the temperature at which most of the stearin and a certain amount of palmitin congeal. The mass is then held at this temperature because the stearin congeals slowly just as the ice in cider congeals slowly. This part of the process is known as "graining," because the mass gradually becomes granular, owing to the particles of separating stearin which are suspended in the still-liquid portion. If the amount of stearin in the fat is large, the whole mass may become a soft, buttery solid.

When as much stearin has congealed out as it is desired to let separate, the still-liquid portion is drained off, care being taken not to let the mass cool further before draining is complete. As mere draining leaves a good deal of liquid adhering mechanically to the stearin, it is common practice to make the separation more complete by pressing, in order to squeeze out the liquid fraction more perfectly than is accomplished by mere draining. Hence, the process here described is often known as pressing, though pressing is not the essential feature.

By this really simple mechanical procedure, it is possible to separate most fats into one fraction much harder than the original fat and another much softer. The consistency of the two fractions depends upon the nature of the original fat, the manner in which graining is done, and the degree of pressure applied. Stearin

made commercially in this way is never the pure substance the chemist knows as stearin. It is always a mixture, chemically speaking, of stearin with more or less palmitin and small amounts of olein. The perfect separation of these substances one from the other is so difficult that it is troublesome even in the laboratory.

The earliest record the writers have been able to find of the use of this method for the separation of a solid fat into a liquid and a solid fraction is the method attributed to Blondeau<sup>1</sup> about the middle of the eighteenth century. Slaughterhouse offal was rendered with much water at a low temperature, while the fat was skimmed off and treated with boiling water for twenty-four hours. The fat was again skimmed off and put in a kettle with water just warm enough to prevent the fat from wholly congealing. The portion of the fat that congealed settled out. Oil of different thickness was drawn off through three cocks, one above the other in the side of the kettle. The oil was used in currying leather. It is highly probable that the separation of soft or buttery fat into a solid and a liquid fraction had been known before Blondeau's time. Spermaceti must have been prepared in some such fashion, and in French colonial Louisiana bear oil was produced in this way.<sup>2</sup> There is no record that pressure was used by Blondeau, but since the pressing of oilseeds was a well-known practice, it is not unlikely that Blondeau's process may soon have been perfected by the application of pressure to the solid fraction. Morfit<sup>3</sup> states that Bolts made candles from pressed tallow in 1799, but the patent issued to him is not clear on this point.<sup>4</sup> It would seem that he cooled the melted tallow under pressure without expressing any oil.

<sup>1</sup> Le François de la Lande, "Art du Corroyeur" (Paris, 1767), p. 19. In *Descriptions des arts et métiers, faites ou approuvées par Messieurs de L'Académie Royale des Sciences* (Paris, Desaint & Saillant). (Publication of this series began in 1761; the individual monographs are not numbered but merely dated, have no separate title pages, and are not assigned to volumes.)

<sup>2</sup> J. Lippincott, "Industry among the French in the Illinois Country," *Journal of Political Economy*, February 1910, XVIII, 114.

<sup>3</sup> Campbell Morfit, *A Treatise on Chemistry Applied to the Making of Soap and Candles* (Philadelphia, Henry Carey Baird, new edition, 1860), p. 290. This is a later edition of the work previously cited (p. 234). There was another edition, not accessible to the writers, *A Treatise on Chemistry Applied to the Manufacture of Soap and Candles . . .* (Philadelphia, Parry & McMillan, new edition, 1856). At the time of the 1856 edition, Morfit was "Professor of Analytic and Applied Chemistry at the University of Maryland in Baltimore."

<sup>4</sup> *The Repertory of Arts and Manufactures: Consisting of Original Communications, Specifications of Patent Inventions, and Selections of Useful Practical Papers from the Transactions of the Philosophical Societies of All Nations*, 1800, XII, 368.

While the separation of fats into a fraction harder and a fraction softer than the original fat began to be practiced some time in the eighteenth century or even earlier, very little was then known concerning the chemistry of fats. It was not clearly understood that they are physical mixtures of different chemical substances of varying properties. Braconnot was the first to show that fats, whatever their consistency, are composed of both a solid and a liquid fraction.<sup>1</sup> This, he demonstrated by pressing the fat between sheets of brown paper. The paper absorbed the oil which was thereupon recovered by wetting with warm water and subjecting the paper pulp resulting to the action of a press. These experiments are perhaps the first cases of "capillary analysis" to be found recorded in the literature. In this manner, Braconnot fractionated butter, lard, beef marrow, mutton marrow, and goose, duck, and turkey fat. He also showed that oils like olive, almond, and colza oil, if sufficiently chilled, may be fractionated similarly, and he quotes Professor Gottling as having made a similar demonstration for linseed oil. Lard, when subjected to the brown-paper treatment, produced a hard fraction of the consistency of soft wax, because it retained a certain amount of the liquid fraction. To secure more complete removal of the fluid fraction, Braconnot melted lard that had been pressed once between brown paper with oil of turpentine, cooled it, and again compressed it in brown paper. In 1818, Braconnot and Simonin received a patent for what appears to be the first commercial process of pressing tallow. Tallow, mixed with turpentine or other volatile oil, was placed in a perforated round vessel lined with felt, and gradual pressure was applied. The solid residue remaining on the felt was boiled with water to drive off the turpentine or volatile oil; then heated with fresh powdered bone-black and filtered. It was too brittle to use for candles, but could be so used if mixed with one-fifth its weight of beeswax. The oil obtained was fit for soap.<sup>2</sup> The writers have not been able to determine whether the process was used commercially.

<sup>1</sup> H. Braconnot, "Sur la nature des corps gras," *Annales de chimie*, March 1815, 2 Sér., XCIII, 225.

<sup>2</sup> The patent record reads: 940, July 29, 1818. "Brevet d'Invention de Cinq Ans, Pour la fabrication en grand d'une matière analogue à la cire, appelée *ciromême*, et propre à faire des bougies, des savons et du sulfate de potasse, Aux sieurs Braconnot et Simonin," *Description des machines et procédés spécifiés dans les brevets d'invention, de perfectionnement et d'importations, dont la durée est expirée*; Publiée d'après les ordres de Son Excellence le Ministre de l'Intérieur Par M. Christian, Directeur du Conservatoire Royal des Arts et Métiers (Paris, Huzard, 1825), X, 361.

See also *Bulletin de la Société pour l'encouragement de l'industrie nationale*, January 1826, X, 16, and *Dinglers polytechnisches Journal*, 1826, XX, 310.

In 1821 Dr. Claude Anthelme Manjot was commended by the Société pour l'Encouragement de l'Industrie Nationale for his candles, because he had found means to purify, to harden, and to bleach tallow and make candles from it. A factory was established about that time. By 1826, Manjot had sold his patents and his factory at Monceau near Paris to Hebert.<sup>1</sup> Manjot's price for candles in 1821 had been 22 sous a pound; Hebert's, in 1826, was 19 sous.

Manjot apparently held the view recently disproved by Chevreul that the elements of flesh were directly converted into adipocere, and he believed that all that is necessary to convert muscle substance into fat is to remove the nitrogen. This he endeavored to do by chemical means. He rendered adipose tissue with a mixture of dilute sulfuric and nitric acid by which method he obtained better yields and a lighter-colored product. The tallow thus rendered was then treated with a mixture of stronger sulfuric and nitric acid or hydrochloric and nitric acid, together with alcohol. A second method was to treat with sulfuric acid and oxide of manganese and at the same time pass oxygen through the molten mass.<sup>2</sup> The first treatment undoubtedly hardened the tallow.

A year later, in 1821, a French patent was granted to Samuel Pugh of Rouen for the use of dilute sulfuric and nitric acids in rendering tallow, whereby evil odors were avoided and a harder and whiter product obtained.<sup>3</sup>

J. L. Cambacérés,<sup>4</sup> in his patent (*brevet*) of February 10, 1825, of which more hereafter, described a commercially practical method of pressing in a hydraulic or in an ordinary press, the novel point of which was that the fatty matter was warmed before pressing to a temperature adjusted to the proportion of oily material it was desired to express. The more oil it was intended to remove, the higher the temperature.<sup>5</sup>

<sup>1</sup> *Bulletin de la Société pour l'encouragement de l'industrie nationale*, October 1826, p. 311; quoted in detail in *Dinglers polytechnisches Journal*, 1827, XXIII, 128.

<sup>2</sup> No. 2746, March 1, 1826. *Brevets d'invention* ... (1836), XXIX, 203.

<sup>3</sup> No. 1960, December 5, 1821. *Ibid.* (1832), XXII, 253.

<sup>4</sup> J. L. Cambacérés, an engineer, was the originator of many improvements in candle making. The writers have been unable to find a biographical sketch of him. They have encountered no evidence that he was related to Jean Jacques Régis de Cambacérés, Duke of Parma. Malepeyre describes him as "ingénieur des ponts-et-chaussées."

<sup>5</sup> F. Malepeyre, *Nouveau Manuel complet de la fabrication des acides gras concrets employés dans les arts, et de celles des bougies stéariques margariques, élaidiques, palmitiques et cociniques, comprenant aussi la fabrication de la stéarine, de la margarine, de la élaidine, de la palmitine et de la cocinaie, ainsi*

In 1826, Nicholas Hogesippe Manicler received an English patent for a new method of preparing fats and using them in illumination.<sup>1</sup> Fats were rendered with water in tight kettles under a pressure of 15 pounds per square inch. The fat, separated from the water, was spread at a temperature of 90°–100° F. on wool cloth or felt. The edges were turned in and the cloths stacked alternately with iron plates. The pile was weighted and the room kept at 90°–100° F. After most of the oil was thus expressed, the residue was further pressed at 80°–90° F. in a hydraulic press. Turpentine oil (1:7) could be used to facilitate expression of the oil. The residue was crumbly and was to be used for candles mixed with 10 per cent of beeswax or boiled linseed oil. Such mixtures could be bleached by placing in a steam-heated kettle closed with a glass window and introducing chlorin gas. The excess of chlorin was removed by boiling with water. The mixture was then melted with powdered charcoal and pressed through woolen cloths at 150° F. The product was to be called "cerine" and was to be used in candles; the expressed oil could be used in lamps, for soap, or as a lubricant.<sup>2</sup>

This process of Braconnot was apparently improved by Lecanu, who melted the fat and the turpentine together and then cooled before pressing.<sup>3</sup> The treatment with chlorin was not merely to bleach, but also to render the stearin less brittle.<sup>4</sup>

J. Eboli treated the pressed stearin with ether which Lecanu had earlier recommended as a recrystallizing agent for laboratory use to remove traces of turpentine.<sup>5</sup> It is this process that Gus-

*que des bougies de composition qu'on peut faire avec ces corps seuls ou mélangés aux acides gras concrets* (Paris, Librairie Encyclopédique de Roret, 1849), p. 134. Also 4325, February 10, 1825. *Brevets d'invention* ... (n.d.), XXI, 296.

<sup>1</sup> "Patent granted to Nicholas Hogesippe Manicler, Great Gullfordstreet, Southwark, county of Surrey, for a new preparation of fatty substances, and the application thereof to the purpose of affording light. Dated March 20, 1826," *Repertory of Patent Inventions and Other Discoveries and Improvements in Arts, Manufactures, and Agricultures, etc.*, December 1827, Series 3, III, 380.

<sup>2</sup> The editor of the *Repertory of Patent Inventions* . . . . (*op. cit.*) wrote that the pressing of fat and the use of turpentine were well known, having been reported by Braconnot in 1815, that the patentee "being a chemist, and consequently a man of education" should have known Braconnot's work and that "he certainly has not done right in putting Mr. Braconnot's processes into his specifications as if they were his own discoveries." Rendering with steam under pressure the editor regarded as a useful improvement. French patents were issued to Manicler on August 11, 1826, and on November 3, 1826, which were declared "en déchéance par ordonnance du Roi," in No. 2006, September 25, 1833. *Brevets d'invention* ... (1833), XXIII, 22.

<sup>3</sup> Malepeyre, *op. cit.*, 242.

<sup>4</sup> *Ibid.*, 243.

<sup>5</sup> No. 4169, March 15, 1836. *Brevets d'invention* ... (n.d.), XI, 434.

serow described as a quantitative laboratory method.<sup>1</sup> According to Malepeyre, the process of Eboli was probably never much used,<sup>2</sup> for in 1840 Tresca and Eboli took out a new patent in which the oil from previous pressings was used instead of turpentine.<sup>3</sup>

In 1833, Reichenbach proposed the substitution of cresol for turpentine,<sup>4</sup> and in 1842, de Milly received a patent for the use of shale oil (*huile volatile de schiste*).<sup>5</sup> As late as 1833, Schaedler referred to the addition of 10 per cent of benzene or turpentine to facilitate the expression of tallow oil from tallow.

In 1842, John H. Smith applied for a United States patent, employing alcohol or a mixture of alcohol and camphene,<sup>6</sup> and Morfit claimed that he rediscovered the process quite independently in 1842 or 1843.<sup>7</sup> He worked out the process in greater detail than Braconnot, even down to the publication of a statement of costs and profits. The process does not, however, seem to have been used commercially in America, for he complained that he was not able to interest capitalists in it on any basis satisfactory to him. He used lard or lard stearin, rather than tallow, and hoped to supplant tallow candles without competing with sperm. He submitted his process, together with samples including candles, to the Franklin Institute at Philadelphia, which awarded him a certificate of honorable mention and referred to him as "a very young man."<sup>8</sup> Morfit wrote with justifiable pride that his candles had received as high a premium as the adamantine (stearic acid) candles of Hancock and Mann, with which they competed, although this firm was perhaps the best of its type and although its candles were twice as expensive as his.

The use of tallow or stearin unmixed in candles was of short duration, for it was soon superseded by the use of stearic and other hard fatty acids or mixtures of fatty acids with stearin and other hard fats. The new process was made possible by the pure

<sup>1</sup> C. A. Gosserow, "Neue Untersuchungen über die Fette und den Seifenbildungsprozess," *Chemisches Centralblatt*, May 7, 1830, I, 145.

<sup>2</sup> Malepeyre, *op. cit.*, 244.

<sup>3</sup> No. 5874, August 14, 1840. *Brevets d'invention ...* (1843), XLIX, 423.

<sup>4</sup> "Besonders zusammengestellte Eigenschaften des Kresots . . . ," *Chemisches Centralblatt*, April 17, 1833, IV, 262, a résumé of a series of articles by Reichenbach appearing in the *Journal für Chemie und Physik von Schweigger*, 1832, LXVI, and 1833, LXVII.

<sup>5</sup> No. 12667, March 10, 1842. *Brevets d'invention ...* (1858), LXXXIX, 17.

<sup>6</sup> Ellsworth, *Report of the Commissioner of Patents for 1843* (Washington, D.C., 1845), Appendix 11, p. 91.

<sup>7</sup> Morfit, *Chemistry Applied to the Manufacture of Soap and Candles . . .*, 453.

<sup>8</sup> Campbell Morfit was born in Missouri in 1820.



science investigations of Chevreul, Braconnot, and others which had cleared up the chemical nature of saponification. The use of fatty acids for candle making was apparently proposed at about the same time and independently by the distinguished chemists Chevreul and Gay-Lussac and by the engineer Cambacérés. The new process, however, did not eliminate pressing; it involved either the pressing of the fat itself before saponification or the pressing of the fatty acids after saponification.

Gay-Lussac and Chevreul took out a French patent covering the process<sup>1</sup> and so did Cambacérés<sup>2</sup> at about the same time. Gay-Lussac and Chevreul never themselves exploited the patent. Their claims covered the use of solid fatty acids from whatever source and prepared in whatever manner; saponification under pressure; separation of the liquid from the solid acids by pressure or by extraction with hot alcohol. The fatty acids might be prepared either by acidifying the saponified material with hydrochloric acid after it had been washed to remove oleate or the saponified material might be treated with alcohol before acidification to remove oleates. The process proved too expensive and some potassium chloride remained in the fatty acids despite careful washing. This crepitated when the candles burned.<sup>3</sup>

Furthermore, ordinary wicks would not burn with fatty-acid candles, so that Gay-Lussac and Chevreul found it necessary to take out a supplementary patent for an improved wick, under date of August 4, 1825.<sup>4</sup> Unfortunately, a patent had been taken out for a similar wick on February 10, 1825, by Cambacérés. It

<sup>1</sup>No. 4323, January 5, 1825. *Brevets d'invention* ... (n.d.), XLI, 392. Since at that time it was not the practice of the French government to make public the text of a *brevet*, the first publication of the process was through the English patent granted to Moses Poole, Gay-Lussac's agent, in June 1825. Cf. The National Agricultural Society, *Mode of Manufacturing Sugar from Corn Stalk and of Oil and Stearine from Lard, etc.* (Washington, D.C., J. and G. Gideau, 1842), and "Stearinkerzen," *Wagners Jahres-Bericht* (1855), I, 398. Gay-Lussac's name did not appear upon the English patent, only that of his agent, Moses Poole. It is amusing to note that the patent called forth the harshest criticism. The *Repertory of Patent Inventions* . . . (1826, Series 3, II, 138) remarks that rarely has it found so many gross errors and patent ignorance in so small a compass. One wonders whether the editor of the *Repertory* would have made his criticism had the patent been issued under the distinguished name of Gay-Lussac.

<sup>2</sup>No. 4325, February 10, 1825. *Brevets d'invention* ... (n.d.), XLI, 396; J. L. Cambacérés, *Mémoire sur l'application des acides gras à l'éclairage*. According to Malepeyre (*op. cit.*, 167), this memoir from which he quotes at length was presented to the Académie des Sciences in 1844, but the writers have been unable to trace it.

<sup>3</sup>Malepeyre, *op. cit.*, 106-8, where the essential features of the patent are reprinted.

<sup>4</sup>No. 4323, August 4, 1825. *Brevets d'invention* ... (n.d.), XLI, 393.

is to him that the first distinct success in the manufacture of stearic-acid candles on a large scale is due.

Malepeyre attributed the use of burnt lime to him, but in 1829 Pierre Joubert received a patent for a method to saponify tallow for candle making with unslaked lime and soda. He separated and washed the soaps thus formed, decomposed them with sulfuric acid or hydrochloric acid, washed the free acids, heated them in alcohol, and then pressed them to remove the liquid portion with the alcohol.<sup>1</sup> At any rate, the firm of de Milly et Motard seems to have been using burnt lime as saponifying agent in 1831. This firm became the *concessionnaire* of the patents of Cambacérés and was the pioneer in the rapidly developing stearic acid-candle industry. Such candles were commonly known as stearin candles, although they were composed of stearic and related acids or of mixtures of these acids with stearin and solid fats and not of stearin alone.

The development of the stearic acid-candle industry must have stimulated the pressing of stearin. Indeed, Cambacérés in his original patent proposed to remove most of the olein by pressing before saponification.<sup>2</sup> However, it is not now to be determined whether de Milly and Motard pressed their tallow before saponifying it. Their patent of 1834<sup>3</sup> makes no mention of it. This patent is principally concerned with an autoclave provided with an agitating device to stir while saponifying under pressure.<sup>4</sup> W. Hempel of Oranienburg, a suburb of Berlin, took out a patent in 1836 in which as a first step olein was removed by pressing, saponification with burnt lime following as the next step.<sup>5</sup>

As the process was originally conducted by de Milly, tallow or other hard fat was saponified with burnt lime suspended in water, and the resulting hard, insoluble calcium (lime) soaps were separated from the aqueous liquor containing the glycerin. The fatty acids were next separated from the calcium with which they were combined in the soap by treatment with a strong acid, usually sulfuric. The melted free fatty acids were then separated from the insoluble calcium sulphate. The mixture of free fatty acids thus obtained consisted principally of stearic and palmitic acids, which are solid, and oleic acid, which is liquid. The oleic acid was separated from the other two by pressure.<sup>6</sup>

<sup>1</sup> No. 4091, September 24, 1829. *Brevets d'invention ...* (n.d.), XL, 153.

<sup>2</sup> *Op. cit.*

<sup>3</sup> No. 6448, March 3, 1834. *Brevets d'invention ...* (1844), LJI, 505.

<sup>4</sup> Malepeyre, *op. cit.*, 114.

<sup>5</sup> *Ibid.*, 117.

<sup>6</sup> The process is described in detail in J. Pelouze and E. Fremy, *Traité de Chimie* (Paris, Victor Masson et fils, 1865, 6 vols., 3d edition), V, 256; also

Oleic acid (red oil) was, therefore, a by-product of which there was overproduction in France, and it brought a price only a little higher than half the price of tallow. It could only be used in large amount for soap. It is not suitable for illumination because it corrodes the lamps. It was used to treat wool, but this outlet was not large enough to raise the price and make a material lowering of the price of stearic acid possible. The Société pour l'Encouragement de l'Industrie Nationale in 1833 offered a prize of 4,000 francs for the manufacture of cheap candles but without results. The lowest price at which candles of good quality could be furnished remained 1.50 francs.<sup>1</sup> It is natural, therefore, that candle-makers sought raw materials high in stearic acid and low in oleic acid content.<sup>2</sup> In consequence, stearin pressed from such fats as tallow and lard must have been at a premium. W. Hempel in Berlin was separating tallow oil from tallow by graining and pressing in 1836;<sup>3</sup> but in France the pressing of stearin seems not to have achieved any considerable importance. Pelouze and Fremy<sup>4</sup> stated that up to the present it had been impossible to separate stearin industrially from tallow or other neutral fats either by pressure or with the help of solvents.

Perhaps the reason why there was so little pressing of tallow in France is to be found in the general neglect of tallow as a raw material for industry because of the general availability of olive oil. Thus, tallow was not used in soap manufacture in France till the early years of the French Revolution, although it had long been used in England and Germany.<sup>5</sup> Moreover, there seems

by F. C. Calvert, "On Chemistry Applied to the Arts," *Chemical News*, July 30, 1864, X, 53; reprinted in the *Journal of the Franklin Institute*, October 1865, 3d series, L, 244.

<sup>1</sup> Cambacère cited in Malepeyre, *op. cit.*, 120. Also Chr. H. Schmidt, *Die Kerzen und die Seifenfabrikation* (Weimar, B. Fr. Voigt, 1852), 153. This book of Schmidt's is almost a literal translation without credit of the treatise of Malepeyre.

<sup>2</sup> This remained true throughout the nineteenth century. As late as 1897, J. Lewkowitsch, in a paper entitled "On Attempts to Convert Oleic Acid into Candle Material" (*Journal of the Society of Chemical Industry*, May 31, 1897, XVI, 389), wrote, "This acid [oleic] must rank in the candle works as a by-product, the sale of which for soap-making becomes more and more difficult the greater the pressure of cottonseed oil and other cheap oils is on the market."

<sup>3</sup> Schmidt, *op. cit.*, 151-52; Malepeyre, *op. cit.*, 117.

<sup>4</sup> *Op. cit.*, 389.

<sup>5</sup> Darceet, Lallèvre et Pelletier, "Rapport sur la fabrication des savons, sur leur différents espèces, suivant la nature des huiles et des alkalis qu'on emploie pour les fabriquer; et sur les moyens d'en préparer par-tout, avec les diverses matières huileuses et alkales, que la nature présente, suivant les localités," *Annales de chimie*, 1797, Série I, XIX, 293.

to have been no notable surplus production of tallow in France and in other European countries. Tallow was among the articles imported, principally from America and Russia. At any rate, it was in America, where there was a surplus of animal fats, that the pressing of stearin became an important industry. By 1840, lard was being pressed; the stearin obtained was known as "solar" stearin to distinguish it from ordinary stearin made from tallow. It is said to have been exported to Germany as early as 1840.<sup>1</sup> In the year 1841, the greatest of our Commissioners of Patents, Ellsworth, mentions the manufacture of lard oil as a newly-established industry.<sup>2</sup> He was quite aware of the economic significance of the new industry, for he wrote: "allowing then for the value of the stearine above the oil, and it may be safely calculated, that when lard is six cents per pound, as it is now but four or five cents at the West, a gallon of oil can be afforded there for fifty cents, since the candles from the stearine will sell for from twenty-five to thirty cents a pound." In 1842, he discussed the outlook for the lard-export trade of the United States in a manner nothing short of prophetic. He foresaw the rôle the hog was to play as a means of marketing the corn crop of the Middle West, and he predicted that for years the prosperity of this region would depend in large measure on the export of lard.<sup>3</sup>

Apparently, the new lard-pressing industry was regarded as important, for the National Agricultural Society published a pamphlet in 1842 describing the method of producing stearin and lard oil,<sup>4</sup> while Ellsworth in his report for the same year<sup>5</sup> recorded the establishment of several large factories in Cincinnati. Others existed in Cleveland, Chicago, Burlington, Hannibal, and elsewhere in Western and Atlantic states.

The rapid growth of the pressing of fats in the United States was stimulated by the introduction of steam rendering, described by J. R. Stafford, "Agent Cleveland Lard Oil and Candle Co.,"<sup>6</sup> by which it was possible to render not merely the fat that could be trimmed off the carcass but the entire carcass. Concerning the quality of the lard thus obtained, Stafford has the following to say: this "lard is good, but not equal to leaf lard or suet; the carcass fat does not contain as much concrete principle (stear-

<sup>1</sup> "Amerikanisches Schweineschmalz und Schweineschmalzöl," *Jahrbuch für praktische Pharmazie und Verwandte Fächer*, etc. (1850), XX, 6.

<sup>2</sup> *Report of the Commissioner of Patents for 1841* (Washington, D.C., 1842), 80.

<sup>3</sup> *Report of the Commissioner of Patents for 1842* (Washington, D.C., 1843), 42.

<sup>4</sup> *Ibid.*, 217.

<sup>5</sup> *Ibid.*, 39.

<sup>6</sup> *Ibid.*, 89.

in). Whole hog lard cannot be refined and made hard without a portion of the oil is extracted. I take from 20 to 40 per centum of the oil; then the balance goes through several washings in pure *rain water* by steam, after which it is refined lard. The expense is not more than one-quarter cent per pound, but it is of more value to us than common lard, as we have a great deal of trouble and expense with it; and in only extracting a portion of the oil, we would lose by it, did it not command a better price in the market, which it should from its purity." Stafford remarks further that he has enlarged his plant to handle 2,000 pounds of lard a day; that lard costs five cents a pound; that lard oil sells wholesale for 75 cents a gallon and retails for one dollar; that Cincinnati lard oil sells for one-third less because it is not so good as his own product.

In the light of subsequent developments, it should be noted that Stafford understood "refined lard" to be lard hardened by the expression of some lard oil and treated with pure water and steam; that Stafford used the term "whole hog lard" much as it was used later; and that the latter was a new product made possible by the newly introduced method of steam rendering. Cottonseed oil was not yet used in refined lard, for this oil was not commercially available, although attempts at commercial production had been in progress for a few years.

While steam was used to render tallow and other oleaginous materials early in the nineteenth century, it is not clear who first used steam to render materials not specially rich in fat, like slaughterhouse offal, fallen animals, etc. Bones had long been boiled with water and the oil that rose to the surface recovered, and neatsfoot oil had long been made in this way. The first recorded use of steam for this purpose seems to be the patent issued to P. L. Cambacères in 1837. In 1832 and 1833, he had operated a factory in Buenos Aires producing grease, oil, glue, and bones from slaughterhouse offal. He steamed such material in open tanks with double bottoms and proposed to use the process to render fallen horses and other domestic animals in Paris.<sup>1</sup>

When steam rendering was first done under pressure is difficult to determine. It was probably done soon after the introduction of steam rendering. Papin had invented the pressure cooker in 1681. D'Arcet had used it in extracting glue from bones in 1810. Appert, the inventor of the preservation of food by heat sterilization (canning) about 1823, recommended the rendering of tallow with one-third of its weight of water in autoclaves at a

<sup>1</sup> No. 8806, September 26, 1837. *Brevets d'invention ...* (1847), LXIV, 458.

temperature of 115°-130° C.<sup>1</sup> Manicler, in 1826, was rendering fats under pressure (see p. 239); de Milly and Motard were granted a French patent for a pressure cooker with agitator in 1834.<sup>2</sup> Dumas, in 1843, writes of rendering with steam at 120°-130° C. and 2 to 3 atmospheres pressure without treating it as a novelty.<sup>3</sup> In 1844, that is, only a few years after the steam rendering of hogs began, in describing the "Steaming of Cattle, etc.,"<sup>4</sup> Ellsworth writes: "The great object is, however, to extract from the carcass all the oil or grease both from the flesh and bones. For this purpose, the carcass is cut in pieces and thrown into an iron cylinder capable of holding 10,000 to 15,000 pounds of beef. After the top is fastened down, steam is let in to the extent of 70 pounds to the square inch, which is equal to 306° F. After boiling 12 to 14 hours, and all the oil or grease has risen to the top, it may be drawn into barrels for the European market." Steaming was also done in large wooden tubs.<sup>5</sup> In 1842 a United States patent was granted to L. Moutrop of Baltimore, with the following claim: "the combined use of steam introduced into the kettle in which the tallow is melted, and around it between the kettles, thus melting tallow under high pressure."<sup>6</sup> Morfit described the patented pressure cooker of Wilson, of E. Wilson & Company of Cincinnati, as the best in use in 1860. The whole hogs, excepting the hams and shoulders, properly cleaned, were steamed ten to fifteen hours with a steam pressure of 50 to 75 pounds to the square inch. The digesters were tight, upright, cylindrical tanks made of boiler plate and of 12,000 to 15,000 gallons capacity. After shutting off the steam, the water from the condensed steam was drawn off and time given for settling. The fat was then drawn off. The product was superior and commanded a premium, though there was danger of contamination with water. The yield of lard was 12 per cent greater than by any other method. For tallow, the gain in yield was 6 per cent. In the West, "bones and other matters" were thrown in with the suet in preparing tallow.<sup>7</sup> Western lard was of granular texture, so that it was especially suitable for

<sup>1</sup> *Dinglers polytechnisches Journal*, 1826, XXI, 454; also *Wagners Jahres-Bericht* (1855), I, 391.

<sup>2</sup> No. 6440, March 3, 1834. *Brevets d'Invention* ... (1844), LII, 565.

<sup>3</sup> M. Dumas, *Traité de Chimie Appliquée aux Arts* (Paris, Béchét jeune, 1826-46, 8 vols.), VI, 670.

<sup>4</sup> *Report of the Commissioner of Patents for 1844* (Washington, D.C., 1845), Appendix 35, (1), p. 396.

<sup>5</sup> *Ibid.*, Appendix 35, (2), p. 398.

<sup>6</sup> U.S. Patent No. 2694 (June 27, 1842).

<sup>7</sup> Morfit, *Chemistry Applied to the Manufacture of Soap and Candles* . . . . 321-23.

the expressing of lard oil as it could be pressed without further treatment. The press cake was sometimes known as "solar stearine" and amounted to 30 to 38 per cent of the lard.<sup>1</sup>

Steam rendering grew rapidly in the United States. In his report for 1843 (issued 1844), Commissioner Ellsworth reported upon the growth. There were four plants using the process in Cincinnati alone. The stearin industry had also expanded. In 1842 eighty tons of lard had been worked up in Cleveland, while in 1843 two hundred and fifty tons had been converted. There were thirteen plants in Cincinnati making lard oil and stearin, with outputs ranging from 300 to 2,500 barrels of oil per annum. Stearin and lard oil were also produced at Columbus, Wheeling, Pittsburgh, Indianapolis, Nashville, Springfield, Illinois, New Orleans, Rochester, New York, New York City, and elsewhere. Reference is also made to the use of lard in the production of illuminating gas.<sup>2</sup> The report also contains an investigation by the Franklin Institute upon lard oil as an illuminant.

As has been pointed out (p. 243), there was in the early days of the stearic acid-candle industry little outlet for the by-product, oleic acid (red oil). It cannot be used as a burning oil, because it corrodes the metallic parts of lamps. Much work was done by chemists and inventors, through the nineteenth century and into the twentieth century, to find better outlets for oleic acid and to convert it into a solid, but the problem was finally solved only by the introduction of the hydrogenation of oils in the twentieth century (see p. 266). In the early days it was proposed, for example, to convert oleic acid to elaidic acid (melting-point 51° C.) by oxidation with nitrous acid,<sup>3</sup> or to split it by fusion with potassium hydroxid into solid palmitic acid and acetic acid. Attempts were also made to convert oleic acid into oxystearic acid, the lactone of which has a melting-point of 41° C. The process proposed was to add sulfuric acid at the double bond and then to saponify the resulting sulfuric acid compound with steam. Until the invention of hydrogenation, it was not possible commercially to convert liquid oils into solid fats, except by admixture of hard fats. Oleic acid (red oil) was used, therefore, principally in soap-making and to wash wool.

However, the process using sulfuric acid combined with steam distillation was used by candle-makers. It was based upon the studies of Fremy, published in 1838, and the observations of

<sup>1</sup> *Ibid.*, 111.

<sup>2</sup> Apparently, this refers to the method of producing illuminating gas by dripping an oil upon incandescent coke.

<sup>3</sup> Cf. patent issued to Edward Heard in 1819, *Dinglers polytechnisches Journal*, 1820, III, 107.

Dubrunfaut and of G. F. Wilson that fats may be saponified and the resulting acids distilled in one operation by heating to 325°-330° C. and passing a current of superheated steam through the hot fat. Because of the treatment with sulfuric acid, predominantly solid fatty acids are finally obtained containing little oleic acid, which is liquid. Dubrunfaut's observations were made in 1841 and 1842. Soon thereafter, Tribouillet and Masse at Neuilly operated the process commercially.<sup>1</sup> The same process was developed in England at about the same time or even earlier.<sup>2</sup> This, then, is a process by which a higher yield of solid fatty acids fit for candle-making is obtained from fats and oils than by ordinary simple saponification. It has not been feasible to use it in the preparation of food products.

From about this time, also, dates the use of a vegetable fat, coconut oil, as a hardening agent in the candle industry. In 1840 G. F. Wilson of the Price Candle Company, while experimenting with the view of making candles which would not require snuffing, for the illumination on the occasion of Queen Victoria's marriage, discovered that a combination of coconut stearin with stearic acid would make candles giving a beautiful light but free from the necessity of snuffing. These he called "composite" and they were soon sold extensively.<sup>3</sup>

#### THE PRODUCTION OF ILLUMINATING OILS

Before the advent of illuminating gas and of electricity, there were two principal instruments of illumination, both used in ancient times, the oil lamp and the candle. Through the centuries, there was competition between lamp and candle, or rather between the inventors of improved lamps or better-burning oils and inventors of improved candles, a competition that subsided only with the widespread use of gas and electricity.

In northern Europe, during the Middle Ages, the rush light and the candle had the advantage. Lamps were not much used, except in churches, partly, no doubt, because they were unsatisfactory, but principally because little oil was produced, whereas there were available hard fats from the slaughter of cattle, sheep, and goats, suitable for candle-making. North of the olive-growing

<sup>1</sup> Described in detail by Pelouze and Fremy, *op. cit.*, 477.

<sup>2</sup> According to Lewkowitch, *Chemical Technology* . . . , III, 237, W. C. Jones and G. F. Wilson received English Patent 9542 in 1842; G. Gwynne and G. F. Wilson, English Patent 10000 in 1843; G. F. Wilson, G. Gwynne, and J. P. Wilson, English Patent 10371 in 1844; Dubovitz, English Patent 2909 in 1910; Fremy's French patent dates from the year 1855.

<sup>3</sup> Calvert, *Journal of the Franklin Institute*, October 1865, 3d series, L, 245.



regions, almost the only oil crops were rape, flax, and nuts, yielding respectively rapeseed, linseed, and nut<sup>1</sup> oils. Of these, linseed and nut oils were not available for use in cloth manufacture because they are drying oils. They soon became too expensive for food uses, because of their value in paints and varnishes, though linseed oil is still used for food in Russia, and some nut oil in France. Rapeseed oil was the principal locally produced oil available for technical uses other than painting. It is unsatisfactory as a food oil because of its disagreeable taste, though it was and is so used to some extent especially in Russia. Some whale oil was also obtained from stranded whales. Later, whales began to be caught, especially by the Scandinavians and also by the Basques about the Bay of Biscay. The fishing flourished there in the twelfth and thirteenth centuries,<sup>2</sup> but the production of whale oil hardly reached general commercial importance in western Europe till the beginning of the sixteenth century.<sup>3</sup> It then became a serious menace to rapeseed-oil producers.<sup>4</sup> Ultimately, the supply of whale oil became great enough to permit of its extensive use in soap.

However, even after whale oil had become available in northern Europe, the use of candles grew, because oil lamps were unsatisfactory and because whaling furnished an excellent material for candle-making—spermaceti. However, the invention of the Argand lamp in 1784 made the use of oil lamps so satisfactory as to stimulate greatly the use of illuminating oil. Inventors were spurred to discover new ways of producing oil. France was especially put to it to secure oil, because it was cut off from free access to whale oil by the English blockade of the continent. Plantings of colza and rape were increased, and methods of refining vegetable oils to make them suitable for lamps were discovered. The English, retaining free access to supplies of whale oil, continued to burn it in lamps and to use tallow and spermaceti for candles. It is perhaps due to the blockade that the French became the leaders in oil-refining and in candle-making.

The first important improvement was to treat oils so that they did not congeal easily in cold weather. This was accomplished by chilling the oil by exposure in winter until the higher-melting constituents, mostly stearin and palmitin, crystallized out. These were then separated by filtration. At a later period, the solid

<sup>1</sup> Principally from the seed of the walnut, *Juglans regia*.

<sup>2</sup> J. T. Jenkins, *A History of the Whale Fisheries* (London, H. F. and G. Witherby, 1921), 61.

<sup>3</sup> Tower, *op. cit.*, 11 ff.

<sup>4</sup> Jenkins, *op. cit.*, 68-69.

material filtered off was pressed to recover the oil mechanically adhering to the stearin. The process is known as "winterizing" or "demargarination," and the treated oil as "winter oil." The writers have been unable to determine who first used this process. It is probably an ancient one that was perhaps first extensively used in connection with the preparation of spermaceti from sperm oil. Braconnot (see p. 237) described the fractionation of oils in this manner. Ellsworth<sup>1</sup> refers to the use of winter stearin for culinary purposes, for which use it was found to compare favorably with leaf lard.

The next important step was the preparation of oils from solid fats in the manufacture of stearin, a process that has already been described (p. 235). In this way, oil for lamps could be produced in countries where only solid animal fats were available. We have already seen that the pressing of fat to produce stearin for candle-making became an important industry in the United States. The fact that oil was produced jointly with stearin helped pressing to become established. Pressing lard became especially profitable because the lard oil produced jointly with stearin was particularly suitable for lamps and for other purposes. Ellsworth stated (1841) that lard oil had been found superior to olive and sperm oil for machinery; that it is better than sperm oil for the blowpipe and that it is a good burning oil. He also presented comparative analyses of lard and sperm oil as well as directions for the use of lard oil for lighting and for the construction of proper lamps. He further said that it was being tried out in England for combing wool, an order for 600 gallons having been received from a factory at Huddersfield, England. The export to England is said to have amounted to 16,000 barrels.

Even at this early date, lard oil was being winterized, for Ellsworth writes: "An objection has been made against lard oil, that it is not capable of being preserved in a liquid state in cold weather; but by a process similar to that by which the winter sperm is prepared lard oil can be made which will not chill at 30° F."

Lard oil is said to have been used as early as 1840 to adulterate sperm oil in the United States and in France, to adulterate olive oil.<sup>2</sup>

The rapid growth of the lard-pressing industry is well illustrated by a quotation from the *Journal of Commerce* to the following effect: "Heretofore the whale fishery has supplied light

<sup>1</sup> Report of the Commissioner of Patents for 1844, 118, 170.

<sup>2</sup> *Jahrbuch für praktische Pharmazie und verwandte Fächer, etc.* (1850), XX, 6.

for a vast portion of the country. In all the large towns and villages sperm oil has been sold freely. That trade has suddenly ceased. This spring there has been almost no demand from the interior for sperm oil, and very little from the city. Camphine and lard oil have supplied the demand at a cheaper rate. Crude sperm oil has fallen one-third in price, and yet remains neglected. The hogs have fairly run the whales out of the market, and are likely to hold their ground, unless some new process of cheapening can be contrived on the other side. The woods of the West are more full of the quadruped than any ocean is of the finny whale, and the quadruped is much more easily taken. The way now is to turn the 'whole hog' into oil."<sup>1</sup>

#### THE REFINING OF OILS

The fats of domesticated animals, if prepared in a cleanly manner from fresh, edible material, are fit for food without further treatment; but only a few vegetable oils, for example olive, almond, and sesame oils, are acceptable for food purposes without refining. Indeed, the best grades of these oils are not refined because they lose their highly prized flavor. However, most oils, as they come upon the market, are objectionable in taste, odor, or color because the conditions of their production necessarily involve the employment of raw materials more or less fermented or decomposed. Most of the oil available in northwestern Europe has been of this character, though in recent decades there has been a tendency toward improvement of quality, especially of palm and whale oils. Most of the oil is, nevertheless, still objectionable in odor, and more or less rancid, with a high fatty-acid content. Oil in this condition is desirable neither for food uses nor for illumination. It spreads a disagreeable odor when burned in lamps and the free fatty acid tends to corrode the metal parts. Therefore, about the end of the eighteenth century, there was much experimentation to develop methods of refining that would remedy these defects of the cheaper oils then available.

Two methods were developed. One, employing strong sulfuric acid, was said to have been originated by Gower in 1792 and perfected by Thénard in 1801.<sup>2</sup> Desormes, however, attributed the discovery to Carcel.<sup>3</sup> The second method employs strong caustic

<sup>1</sup> Cited in *Niles' National Register*, June 25, 1842, Fifth Series, XII, 272.

<sup>2</sup> Kamarsch, *op. cit.*, 338; F. Knapp (translated by E. Ronalds and Th. Richardson), *Chemical Technology, or Chemistry Applied to the Arts and to the Manufactures* (London, Hyppolyte Baillièrre, 1848), I, 109.

<sup>3</sup> Clément-Desormes, "Conservatoire des Arts et Métiers," *Recueil industriel*, January 1829, 74; abstracted in *Dinglers polytechnisches Journal*, 1829, XXXII, 104.

alkali and has been variously attributed to Cambacérés,<sup>1</sup> to Cogen,<sup>2</sup> and to Barreswill.<sup>3</sup> As a matter of fact, Barreswill did not claim to be its discoverer. He merely described the method and pointed out that, while not at the time in widespread use, it was destined to compete with the sulfuric-acid method of Thénard.

In 1840 a patent was issued to L. A. Bourgeois for a method using a solution of soda by which all the coloring matter was precipitated in the form of soap.<sup>4</sup>

In 1842 a patent was issued to Auguste Schmersahl of Paris for the purification of cottonseed oil based upon partial saponification with caustic alkali, preferably burnt lime. The oil was mixed cold with milk of lime of a strength of 1'-1.5' Baumé, boiled two to three hours, separated from the coagulum formed, and finally filtered with granulated or powdered animal charcoal.<sup>5</sup>

P. Bancroft was granted an English patent in 1846 for purifying fats and oils. Tallow was melted with steam to just above its fusion point and a strong solution of caustic potash was then added with vigorous stirring so long as a precipitate formed. The precipitate was allowed to settle and was then removed.<sup>6</sup> This is essentially the present-day method of refining cottonseed oil, but Bancroft's main purpose seems to have been to improve color.

Cambacérés in 1844 obtained a patent<sup>7</sup> involving an analogous procedure as a preliminary step in soap-making. The oleaginous material was digested with aqueous weak alkali for some hours. The aqueous liquid was then drawn off and a small amount of very concentrated lye added, which precipitated most of the coloring matter. This was then removed and the saponification continued in the usual way.

These alkali methods were nothing more than a practical application of a phenomenon well known to soap boilers, viz., that, in boiling soap, dark impurities, known as the "nigger," may settle out in the kettle and form a layer between the lye below and the clear soap on top. Indeed, the method was probably used before 1800, for Dossie<sup>8</sup> in 1803 described the use of a combination of chalk, slaked lime, and pearl ash in water to purify train

<sup>1</sup> Schmidt, *op. cit.*, 158.

<sup>2</sup> Knapp, *loc. cit.*

<sup>3</sup> L. C. A. Barreswill, "Variétés," *Journal de pharmacie et de chimie*, 1858, Troisième Série, XXXIII, 446.

<sup>4</sup> No. 7765, October 2, 1840. *Brevets d'invention ...* (1846), LIX, 287.

<sup>5</sup> No. 6864, May 7, 1842. *Ibid.* (1845), LIV, 472. <sup>6</sup> Malepeyre, *op. cit.*, 115.

<sup>7</sup> No. 8687, January 23, 1844. *Brevets d'invention ...* (1846), LXI, 106.

<sup>8</sup> R. Dossie, "The Principle on Which the Purification of Fish Oils May Be Performed, and the Uses to Which It Is Applicable," *Journal of Natural Philosophy, Chemistry, and the Arts*, May 1803, V, 13.

oil as by no means a novelty. Moreover, sperm oil was refined or "physicked" with caustic potash,<sup>1</sup> and this alkali was also used to purify spermaceti.<sup>2</sup>

However, refining with caustic alkali does not seem to have come into use for refining oils in general much before the middle of the nineteenth century, for Knapp speaks of it as a method requiring "further experiment to prove its advantage." In the end, it became widely used, except for very special oils.<sup>3</sup> When it was first introduced in America, the writers have been unable to ascertain. The methods first used for the refining of cottonseed oil were treated as trade secrets, but it seems likely that cottonseed oil was soon refined with caustic alkali, presumably pearl ash, for this was a customary practice in lard refining at that time. Nor is it clear when, in America, the cheaper but equally effective caustic soda was substituted for the dear caustic potash (pearl ash). Certainly as late as 1883 the N. K. Fairbank Company used pearl ash in lard refining. David Wesson was responsible for the shift of this company to caustic soda.

#### BLEACHING OIL

The refining of oils was not enough to make them acceptable for culinary purposes; dark oils had still to be decolorized or bleached. Even for illumination a white oil is preferred by users, though for this purpose the only advantage may be its cleaner appearance. Aside from exposure to sunlight, the first bleaching process seems to have been to blow air and steam through the oil.<sup>4</sup> Subsequently, bleaching was done with "high steam."<sup>5</sup> G. Gibbs bleached palm oil at 110° C. by blowing steam through it supplied from a boiler at a pressure of two atmospheres.<sup>6</sup>

The introduction of palm oil, which is orange colored, furnished a strong incentive to search for satisfactory methods for bleaching fats and oils. This oil was perhaps the first tropical oil to be introduced to the European market in quantity. The reason is to be sought in the commerce brought about by the slave trade between Europe and that part of Africa that lies about the Gulf of Guinea, the home of the oil palm. Manufactured

<sup>1</sup> Morfit, *Chemistry Applied to the Manufacture of Soap and Candles* . . . , 507.

<sup>2</sup> No. 2660, January 5, 1825 (issued to M. L. A. Leroux Lajonkaire). *Brevets d'invention* ... (1836), XXVIII, 301; also Knapp, *op. cit.*, 119.

<sup>3</sup> For a description of the method, see Appendix A, under "Refining."

<sup>4</sup> Collin, "Expériences relatives à la fabrication des Savons durs," *Annales de chimie et de physique*, September 1816, Série 2, III, 1.

<sup>5</sup> Morfit, *Chemistry Applied to the Manufacture of Soap and Candles* . . . , 112.

<sup>6</sup> Malepeyre, *op. cit.*, 206.

goods had to be sent there to pay for slaves and return cargo space to Europe was available. There was a sort of three-cornered trade. Europe sent manufactured goods to Africa; Africa sent slaves to the Americas; and the slaver was paid in bills of exchange based ultimately on exports from the Americas to Europe. With these goods, the slaver liquidated his debt to Europe for manufactured goods. The palm-oil trade originally was merely an incident of the slave traffic; the oil was carried instead of ballast. But with the suppression of the slave trade, it assumed an importance of its own, and a satisfactory method of bleaching it became important. The earliest method seems to have been by exposure to sunlight. This method, apparently, was first proposed by Lampadius, in 1832.<sup>1</sup> However, wax for candle-making had for many years been bleached in this way and it was the common way to bleach tallow candles. The process was later improved in that the oil was exposed to sunlight in a thin layer floating on a water surface, while the lower water layer was warmed by means of a steam coil. The oil was bleached in this way in ten to fifteen hours.<sup>2</sup> Zier recommended running palm oil slowly in a thin layer over warm metal plates. The oil absorbs oxygen, gives off vapors of strong odor, and becomes white. The process was used in England.<sup>3</sup>

Michaelis bleached with sulfuric acid and peroxide of manganese.<sup>4</sup> Others used chlorin, usually derived from calcium hypochlorite.

Cottonseed oil seems to have been bleached by exposure to sunlight in the early days. The N. K. Fairbank Company had large tanks on the roof of its factory for this purpose. Care was taken to have no more than a depth of two feet of oil in them, so that light might penetrate to the deeper strata. The method was of course unsatisfactory, because it tied up much capital and required much space and, above all, because the oil tended to deteriorate. The chemical methods of that period were not suitable for food oils. The most generally used of these was treatment with sulfuric acid and potassium bichromate, for which Charles Watt, Sr., received an English patent in 1845.<sup>5</sup> This

<sup>1</sup> *Erdmanns Journal*, XIV, 455; abstracted in *Chemisches Centralblatt*, October 6, 1832, III, 717.

<sup>2</sup> *Journal de chimie médicale*, Série 2, VIII, 121; abstracted in *Silliman's American Journal of Science*, October 1844, XLVII, 196. Also Malepeyre, *op. cit.*, 203.

<sup>3</sup> Malepeyre, *op. cit.*, 197.

<sup>4</sup> *Ibid.*, 196.

<sup>5</sup> C. Watt, Sr., "On Chromic Acid as a Bleaching Agent and a Cheap and Easy Means of Recovering It," *The London Journal of Arts, Sciences and Manufactures and Repertory of Patent Inventions*, 1848, XXXII, 134.

method yields a product which is white, but of bad flavor. Some cottonseed oil was so bleached to sell to miners for use in lamps.

Sometime during the nineteenth century charcoals began to be used to a limited extent in Europe to bleach oils. No record of their use for this purpose in America has been found. As early as the fifteenth century, wood charcoal was known to decolorize fluids,<sup>1</sup> but it was not used for this purpose till toward the end of the eighteenth century.<sup>2</sup> It began to be used in laboratories and later in the refining of raw sugar. According to de Fontenelle,<sup>3</sup> Denis de Montfort described a carbon filter for oil. About 1818 Braconnot and Simonin used it in preparing stearin (see p. 237). In the middle of the nineteenth century, animal charcoals and the residues from the manufacture of potassium ferrocyanid were employed, but they never came into general use because they were fairly expensive and retained 100–250 per cent of their weight of oil. Their use was, therefore, fairly costly, and was abandoned when the decolorizing by bleaching earths was discovered.<sup>4</sup>

The use of these earths, though proposed earlier, was an American achievement. Clays and various white earths had been used in ancient times as detergents, since many varieties of them absorb grease readily. With the growing use of soap, unknown in the Mediterranean world before the Christian era, the use of clays became less common. It survived principally in the fulling of cloth.<sup>5</sup> Fuller's earth seems to have been proposed to bleach wax as early as 1774,<sup>6</sup> and was used by Wilks<sup>7</sup> early in the nineteenth century in treating vegetable oils. Wilks treated rape or other oil with sulfuric acid and fuller's earth; then added burnt lime and heated with water; and, finally, decanted the clear oil. It is

<sup>1</sup> I. Davidsohn, *Die Bleichung der Öle, Fette, Wachse und Seifen* (Berlin, Gebrüder Borntraeger, 1931), 96.

<sup>2</sup> T. Lowitz, "Neue Anwendungen der Kohlen durch ihre Reinigungskraft; nebst fernern Erläuterungen, um dem Misslingen bey ihrem Gebrauche sicher auszuweichen," *Chemische Annalen für die Freunde der Naturlehre, Arzney-gelahrtheit, Haushaltungskunst, und Manufacturen von D. Lorenz Crell . . .* (Helmstädt, G. G. Fleckeisen, 1784–1804), 1793, I, 3.

<sup>3</sup> J. de Fontenelle, *Nouveau manuel complet du fabricant et de l'épurateur d'huiles*, new edition edited by F. Malepeyre (Paris, Librairie Encyclopédique de Roret, 1852), 209.

<sup>4</sup> Davidsohn, *op. cit.*, 7.

<sup>5</sup> Cf. J. Beckmann (translated by W. Johnston), *A History of Inventions and Discoveries* (London, Longman, Hurst, Rees, Orme, and Brown, 1817, 3d edition), 247. Cloth cleansers in ancient Rome were known as *fullones*.

<sup>6</sup> A. and C. R. Altkin, *A Dictionary of Chemistry and Mineralogy, with an Account of the Processes Employed in Many of the Most Important Chemical Manufactures . . .* (London, J. and A. Arch [etc.], 1807), 483.

<sup>7</sup> *Dinglers polytechnisches Journal*, 1829, XXXI, 236.

not plain whether he understood the rôle played by the fuller's earth in the process. In 1880 Alexander W. Winter secured a United States patent<sup>1</sup> for purifying animal and certain vegetable oils by melting, mixing with pulverized fuller's earth, and separating the earth from the oil or fat.

However, there is no evidence that bleaching earths were in practical use until they were adopted by the N. K. Fairbank Company. In the early days, trained experts were not employed in the fat and oil industries in America—at least their employment was exceptional. No chemist, for example, was engaged in the Chicago meat-packing district until the N. K. Fairbank Company in 1879 employed William B. Allbright, a young graduate of the Massachusetts Institute of Technology and a student of Professor John M. Ordway. In 1883 David Wesson, another young graduate of the Massachusetts Institute of Technology, became his assistant. He soon succeeded Allbright as chief chemist, for Allbright elected to take charge of the new refinery erected by the company in New York, and in 1887 left the employ of the company. A number of practical men, engineers, mechanics, and later chemists, including Boyce, Eckstein, and Burnham, were associated with Allbright and Wesson. They formed a co-operating group, and it is not always clear which one originated an invention or a new process.

About 1880 Allbright and Eckstein introduced the use of fuller's earth for the bleaching of lard and cottonseed oil. It is said that one of the employees of the N. K. Fairbank Company, a Mr. Bauscher, learned from a person who had lived in Morocco that the natives of that country sometimes bleached olive oil with a kind of clay. Accordingly, many samples of clay were secured from different parts of the world and tested. A clay from England, known then as fuller's earth, was found most effective.<sup>2</sup> It adsorbs basic dyes. A patent covering the use of fuller's earth was issued to Allbright in 1886.<sup>3</sup>

Lard or oil was heated with one-half of one per cent to two per cent of fuller's earth, according to the quality of the latter. If too high a temperature is maintained or too much earth is

<sup>1</sup> U.S. Patent No. 233,452 (filed June 22, 1880; issued October 19, 1880). The writers have been able to learn little concerning Alexander W. Winter, except that he lived at one time in San Francisco and is the author of two books on meat packing-house practice: *Packers' and Refiners' Encyclopedia* . . . (Chicago, Laird and Lee, 1893), and *Winter's Handy Book of Reference* . . . (Chicago, Laird and Lee, 1894), which is a cheaper, abbreviated edition of the preceding work.

<sup>2</sup> Similar clays were later found in the United States and utilized. Cf. C. L. Parsons, *Fuller's Earth* (U.S. Bureau of Mines Bulletin 71), 1912.

<sup>3</sup> U.S. Patent No. 345,872 (July 20, 1886).



added, the fat acquires an earthy flavor. The removal of the earth was at first accomplished by settling and decantation. Soon, however, filter presses were used for the purpose, but the retention of oil by the earth in the press cake entailed heavy losses. In 1883, H. G. Eckstein, also of the N. K. Fairbank Company, conceived the simple idea of passing dry live steam at a pressure of 40 to 60 pounds to the square inch through the caked fuller's earth, which remains in the filter presses, whereby about 75 per cent of the retained fats were reclaimed from the mass. This procedure was also covered in the Allbright patent above cited.

The introduction of fuller's earth largely solved the problem of bleaching cottonseed oil, though its use still entails considerable loss of oil retained in the earth. This it has been proposed to recover by extraction with solvents, but, so far as the writers have been able to learn, the proposal has not been adopted in America.<sup>1</sup> The fuller's-earth method soon superseded all other methods theretofore in use, and remains the principal method today, although, as we shall see, the use of charcoals is coming back.

The fuller's earth first used was imported from England. After 1890, deposits were discovered in Arkansas, Florida, and elsewhere, but bleaching earths from these sources were largely used to refine petroleum products rather than fats and oils. Subsequently deposits were discovered elsewhere, and in Germany methods were discovered for activating relatively inactive earths, principally by acid treatment.<sup>2</sup> The extensive use of such activated earths was forced upon Germany during the war. Attempts have also been made to prepare bleaching earths synthetically.<sup>3</sup>

The war had another effect. It brought back the use of active charcoals, or as they are now known, activated carbon,<sup>4</sup> for charcoal was the principal agent used in gas masks. A vast amount of research upon the activation of carbon was done, so that after the war very active carbons began to be placed upon the market and numerous process patents have been issued.

Active carbons are used to bleach oils in the same manner as fuller's earth, except that instead of adding the carbon all at once as the earth is added, it is more economical to add the carbon

<sup>1</sup> For a description of the various methods proposed to recover oil retained by the fuller's earth, see Davidsohn, *op. cit.*, 76.

<sup>2</sup> Cf. Davidsohn, *op. cit.*; also O. Eckart and A. Wirz Müller, *Die Bleicherde* (Braunschweig, Serger und Hempel, 1925), and O. Kausch, *Das Kieselsäuregel und die Bleicherden* (Berlin, Springer, 1927).

<sup>3</sup> E. Silvermann, *Versuche zur Gewinnung synthetischer Bleicherden* (Berlin, Inaugural Dissertation, 1930).

<sup>4</sup> Cf. O. Kausch, *Die Aktive Kohle* (Halle, Knapp, 1928).

in successive portions at 15- to 20-minute intervals. The advantage of using carbon is that much less is required than of fuller's earth, since carbons may be 10 to 20 times as active as the best earths. In consequence, less oil is retained by the decolorizing agent, and the oil losses are thus reduced. Moreover, carbon does not give the oil an off-flavor as fuller's earth sometimes does. Against these advantages must be balanced the greater cost of the carbon; despite its greater activity, decolorizing with carbon may therefore be more expensive than with fuller's earth. Hence some refiners use a mixture of active carbon and fuller's earth, for it has been found that such a combination is more effective than would be expected from the sum of the decolorizing powers of the two agents used separately. Moreover, it seems possible to carry the decolorizing of refractory oils further with carbon than with fuller's earth.

Other combinations with fuller's earth are also in use, and in recent years there seems to be a trend back to the use of chemical bleaching, such as oxidation with air, ozone, hydrogen peroxid, other peroxids, hydrosulfurous acid (blankite), sulfuric acid, organic acids, and alkalis. Most of these procedures are used for non-food oils. For details, the reader is referred to the monograph of Davidsohn.<sup>1</sup>

Before leaving the subject, it should be pointed out that sharp distinctions cannot be drawn between refining, bleaching, and deodorizing, for each of these processes may at the same time have more or less the effects of the other two. Thus, the purpose of refining with strong caustic alkali is to remove free fatty acids and other impurities, but incidentally some bleaching and some deodorizing is brought about.<sup>2</sup>

Mention must also be made of the custom in the early days of coloring some brands of compound yellow with annatto. Apparently, this was done either because Cottolene (an N. K. Fairbank Company product, see p. 29), which was made of yellow oil, set the fashion or because some portions of the consuming public regarded the yellow color as indicative of richness. The yellow brands seem to have been in special demand by commercial bakers.

#### DEODORIZING OILS

While the use of fuller's earth solved the problem of decolorizing cottonseed oil, the removal of odor and flavor still presented difficulties. The flavor and odor limited the uses to which

<sup>1</sup> *Op. cit.*

<sup>2</sup> *Ibid.*, 9 and 188.

bleached cottonseed oil could be put. The deodorizing of fats by boiling with water and by blowing steam through them had been practiced for some time.<sup>1</sup> Cameron decolorized palm oil, heated to 110° C., with high pressure steam as early as 1845. About 1891, Eckstein succeeded in deodorizing cottonseed oil by blowing high-pressure steam through the oil, heated to 340° F., in inclosed kettles with openings at the top to permit the exit of the steam with the volatile or objectionable portions of the oil. After Eckstein left the employ of the N. K. Fairbank Company, James Boyce, chemist of the American Cotton Oil Company, improved the method by perfecting the equipment and the methods of operation.

The final step in deodorizing was taken by Wesson about 1900, after he had left the American Cotton Oil Company. It consisted in deodorizing by treating the oil with steam *in vacuo*, and permitted a lower temperature than when no vacuum was used, thus avoiding the danger of imparting a cooked flavor. Carefully refined and decolorized oil subjected to this treatment is not merely better in odor and flavor, but also of better keeping quality than oil treated by the earlier process.

#### EARLY FORMS OF COMPOUND IN EUROPE

We see, then, that by the early 1880's technology had set the stage for the emergence of a compound industry, at least in America. Methods had been developed for preparing hard fats (stearin), and for refining many sorts of oil so as to make them edible. All that was necessary to produce compound was to blend such hard fats and oils together. However, the production of solid edible fats, i.e., compound, from oils had been attempted earlier. In 1855 Puscher<sup>2</sup> reported that for about two years previously a "lard oil" and a "lard butter" had been manufactured in Hamburg and Leipzig by heating rape oil with potato starch until its disagreeable odor and taste had disappeared. The carbonized starch was allowed to settle and the clear oil was decanted. By mixing two parts of the oil with one part of freshly rendered beef fat, lard butter was obtained.

In 1875 Jakobsen<sup>3</sup> stated that this sort of artificial lard or oil lard had been made as a butter substitute in Nürnberg and

<sup>1</sup> Cameron, *Polytechnisches Centralblatt*, Band 4, Heft 5; abstracted in *Chemisches Centralblatt*, October 27, 1845, XVI, 734.

<sup>2</sup> C. Puscher, "Die Bereitung von Schmalzöl und Schmalzbutter," *Dinglers polytechnisches Journal*, 1855, CXXXVI, 231.

<sup>3</sup> Emil Jakobsen, "Ueber die Bereitung von Kunstbutter," *Chemisch-technisches Repertorium*, 1875, Erstes Halbjahr, 186.

elsewhere in Germany for more than fifty years, both for domestic purposes and for export. The oil was heated with potatoes and onions,<sup>1</sup> the steam thus generated having the effect of a steam distillation in removing the sulfur-containing ingredient of the oil. The rape oil thus purified was melted with enough tallow to give the desired consistency. The product could not have been very efficiently deodorized, for Jakobsen remarks, while discussing the oleomargarine industry which was then new, that this rape-and-tallow compound would create a prejudice against oleomargarine, since it was of poor quality in that it had a bad odor and easily turned rancid. This remark also indicates that the product must have been fairly well known and of some commercial importance.

Wagner, however, took exception to Jakobsen's statement,<sup>2</sup> and attributed the invention to Puscher. However, it seems to be a fact that rape oil had been customarily rendered edible in the manner described by Jakobsen in many German homes for a long time previously.<sup>3</sup> Bread crusts were used in this way in Flanders and Brabant.<sup>4</sup> This lends support to the statements of Jakobsen which may have been drawn from the book on soap-making by Leuchs, to which Jakobsen makes reference.<sup>5</sup> Puscher's process was obviously only the improvement of a method that had long been in daily use by the working classes in many parts of Germany. In northern Germany, rape oil was heated with pieces of bread or bread crusts till these were charred and the greater part of the flavor of the oil had been removed.<sup>6</sup> In doubt is left only the question whether Puscher was the inventor of the use of tallow to harden an oil. That he was may be doubted, for the idea is an obvious one. Dossie, in 1803, described the thickening of fish oil<sup>7</sup> for use in woolen manufacture by adding tallow, or fat, or "the refuse grease of families, commonly called *kitchen-stuff*." Moreover, tallow has been mixed with lard by farmers and others for decades, perhaps for centuries. A report

<sup>1</sup> The use of onions for this purpose was also recommended in 1834. Pohl, *Hauswirthschaftliche Neugierketten*, 1834, No. 1, 55; abstracted in *Pharmazeutisches Central-Blatt*, August 2, 1834, Fifth Year, Vol. II, No. 30, p. 573.

<sup>2</sup> J. R. Wagner, *Jahresbericht über die Fortschritte der chemischen Technologie* (Leipzig, Wiegand, 1876), 1029.

<sup>3</sup> Wagner, *op. cit.* (1855), 257.

<sup>4</sup> See de Fontenelle, *op. cit.*, 211.

<sup>5</sup> Leuchs, *Der Europäische Seifen-Fabrikant* (Nürnberg, 1809). This treatise was not accessible to the writers.

<sup>6</sup> The practice seems to be an ancient one; Sir Hugh Plat attributes it to the cook of Pius V in *The Jewel House of Art and Nature* (London, Bernard Alsop, 1653), No. 131, p. 182.

<sup>7</sup> Dossie, *op. cit.*, 15.

of the New Hampshire State Board of Health, prepared in 1890, contains the following sentence: "Beef stearine or suet has been mixed with lard for years, and among farmers is considered better for summer use than the pure leaf, in consequence of the melting-point being a little higher."<sup>1</sup> It is unlikely, therefore, that the stiffening a soft fat or oil with tallow was first practiced by Puscher. Indeed, his article contains no specific claim of priority, nor does he seem to have sought any patent protection.

As already stated, there was great economic pressure in the first half of the nineteenth century to produce very hard fats for the candle-maker and oils to take the place of whale oil; but there was little economic pressure to produce substitutes for solid edible fats except butter. A number of efforts were made in this direction from 1860 to 1870, which culminated in the invention of oleomargarine by Mège-Mouriez in 1869. The economic effects of the rise of the oleomargarine or margarine industry have been treated in the main body of the text. Here, it is only necessary to point out that the manufacture of margarine depended upon the pressing of edible tallow. Had not the processes of pressing fats for illuminating purposes been developed, margarine could not have been invented at that time.

With the growth of the margarine industry, large quantities of edible stearin became available. This, as pointed out in the main body of the text, sought an outlet. Its use to stiffen soft lards took only limited amounts. Moreover, the lard-pressing industry at about this time began to suffer from the competition of petroleum products, illuminating oil, and paraffin. Whale oil was driven altogether out of the illuminating field and lard oil was restricted to a few uses: as an illuminant for railroad-signal lights, lighthouses, and beacons. In this very limited field, lard oil maintained itself for a time, but in recent decades it has been largely displaced by mineral-oil products from even this modest use. Lard oil remained in use as a lubricant, but, as time went on, its use was more and more restricted even in this field; today, it is used as a lubricant only for special purposes, especially as a "cutting oil" to lubricate the cutting edge of tools in metal working.

Stearin fared somewhat better than lard oil as regards its use in the arts, for though illumination with gas, with petroleum, and finally with electricity limited the use of candles, candles have not wholly disappeared as has the whale-oil lamp. Candles are still extensively used even today under a variety of circum-

<sup>1</sup> *House Reports*, Vol. 3, No. 970, 1889-90, Part 2, p. 14 (51st Congress, First Session, Serial No. 2809).

stances and for a variety of purposes.<sup>1</sup> Candle-making is still an important industry, though candles are not now always made wholly from fatty acids. Considerable quantities of paraffin are also employed. Paraffin was first used in small amounts to overcome the brittleness of stearic-acid candles. By 1860, paraffin had already become an important candle-making material, though it was expensive and not yet derived from petroleum. Earth wax (ozocerite) was used and also paraffin obtained in England from the distillation of shale. It was also obtained in Europe by distilling wood and coal. It sold in the United States in 1860 for 50 cents a pound.<sup>2</sup> When, as the petroleum industry grew, paraffin became cheap as compared with stearic acid, it displaced stearic acid to some extent, at least in the cheaper grades of candles. This lessened use of stearic acid has in more recent years been counterbalanced in part by the new uses of stearic acid that were unknown or unimportant seventy-five years ago. For example, zinc stearate is widely used in medicine as a dusting powder and in ointments. Today, of course, stearic acid is made principally from greases and inedible tallow or from the stearins derived from them by pressing.

The point to be made in this connection is that the narrowing

<sup>1</sup> According to the Census of 1810, there were produced in the United States 3.8 million pounds of candles valued at \$508,606, or an average of a trifle more than 13¼ cents a pound. Of this production, there were exported 187,190 pounds of spermaceti candles, 7,636 pounds of wax candles, and 618,039 pounds of tallow candles, or \$12,875 pounds in all (Pitkin, *op. cit.*, p. 65). Exports fluctuated greatly, the maximum export of tallow candles prior to 1810 having been 266,084 pounds in 1804 and of sperm candles 294,789 pounds in 1806.

In 1925 the value of candles produced was \$7,578,230; the volume of production is not given by the Census. In the same year, there were exported 1,383,936 pounds valued at \$251,618 or 18.18 cents a pound. Assuming the average value of the candles consumed and not exported to be the same as those exported, the total production for the year 1925 would have been 41,684,433 pounds. Deducting exports and adding imports leads to a figure for per capita consumption of 0.3619 pounds. An exactly equivalent figure for 1810 cannot be arrived at, for the writers have not been able to find data on imports in that year. However, deducting exports and making no allowance for imports, we obtain a per capita consumption of 0.5292 pounds. These figures are, of course, not strictly comparable for a number of reasons that cannot be set forth in detail here. Nevertheless, the inference is warranted that the per capita commercial production of candles in the United States is today of the order of magnitude of about three-fifths that of 1810, whereas the total volume is very much greater than it was in 1810. Apparently, the relative importance of the candle industry today is not so much less than in 1810 as one might suppose. However, one cannot regard the figure for 1810 as representing total consumption, for candles were very generally made at home for home use. Concerning the volume thus produced there is no information, but it was probably many times the commercial production.

<sup>2</sup> Morfit, *A Treatise on Chemistry Applied to the Making of Soap and Candles*, 543-44.

of the market for lard oil forced lard pressers to sell lard stearin—as well as lard oil—on a narrow margin. The tendency was to depress the price of all stearin, the inedible as well as the edible obtained as a by-product in margarine manufacture. The pressure to find new outlets for edible stearin was great. As has been pointed out in the text, at first it took the form of adulterating lard; and a further outlet was found by making lard substitutes from lard, stearin, and cottonseed oil, or from stearin and cottonseed oil alone. The economic pressure to utilize stearin and cottonseed oil developed at about the time when sufficient progress had been made in technology to facilitate such utilization.

#### EARLY PROGRESS IN THE MANUFACTURE OF COMPOUND IN THE UNITED STATES

From cottonseed oil and stearin, compound with a smooth, firm texture resembling lard could not be made by cooling the melted mixture by the methods then current for cooling lard. Lard contains relatively little of high-melting constituents; hence, slow cooling was satisfactory, provided in due time the melted lard got stiff enough to package without too much grain. The N. K. Fairbank Company used the Allen lard cooler and ice water.<sup>1</sup> However, after the addition of cottonseed oil and beef fat to lard, there was a tendency for the stearin to separate from the melted mixture at a temperature above that suitable for drawing the mixture into packages. At this temperature, the beef stearin appeared and continued to separate as the slow cooling went on. Allbright discovered that this difficulty was avoided by sudden chilling, but the resulting firm fat was translucent and, therefore, not marketable as lard. The difficulty was overcome by the invention of the lard-cooling roll with the help of O. G. Burnham, to whom patents covering the invention were issued in 1883.<sup>2</sup> The lard roll consists of a revolving hollow metal cylinder chilled by circulating cold water or chilled brine through its interior. The melted lard or compound is allowed to run in a thin film over the revolving cylinder on which it is almost instantly chilled. The thin layer of fat is then scraped off automatically and drops into a trough within which a picker shaft and a worm conveyer beat it up to destroy the translucent appearance. This lard roll, which is now in almost universal use,

<sup>1</sup> W. B. Allbright, "Practical Considerations in Lard Manufacture," read before the American Meat Packers Association at Chicago, October 12, 1909, in *Catalogue No. 3, The Allbright-Nell Company, Special Lard Machinery, Chicago, 1909.*

<sup>2</sup> U.S. Patents No. 287,362 (October 23, 1883) and No. 289,809 (December 11, 1883).

made possible the admixture of a greater proportion of oil with a lesser proportion of hard fat in the adulteration of lard. Many other devices for cooling lard have been in use before and since the issuance of the Burnham patents, but the cooling roll has displaced nearly all of them. The lard roll proved particularly effective because at about this time there came into use the ammonia refrigeration machine, which rendered feasible the employment of very cold brine to chill the roll. Prior to some time in the 'eighties, the only mechanical refrigeration known in the Chicago stockyards district was by means of machines of the Windhorst type, operating by compressing air, cooling it when compressed, and then allowing it to expand.

Opinions have differed concerning the reasons why sudden chilling has the effect above described. Allbright says that "sudden cooling would combine all the fats."<sup>1</sup> The effects of sudden chilling are now better understood. Fats exhibit curious anomalies in regard to their melting and congealing temperatures. These do not coincide, as theoretically they should. Various explanations have been offered, among others that triglycerids exist in different forms according as they are cooled slowly or chilled rapidly. These forms are assumed to have different melting points. Eldred, at the Food Research Institute, has been able to show that in fact fats do exist in several forms, depending upon the rate of cooling.<sup>2</sup>

#### HYDROGENATION

We see, then, that by 1900 the problem of refining, deodorizing, and decolorizing cottonseed oil for edible purposes had been solved. However, the amount of cottonseed oil that could be used in the manufacture of solid cooking fats was limited by the supply of stearin. Therefore, despite the growing use of the solid vegetable fats, coconut oil, and in Europe palm kernel oil, the problem of hardening oils continued to engage the attention of chemists. Some of the early endeavors of this sort have been mentioned above. A number of laboratory processes were tried out by the candle industry in the second half of the nineteenth century but failed.<sup>3</sup>

Some of the early methods endeavored to hydrogenate fatty acids rather than the neutral fats; they are described by Ellis<sup>4</sup>

<sup>1</sup> Allbright, *op. cit.*

<sup>2</sup> F. H. Eldred, unpublished material.

<sup>3</sup> Lewkowitsch, "On Attempts to Convert Oleic Acid into Candle Material," *Journal of the Society of Chemical Industries*, 1897, XVI, 339.

<sup>4</sup> Carleton Ellis, *Hydrogenation of Organic Substances Including Fats and Oils* (New York, Van Nostrand, 1936, 3d edition), 313-16.



and by Lewkowitsch.<sup>1</sup> Hydrogenation is a chemical process by which unsaturated organic substances (see *Unsaturated compound*, Appendix A) are made to take hydrogen into the molecule. Most fats and oils contain the glycerids of unsaturated fatty acids, which are liquid at ordinary temperatures. If they are made to combine with hydrogen, they become more nearly saturated (with respect to hydrogen). One of the effects is to raise the melting-point; if the process is carried far enough, a liquid fat, i.e., an oil, may be converted into a solid fat. Success in hardening oils (i.e., triglycerids rather than fatty acids) by hydrogenation was finally achieved in 1902 through the use of finely divided metals as catalysts.

As early as 1863, Debus had shown that, if vapor of hydrocyanic acid (HCN) mixed with hydrogen be passed over platinum black, methylamin ( $H_3CN$ ) is formed.<sup>2</sup> It is obvious that this is a reaction involving the addition of hydrogen to hydrocyanic acid; it is hydrogenation. Somewhat later, Saytzeff,<sup>3</sup> working under the direction of H. Kolbe, found that, if a mixture of hydrogen with nitrobenzol vapor be passed over finely divided palladium,<sup>4</sup> the nitrobenzol is converted into anilin, i.e., is reduced.<sup>5</sup> The palladium acts as a catalyst. Later Sabatier and his associates discovered that unsaturated organic compounds in general may be reduced, provided they may be vaporized without decomposition.<sup>6</sup> The great practical value of their discoveries lies in the demonstration that the expensive noble metals, palladium and platinum, are not essential catalysts for the reaction, and that certain cheap base metals (notably nickel, and also cobalt, copper, and iron when finely divided) are good catalysts at temperatures of 150° to 300° C.<sup>7</sup>

<sup>1</sup> *Chemical Technology* . . . , III, 119 ff. and 244 ff.

<sup>2</sup> H. Debus, "Ueber die Darstellung des Methylamins aus Blausäure und Wasserstoff," *Annalen der Chemie*, Part 2, 1863, CXXVIII, 205.

<sup>3</sup> M. Saytzeff, "Ueber die Einwirkung des vom Palladium absorbirten Wasserstoffes auf einige organische Verbindungen," *Journal für praktische Chemie*, October 25, 1873, 2 Folge, VI, 128.

<sup>4</sup> Palladium is a noble metal, in some respects resembling platinum.

<sup>5</sup> The reaction is as follows:



In the language of the chemists before the era of the electron theory, reduction is the removal of oxygen from a molecule or the addition of hydrogen, or (as in the foregoing case) both.

<sup>6</sup> French Patent No. 312,615 (1901); German Patent No. 139,457 (July 26, 1901). See *Chemisches Centralblatt*, April 21, 1897, I, 801; July 28, 1897, II, 257; June 28, 1899, I, 1270.

<sup>7</sup> Cf. P. Sabatier (translated by E. E. Reid), *Catalysis in Organic Chemistry* (New York, Van Nostrand, 1922). A German patent, No. 139,457 (July 26,

However, it was not feasible to use the process in its original form for the hydrogenation of liquid fatty acids and of oils, because these are not readily vaporized without decomposition, except under very special conditions. That hydrogenation can be effected in the liquid phase seems first to have been shown in the German patent of Herforder Maschinenfett- und Oelfabrik, Leprince and Siveke (German Patent No. 141,029 [August 14, 1902]), and the corresponding British patent of Wilhelm Normann (British Patent No. 1515 [November 26, 1903]).<sup>1</sup> According to these patents, the finely divided metal is mixed with the melted fatty acid or fat or oil, and hydrogen is then introduced into the mixture. The novelty of Normann's process as compared with those of Sabatier and Saytzeff consists in the carrying on of the reaction in the liquid state.

The first American patents seem to have been issued in 1912.

The title to the Normann patent soon passed to the English firm of Joseph Crosfield and Sons, Ltd., but was not used commercially for some time, since it required research and experimentation before methods were perfected for the preparation of an active nickel catalyzer and for the devising of suitable machinery with which to carry on the process. However, by 1906 or even earlier, the process was in use in Europe, and whale oil was already being hydrogenated for margarine. A large number of patents have been issued introducing a great variety of modifications and improvements;<sup>2</sup> and many theoretical papers have been published dealing with the scientific aspects of the reaction. Agreement has not yet been reached in regard to its exact nature, especially as concerns the manner of action of the catalyts.

Joseph Crosfield and Sons, Ltd., the owners of the Normann patents, offered the American rights to the American Cotton Oil Company, of which the N. K. Fairbank Company was a subsidiary. This company was interested because the patents made possible the production of an oleostearin substitute from vegetable oils. Mr. Boyce, chief chemist of the company, had been in Europe and

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1901) to J. B. Senderens is probably the first patent record having anything to do with the reduction of organic substances by hydrogen in the presence of nickel catalyts. Cf. also P. Sabatier and J.-B. Senderens, "Nouvelles méthodes générales d'hydrogénation et de dédoublement moléculaire basées sur l'emploi des métaux divisés," *Annales de chimie et de physique*, March 1905, 5ème série, IV, 319.

<sup>1</sup> Details concerning the litigation involving these patents may be found in Ellis, *The Hydrogenation of Oils*, pp. 7-9 and Appendix A. Details regarding the polemic on the methods of producing the nickel catalyst may be found in Ellis, *Hydrogenation of Organic Substances . . .*, chapter xii.

<sup>2</sup> For details, the reader is referred to Ellis, *The Hydrogenation of Oils and Hydrogenation of Organic Substances . . .*

had investigated the process as it was in use there. However, the Crosfield patents ultimately were acquired by the Procter and Gamble Company of Cincinnati, soap-makers (Ivory soap). The rôle of this company in the American solid-cooking fat industry has been discussed in the main body of the text. At about the same time, David Wesson was experimenting on behalf of the Southern Cotton Oil Company, but, since it was necessary to develop a catalyzer that was not covered by patents, quantity production was not achieved till 1912 or 1913. Similarly, at this time, Hugh K. Moore developed a successful process for the Brown Company, of Berlin, New Hampshire, to enable this company to use waste hydrogen from the manufacture of chlorin and caustic soda.

In practice, the process involves three separate operations: the securing of hydrogen, the preparation of the catalyst, and the hydrogenation of the oil.

A pound of olein requires a little more than 0.1 ounce of hydrogen for its conversion into stearin. Since 1,000 cubic feet of hydrogen gas weigh about 5.6 pounds, a short ton of olein requires about 2,500 cubic feet of hydrogen. While only a small quantity of hydrogen by weight is necessary, the volume needed is considerable. Since different oils contain different proportions of olein and since many of them also contain more or less linolin and linolenin (see p. 231), different oils require different volumes of hydrogen. According to Linde, 6 to 10 cubic meters of hydrogen are required for hardening 100 kilograms of oil.<sup>1</sup> The hydrogen, moreover, must be quite pure, so that it may not poison the catalyst. Therefore, one of the chief problems of hydrogenation is to secure a cheap supply of pure hydrogen.

Two principal methods are in use: the steam-iron and the electrolytic process. In the former, steam is passed over hot iron, whereby the iron removes oxygen from the water, converting itself into oxid of iron, and sets hydrogen free. In the latter, an electric current is passed through water between two poles, whereby the water is decomposed into oxygen and hydrogen, one appearing at one pole, the other at the other, so that they may be collected separately. For details of the various processes, the reader is referred to the monograph of Ellis.

Hydrogen is also a joint product of a number of large-scale chemical manufacturing processes—notably the production of caustic soda and bleach by the electrolysis of brine. A considerable proportion of this hydrogen is now used for hydrogenations. The principal cost is its compression, storage, and transportation.

<sup>1</sup> F. Linde, "Production of Hydrogen," *Proceedings of the Third International Congress of Refrigeration* (Chicago, September 1913), II, 219.

The cylinders in which it is compressed are heavy and expensive, so that transportation for considerable distances is not feasible. Gas mains for hydrogen have not as yet been built in the United States.

The catalyst usually employed is nickel, but sometimes a combination of nickel with a small amount of a second metal, most commonly copper, is used. The second metal is known as a promoter. Since the effectiveness of such a catalyst as nickel is in part dependent upon the extent of the surface it exposes to the oil with which it is in contact, the methods of preparation aim to secure the catalyst in a state of fine subdivision. One way to accomplish this is to mix the compound of nickel from which the catalyst is prepared with a finely divided, fluffy or porous, inert substance. Such a substance is known as a carrier. The substance most often used is a diatomaceous earth, commonly known by its German name, *Kieselguhr*.

To prepare the catalyst, finely powdered nickel oxid, hydroxid, or carbonate is placed in a vessel through which a stream of hydrogen is passed. If a carrier is used, the nickel compound is first intimately mixed with the carrier. The vessel is then heated. Under the influence of heat and hydrogen, finely divided metallic nickel is formed, which, if a carrier has been used, is spread over the surface and in the pores of the carrier. The catalyst thus prepared is then added in suitable proportion (0.1 to 2 per cent of the oil) to the oil to be hydrogenated, care being taken to prevent contact with air during the transfer.

Instead of preparing the catalyst separately and then adding it to the oil to be hydrogenated, the catalyst may be prepared in the oil itself. A finely powdered salt of nickel, usually nickel formate, is suspended in oil and the suspension heated while a stream of hydrogen bubbles through. Since the temperature necessary is rather high, the oil may be scorched. This can be avoided by using a little copper with the nickel as promoter; a lower temperature is then adequate. For edible products, copper is objectionable because it is poisonous. Therefore, at least in America, when edible products are manufactured, instead of using copper, the nickel salt is suspended in a small volume of oil and heated. If the oil becomes scorched, the catalyst is filtered off, washed with a little fresh oil, and then added to the oil to be hydrogenated.

A small amount of catalyst, prepared in either way, is adequate for a large volume of oil, and it may be used repeatedly. Ultimately, it becomes inactive, so that, to hydrogenate further parcels of oil, fresh catalyst has to be used.

The hydrogenation, itself, is carried out as follows: A suit-

able quantity of catalyst, prepared in one way or another, is added to the oil, and the suspension heated in a closed vessel while a stream of hydrogen is bubbled through. For a number of fatty oils, the mean temperature of maximum velocity of saturation with hydrogen is about 180° C. or 356° F. When the reaction has proceeded to the desired point, the hydrogen stream is interrupted, the apparatus cooled, the oil withdrawn, and the suspended catalyst filtered off.

The rate of hydrogenation is influenced by the pressure of the hydrogen and the process is usually carried on at a pressure higher than that of the atmosphere (20 to 150+ pounds). The rate is also affected by stirring and the apparatus is, therefore, sometimes equipped with devices to agitate the liquid.

Impurities present in the fat or oil to be hydrogenated may create difficulties, because they interfere with the action of the catalyst. The chemist speaks of this as poisoning of the catalyst. Thus, rape oil contains a substance that poisons the catalyst, and certain marine oils also contain interfering substances. To obviate such poisoning of the catalyst, oils are carefully refined, but other methods may be used.<sup>1</sup> Refining is especially important, if the oil contains considerable quantities of free fatty acids, for, unless the oil be neutral, there is some combination between the nickel and the acid. The resulting nickel soap contaminates the final product. It is, therefore, desirable for the oil to be neutral. This can be attained not merely by refining, but also by converting the free fatty acid present in the oil into a glycerid or other ester. This may be accomplished by adding glycerol, mono- or diglycerids, or alcohol to the oil and heating. It should be noted, as pointed out below, that thus the refining loss is avoided, glycerid is synthesized, and (theoretically) the final yield of hardened oil is materially increased.

While hydrogenation changes the consistency of oils and fats, making them more or less hard according to the degree of hydrogenation, it affects them also in other ways. Rancid fats tend to lose much of their evil odor and flavor when completely hydrogenated; moreover, hydrogenation reduces the tendency of fats to turn rancid. In the language of the oil technologist, they become more stable. While the mechanism by which a fat becomes rancid is not fully understood, it seems certain that oxidation is an important factor. Practically all vegetable oils contain not merely the unsaturated glycerid, olein, which does not readily absorb oxygen at ordinary temperatures, but also glycerids of a lower degree of saturation, which readily absorb oxygen. The

<sup>1</sup> Ellis, *Hydrogenation of Organic Substances* . . . , 47.

most oxidizable of these glycerids are those that contain linolic and linolenic acids. Since these glycerids are the first to be attacked by hydrogen and converted into less unsaturated glycerids, hydrogenation, even if not carried to completion, counteracts oxidation and, therefore, improves the keeping qualities of the oil. A further factor favoring rancidity is the presence in the oil of decomposable organic substances (aldehydes, ketones, and hydroxy fats). These seem to be removed by hydrogenation.<sup>1</sup>

Hydrogenation destroys the characteristic aroma of different fats. They become bland and tasteless, or acquire a slight tallowy flavor. Coconut oil, however, which is without distinctive flavor, is said to be much improved in this regard by hydrogenation through the acquisition of an aroma suggestive of butter. Many of the fats are so changed by hydrogenation that they no longer give the chemical reactions which are commonly used to detect their presence. Thus, cottonseed oil after hydrogenation no longer gives the reactions of Halphen<sup>2</sup> or of Bechi.

Furthermore, it is reported that hardened fats can hold much more water than their unhydrogenated counterparts and may, therefore, be used to advantage in margarine.<sup>3</sup> Clayton did not find excessive moisture content in margarine of British manufacture.<sup>4</sup> However, this is a matter of but slight importance in the United States, where the moisture content of both butter and margarine is limited by governmental regulation to 16 per cent.

By varying the amount of catalyst or its character, the temperature, the pressure, and the degree of hydrogenation, rather different products are obtained. Many oils, for example cottonseed oil, consist largely, perhaps wholly, of mixed rather than simple glycerids. Theoretically, eighteen mixed glycerids are possible in cottonseed oil. How many of them and which ones actually occur is not known, since satisfactory methods adequate for their separation have not yet been worked out. However, since cottonseed oil is so complex a mixture, it is obvious that even slight variations in the conditions of hydrogenation must produce

<sup>1</sup> Cf. U.S. Patent No. 1,605,108 (November 2, 1926) of G. Grindrod.

<sup>2</sup> This reaction, which makes the detection of cottonseed and kapokseed oil easy, was discovered in 1897 (G. Halphen, "Réaction caractéristique de l'huile de coton," *Journal de pharmacie et de chimie*, 1897, Sixième Série, VI, 390).

<sup>3</sup> K. Brauer, "Über das Wasserbindungsvermögen von gehärteten Fetten und der Wassergehalt daraus hergestellter Margarine," *Zeitschrift für öffentliche Chemie*, July 30, 1916, XXII, 209; abstract in *Chemical Abstracts*, June 10, 1917, XI, 1699, and *Zeitschrift für angewandte Chemie*, November 24, 1916, Vol. XXIX, Part 2, p. 492.

<sup>4</sup> W. Clayton, "Modern Margarine Technology," *Journal of the Society of Chemical Industry*, December 15, 1917, XXXVI, 1206.

variations in the product. Hence, it is not at all astonishing that many anomalies are met in melting-points and iodine number in hydrogenated products like vegetable shortenings.<sup>1</sup> From the beginning of hydrogenation of cottonseed oil, the linolin decreases while the stearin increases. Olein rises to a maximum and then continuously decreases. These changes are due to the fact that hydrogenation forms olein from linolin more rapidly than it forms stearin from olein. The rates of the two reactions are affected differently by the conditions of hydrogenation with resultant variation in the product. For example, raising the temperature speeds up the rate of hydrogenation of both linolin and olein; but the linolin rate is raised more than the olein rate. Hence, high temperatures produce a product high in olein, provided, of course, the reaction is interrupted at the proper point.<sup>2</sup>

Finally, it is to be noted that hydrogenation produces changes in unsaturated glycerids other than the mere addition of hydrogen. Iso-oleic acid is formed. This is a solid. A large volume of research has been published on this acid, but no final conclusion has been reached concerning its nature. It seems probable that it is a mixture of acids closely resembling oleic acid, but differing from ordinary oleic acid in the position in the molecule of the point of unsaturation. There is also reason to believe that a high temperature and long operating time favor the formation of iso-oleic acid.

Though refined vegetable oils as a rule do not contain vitamins, certain animal fats do, and the effect of hydrogenation upon their vitamin content is therefore of interest. Though commercially hardened oils seem to lose their vitamins, there is some reason to believe that this is not the result of the hydrogenation *as such*, but of the high temperature and of oxidation.<sup>3</sup> Evans and Burr have found that wheat-germ oil may be hydrogenated without loss of vitamin E.<sup>4</sup> Dubin and Funk have reported that vita-

<sup>1</sup> Cf. David Wesson, "The Glycerides of Cottonseed Oil," *Cotton Oil Press*, November 1919, III, No. 7, pp. 34-35.

<sup>2</sup> Cf. H. K. Moore, G. A. Richter and W. B. Van Arsdel, "The Incomplete Hydrogenation of Cottonseed Oil," *Journal of Industrial and Engineering Chemistry*, May 1917, IX, 451.

<sup>3</sup> S. S. Zilva, "The Stability of the Vitamin A of Cod-Liver Oil Towards the Hardening Process," *Biochemical Journal*, 1924, XVIII, No. 5, p. 881. C. Funk and H. E. Dubin (U.S. Patent No. 1,629,074 [May 17, 1927]) heat codliver oil with glacial acetic acid under reflux for one hour without substantially impairing the vitamin efficiency. According to U.S. Patent No. 1,649,520 (November 5, 1927), these chemists concentrate vitamins A and D from codliver oil by hydrogenating at the low temperature of 60° C. and then extracting the vitamins from the solid fat.

<sup>4</sup> H. M. Evans and G. O. Burr, "The Anti-Sterility Vitamine Fat Soluble E," *Proceedings of the National Academy of Sciences of the United States of America*, June 15, 1925, XI, 339.

mins A and D are unaffected by hydrogenation.<sup>1</sup> They have based a method of concentrating the vitamins of codliver oil upon these observations.<sup>2</sup> However, Nakamiya and Kawakami have reported that "biosterin" (vitamin A7) is destroyed.<sup>3</sup> Sumi found that hydrogenation destroys the antirachitic properties of irradiated ergosterol, while Ueno, Yamashita, Ota, and Okamura were able to hydrogenate various oils without affecting their vitamin content.<sup>4</sup> On the contrary, some of the hardened oils gave rather better results than the unhardened, a fact that these Japanese investigators attribute to their greater stability and the elimination by the chemical treatment of toxic substances. It would seem, therefore, that while commercially hydrogenated oils lose their vitamin activity, this may be retained, if the process is conducted in special ways.

Hydrogenated vegetable shortening may be produced in either of two ways, and the resulting products have somewhat different properties: (1) The whole batch of oil may be hardened to the desired consistency, usually that of lard, and the catalyst then removed. (2) A portion of the oil is more or less completely hydrogenated. This is then melted together with varying volumes of unhardened oil and the mixture cooled on a lard roll. The proportion of hardened oil used varies with its hardness and with the consistency desired—commonly from 7 to 10 per cent of the hardened oil is employed.

Compound of the second type is said to be cheaper to manufacture, and production more flexible. The quantity of the first type that can be produced daily is a function of the hydrogenating capacity of the plant. The second type may be made by a concern that has no hydrogenating plant of its own, but buys fully hydrogenated oil and blends it with unhydrogenated oil. A concern with hydrogenating facilities may meet a peak demand with a smaller plant by hydrogenating some oil completely during periods of slack demand against the time of heavy demand. The amount of capital that it has to lock up in this way by manufacturing for stock is very much less than it would be if the first type

<sup>1</sup> H. Dubin and C. Funk, "Studies on the Chemistry of Cod Liver Oil," *Proceedings of the Society for Experimental Biology and Medicine*, 1923, XXI, 139.

<sup>2</sup> U.S. Patent No. 1,649,520 (November 15, 1927).

<sup>3</sup> Z. Nakamiya and K. Kawakami, "On the Hydrogenation of 'Biosterin'," *Scientific Papers of the Institute of Physical and Chemical Research (Tokyo)*, October 20, 1927, VII, 121.

<sup>4</sup> S. Ueno, M. Yamashita, Y. Ota, and Z. Okamura, "On the Nutritive Value of Hydrogenated Oils," *Journal of the Society of Chemical Industry (Japan)*, June 1927, Vol. XXX, No. 6, p. 378; Abstracts from the original communications, Supplemental Binding, p. 105B.



were manufactured for stock, for only a minor portion of the oil required for the finished product has to be hydrogenated and stored.

The two types of compound differ in properties. The second type retains the flavor of the unhydrogenated oil, which is sometimes desirable. However, as is evident from the method of manufacture, the product contains all of the unsaturated glycerids characteristic of the unhydrogenated oil present; therefore this kind of vegetable shortening is less stable, and keeps less well than the first type. This is a matter of great importance, if it is to be used in food products like crackers, biscuits, and confectionery that may not be consumed for some time after they have been finished. The differences in behavior of the two types of product when used for shortening and other culinary purposes will be discussed in Appendix C.

Since the granting of the Normann patents, there have been issued a large number of patents for the manufacture of solid or semi-solid cooking fats. One of these (U.S. Patent No. 1,135,351, issued to Burchanal on April 13, 1915) was involved in the litigation of Procter and Gamble Company *vs.* Berlin Mills Company. That litigation attracted wide attention because, had the Procter and Gamble Company prevailed, the manufacture of lard-like fats from oil might have been monopolized for the life of the patent. There can be no doubt that this litigation frightened off certain concerns for a time, and thus delayed the spread of hydrogenation in compound manufacture.

Another patent is interesting because it involves pressing.<sup>1</sup> The oil is hardened more than required and then pressed to remove some of the harder material. It is stated that in this way the unstable glycerids of linoleic and linolenic acids are better hydrogenated than by the customary process.

Taking the patents of recent decades as a whole, however, they present little that is fundamentally new; they deal primarily with the restriction of the degree of hydrogenation in special ways, with special formulas for making suitable mixtures of fats and oils, or with modifications of the hydrogenation process. Some deal with methods to improve texture and appearance, such as chilling, emulsification, or heating in air. Others deal with machinery or equipment used in the manufacturing processes.

An interesting possibility to thicken oils is suggested by British Patent No. 187,298 (July 12, 1921), issued to E. V. Schou. A drying or semidrying oil is polymerized, by heating or oxidation or both, until it has a gelatinous consistency. The thickened prod-

<sup>1</sup> Carleton Ellis, U.S. Patent No. 1,058,738 (April 15, 1913).

uct is then added to oils and fats to increase their viscosity. Little seems to be known concerning the digestibility of polymerized and oxidized oils. Other patents involve formation of a stiff emulsion in water with the aid of soap, or the admixture of such stiffening agents as waxes, mucilaginous and gelatinous substances. It is doubtful that any of these products could be classed legally as compound.

Finally, attention may be drawn to the possibility of hardening fats not by hydrogenation but by synthesis of triglycerids. Thus, on August 15, 1924, U.S. Patent No. 1,505,560 was issued to Adolf Grün of Czechoslovakia, which proposes, as a first step, to convert fats into mono- or diglycerids by heating with glycerin in the presence of an esterifying catalyst. As the final step, it is proposed to convert these mono- and diglycerids into new triglycerids by heating with free fatty acids. It is obvious that by this method the consistency of a fat might be raised or lowered according to the character of the free fatty acid used in the final step. If a solid acid like stearic acid be used, the final fat would be harder. The writers do not know whether the process is actually in commercial practice.

The process mentioned above (p. 269) of preventing poisoning of the catalyst by the free fatty acid present in the oil through heating with glycerin<sup>1</sup> or through the addition of mono- or diglycerids<sup>2</sup> involves a similar principle. If the mono- or diglycerid added according to Bolton and Lush contain high-melting acids, like stearic acid, the melting-point of the product would be raised even without hydrogenation.

United States Patent No. 1,547,571, issued to Ellis on July 28, 1925, is also based on synthesis. Stearic acid is heated with glycerin to form the diglycerid. This hard synthetic diglycerid is then blended with oil in suitable proportion to obtain the desired consistency. The writers do not know whether the process has had commercial application. The synthesis is conducted essentially according to the old method of Berthelot. According to the experience of one of the writers, this method is by no means simple, at least on a laboratory scale.

<sup>1</sup> U.S. Patents No. 1,261,911 (April 9, 1918), No. 1,271,575 (July 9, 1918), and No. 1,271,567 (July 9, 1918), issued to Ellis.

<sup>2</sup> British Patent No. 162,382 (January 27, 1920), issued to Bolton and Lush.

## APPENDIX C

# METHOD OF ACTION OF SHORTENINGS

### INTRODUCTION

In the body of the text, reference is frequently made to the properties of fats as determining their special food uses, but why these properties determine such uses is not there made clear; to have treated this subject adequately would have interrupted the argument unduly. The purpose of this appendix is to supply this information with reference to frying fats and shortenings. Other uses of fats are not considered. Unfortunately, many of the principles underlying the operations of the kitchen and the bakery have not been sufficiently studied scientifically; therefore, the material presented in this appendix, all of which is drawn from the literature, is imperfect and incomplete. The attempt is made to present an outline of the conclusions concerning the methods of shortening action that may be reached through a critical analysis of existing American literature. The literature itself is not discussed in detail, for such a discussion would be out of place in an economic study. A critical detailed analysis of the literature will be presented in another publication.

### SHORTENING

*Definition of shortening power.*—A dictionary definition of shortening is: "Material, as lard or butter, used to make pastry crisp." Davis<sup>1</sup> defines the property of shortness in the following terms: "That cake which requires the least load to measure its breaking strength is the shortest, that which requires the heaviest load is the least short. The best shortening is that material which when baked in a dough gives to the product a minimum breaking strength and a minimum crushing strength." It is obvious that this definition of shortness and shortening power assumes that shortening has but one action, namely to produce minimum crushing strength. However, shortening may have other effects, such as to impart a flavor, flakiness, or uniformity of texture to

<sup>1</sup> C. E. Davis, "Shortening: Its Definition and Measurement," *Journal of Industrial and Engineering Chemistry*, September 1921, XIII, 797.

the baked goods, or a special color or consistency to the crust. In bread, the rôle of shortening is certainly not to give minimum crushing strength. The definitions of shortening above given, therefore, seem to the writers too limited in scope.

It is doubtful that it is possible to give a general definition of shortening power sufficiently inclusive to cover all the effects of shortenings in the several sorts of shortened baked products. Baked goods represent a series of products characterized by different shortening content; at one extreme is bread containing little or no shortening, and at the other, products like puff pastry containing much. In between lies a series ranging from batters in which the shortening is introduced in the fluid state, for example popovers and griddle cakes, through crackers, biscuits, cookies, cakes, and plain pastry. In the various products, the effects desired are somewhat different, and it is an open question whether these various effects are all comparable qualitatively or quantitatively.

The writers believe it remains to be proved that the fundamental principles of the action of fats in baked goods are always the same; they believe no general definition for shortening power can be given. One can define it only, they believe, for a given class of products, by describing its effect in these products. It is as yet quite impossible to offer a general definition appropriate for all products; perhaps, no such definition will ever be possible, since shortenings are valued for different purposes in different products, and since their effects upon the finished product depend not merely upon the properties of the shortening itself, but also, upon the manner in which it is incorporated in the dough or batter. The temperature of the water and its proportionate amount, the proportion of sugar, the temperature of the shortening itself, the physical manner in which it is incorporated in the dough, the way in which the dough is mixed or otherwise treated mechanically, the nature of the leavening agent, the oven temperature—all these, at least, contribute to the properties of the finished product.

Perhaps, in the present state of our knowledge, the only practical way to evaluate and compare different fats in respect to shortening power would be to establish some sort of score-card system in which different properties of the shortening would be given different weightings according to their importance. Possibly, it would be necessary to have a different set of weightings for each class of baked products.

*The properties of fats and oils of greatest importance in shortening.*—The properties of fats and oils that, aside from flavor and price, are most important for shortening purposes

are stability, feel in the mouth, consistency, and creaming power.

By stability is meant the property of not turning rancid. The importance of stability is related to flavor, for, if an unstable fat is used, the product sooner or later acquires a rancid flavor.

The feel in the mouth and the way in which a food chews is a property only in part distinguished from flavor. It, as well as flavor, is one of the factors that gives a food a desirable taste. The feel in the mouth is largely a matter of texture, and, since shortenings markedly affect texture, they determine to that extent the feel in the mouth. A shortening should not give the product in which it is incorporated a greasy or slimy feel when it is chewed. It is said that coconut oil, either as such or as margarine, gives less of this objectionable feel than most other fats, especially in articles with a very high shortening content.

The consistency of a fat is important, for it determines the manner in which it becomes distributed through the dough or batter. If a fat is very hard, that is, has a high melting-point, it is difficult to distribute it through the dough. If it is very soft or liquid, that is, has a low melting-point, it may tend to run out of the product and give it a greasy appearance and feel.

By creaming power is meant the ability of a fat, when beaten either by itself or with other substances, especially sugar, to hold air bubbles, increase greatly in volume, and acquire a smooth, plastic texture. It is not known definitely what determines creaming power. It seems generally admitted that lard does not cream well, whereas hydrogenated fats do. Other forms of compound and also butter cream fairly well. Coconut oil, especially the preparations of it which are known in the trade as coconut butters, cream quite well; they are used rather for fillings and icings than for shortenings.

#### METHOD OF ACTION OF SHORTENING

While the effects desired in the use of shortening vary widely, one fact seems fairly well established: It is that the action of all shortenings is primarily physical or mechanical. If this were not so, then petrolatum, a petroleum product that, chemically speaking, is exceedingly inert, would be quite devoid of shortening power. It is, in fact, not at all a poor shortening.

The mechanical effect of shortening fats is exercised by virtue of the formation of films around the particles of the dough or batter. These films are not wetted by and do not mix with water. They create surfaces of structural weakness within the baked product, so that it crumbles, flakes, or tears easily.

Flour is composed principally of two constituents, starch and gluten. Both starch and gluten are easily wetted by water, and both absorb considerable of it. The properties of starch are hardly changed thereby; gluten, however, swells greatly and becomes sticky, gummy, and elastic. In that state, the different particles of flour stick together to form an elastic network holding in its meshes starch granules and other components of the flour. This conversion of dry gluten, as it exists in flour, into the sticky elastic state in which it exists in dough is known as the development of the gluten. If fat is one of the constituents in preparing dough or batter, more or fewer of the gluten particles of the flour are covered by a film of fat. They are more or less sealed off, so that water has less ready access to them than it would have with no added fat present. The result is that the gluten is able to absorb less water and develop less perfectly. In consequence, the dough is less sticky, elastic, and tenacious than it would otherwise be. This lack of tensile strength carries over into the finished baked article, so that it is shorter than it would be had no fat been used in its preparation. The degree of shortness depends upon the amount of fat present and upon the manner of its distribution. If it is very uniformly distributed, so that very many of the gluten particles have been coated with it, the product tends to be crumbly and tender. If the distribution is not so fine, and especially if the distribution is in thin layers, as in certain types of pie crust, the product tends to be flaky. Whether or not it is desirable to distribute the shortening through doughs and batters as perfectly as possible depends upon the texture that it is desired to produce.

#### **CORRELATION OF FLOUR QUALITY AND SHORTENING EFFECT**

The amount of shortening that is necessary to produce a given effect depends not merely on the factors above discussed, but also upon the nature of the flour. It has been well established that standard cookies, varying solely in the kind of flour used, that is with constant shortening content and using the same shortening, range in order of shortness from shortest to least short in the following series: soft winter, medium winter, strong winter, spring. Since shortening as a rule is the most expensive ingredient, the use of soft flours is economical in certain cases. The fact that, to secure a product of given shortness, weak flours require less shortening than strong ones is possibly one of the reasons why soft flours are preferred for short baked products.

**THE EFFECT OF SHORTENING UPON THE LEAVENING PROCESS**

There is no evidence that shortening has any notable effect upon leavening by yeast fermentation or by baking powders as such. It has, however, certain apparent effects. According to American experience, bread dough rises faster and comes to the first punch earlier when shortening has been used than when it is absent. Furthermore, the presence of shortening greatly improves the texture and affects the spring in the oven. This is especially true for cakes made without yeast or baking powder. In these articles, the leavening effect is produced by creaming the shortening before the other ingredients are combined with it. The result is that the dough or batter, as it goes into the oven, has distributed through it a multitude of fine air bubbles, which cause the final porous texture of the baked article.

It is not easy to explain how the shortening acts in all these cases. The most probable hypothesis seems to the writers to be the following: The shortening tends to form through the dough or batter what might be likened to membranes or partitions of fat, that may be very thin, but are, nevertheless, impervious to air, carbon dioxid gas, and water vapor. The result is that, in yeast fermentation of dough, the carbon dioxid generated encounters barriers to its diffusion through and escape from the surface of the dough. In consequence, the dough rises faster in the beginning of the fermentation. Later, when these products, whether bread or cake, are brought into the oven, the fat still acts as a brake on the diffusion of gas and water vapor to the surface, so that the spring in the oven is increased and the shrinkage from evaporation of moisture reduced. This, however, is merely an hypothesis that still awaits the final test of experiment.

**EFFECT OF SHORTENING ON THE ONSET OF STALENESS**

Perhaps the hypothesis above advanced explains why shortening seems to reduce the loss in weight during the first few hours after the baked product comes from the oven. The fat hampers the diffusion of water vapor to the surface of the loaf and therefore there is less loss of water by evaporation. The hypothesis may also have a bearing on the indubitable fact that the presence of shortening delays the onset of staleness, especially in bread. Unfortunately, there is no satisfactory theory of the process of growing stale. It is certain that the loss of moisture is not the cause or even an important factor. It is, therefore, impossible at present to say how the presence of shortening delays the onset of staleness, or even to offer a plausible hypothesis.

## THE MEASUREMENT OF SHORTENING POWER

So far as shortenings are tested at all, only two non-chemical tests are made: creaming power and power to produce a product of minimum breaking and crushing strength. The most important instrument to determine the crushing strength is the shortometer of Davis.<sup>1</sup> This is a simple mechanical device, patterned after cement-testing machines, to measure the force required to break or crush a standard cookie. To determine breaking strength, such a cookie is laid upon two metal rails so that it is unsupported between them. Weights are then placed upon the unsupported section between the two rails, and these weights are increased till the load is great enough to break the cookie. The weight just heavy enough to break the cookie is regarded as the measure or index of the shortening power of the fat or oil used in making the cookie. The shortening power of different fats is assumed to be inversely proportional to the breaking weight. The less the weight required to break the cookie, other things being equal, the shorter the cookie. To test crushing strength, the procedure is the same, except that the two rails are removed and the cookie is placed flat upon the table of the instrument.

Baking technologists differ regarding the value of this method of testing shortening power, but nearly all the quantitative information we have concerning the relative shortening power of different fats has been obtained with the shortometer. Only experiments on the breaking strength of standard cookies are on record in the technical literature. There is no record of the investigation of the resistance of cookies to crushing.

Davis, on the basis of his shortometer tests, evaluates shortenings as follows. "Lard, which has the greatest shortening power, naturally comes first. Compounds rank next, and they have about the same shortening power if they are made by adding oil to animal stearin or to vegetable stearin—namely hydrogenated vegetable oil. Butter fat follows next in order. The oils—cottonseed, peanut, olive, rapeseed, soy bean, and corn—all have approximately the same shortening value, which is about three-fourths of the value of ordinary lard.

"Coconut oil is somewhat lower than the previous group of oils and has about two-thirds of the value of lard. Coconut oil if broken up into olein and stearin fractions shows a value higher than whole coconut oil for stearin, and lower for olein. . . . A liquid paraffin oil with an iodine number of 0.4 has a shortening value very close to that of coconut oil. A sample of white vaseline

<sup>1</sup> Davis, *op. cit.*; also U.S. Patent No. 1,454,130 (June 12, 1923).



had a shortening value fully as good as the ordinary oils, or 75 per cent of that of lard." Davis, furthermore, found that hydrogenation increased the shortening value of an oil.<sup>1</sup>

Platt<sup>2</sup> and Platt and Fleming<sup>3</sup> range shortenings in the following order: lard, lard compound, cottonseed oil, butter, coconut oil, vaseline, and liquid paraffin oil (Nujol).

Putland and Wall,<sup>4</sup> testing products with a higher shortening content than those tested by Davis and by Platt and Fleming, found the following order of shortening power: all-hydrogenated shortening, vegetable compound, oil, pure lard, butter.

No serious attempt seems to have been made to develop an exact method to measure creaming power. The only method in use seems to be the service test. The desired mix is made, thrown into a high-speed mixer, the motor started, the maximum volume to which the mix is beaten up noted, the mixing continued to note to what extent the volume remains large or decreases. Shortenings cannot stand unlimited time of creaming.

As above indicated, the consistency of a fat is of considerable importance. For certain flaky products, like puff paste, plastic fats are generally preferred. Much has been written concerning the plasticity of shortening, but very few exact measurements have been made. Although it is possible to measure plasticity with great exactness, this method of evaluating shortenings is rarely resorted to.

### CHOICE OF SHORTENING

By this time it must be clear to the reader that, since the testing of shortenings is as yet far from exact, the choice of shortenings in practice can hardly be made on a scientific basis. Choice is largely based upon rule-of-thumb, practical experience, tradition, and custom. To a not inconsiderable extent, choice is personal on the part of the master baker. In consequence, what is presented in this section is based on existing practice rather than on scientific principles.

<sup>1</sup> Davis, *op. cit.*; and letter to the editor, *Industrial and Engineering Chemistry*, October 1923, XV, 1089.

<sup>2</sup> W. Platt, "Shortening in Sweet Doughs," *Baking Technology*, July 1923, II, 216.

<sup>3</sup> W. Platt and R. S. Fleming, "The Action of Shortening in the Light of the Newer Theories of Surface Phenomena," *Industrial and Engineering Chemistry*, April 1923, XV, 390.

<sup>4</sup> A. W. Putland and H. Wall, "Variations in Shortening Power of Some Oils and Fats," *Cracker Baker*, February 1929, XVIII, 41.

Since shortenings, as we have seen, are used to bring about quite different effects in different products, it is obvious that the choice of a shortening, aside from considerations of costs, is largely governed by the nature of the product for which it is to be used. The only considerations that are common to the selection of shortenings for all products are flavor and stability. For this reason, butter is widely used in many products, even though it contains but 80 to 85 per cent of fat and is inferior in creaming and shortening power to many other fats.<sup>1</sup> Sometimes butter is mixed with other cheaper fats, so as to get the butter flavor combined with the desirable properties of the other fats.<sup>2</sup> Shortening used in this way should be quite bland, for a small amount of strongly flavored shortening may cover up the flavor of good butter. Unripened sweet cream butter is well-nigh useless for making such a combination, for it imparts little or no butter flavor. The butter should be made with a starter.<sup>3</sup> Most commercial bakers do not use the highest-score butter even for quality goods, since it is less strongly flavored than butter of somewhat lower score. Butter scoring 89 or 90 is most commonly used. While some bakers still regard butter as the ideal shortening for cakes, its yellow color is objectionable for white cakes. A white shortening is then necessary, usually some kind of vegetable shortening. In Europe, margarine is second choice to butter for flavor, but in America it is not in general use.

Many American bakers prefer lard for bread, because of its flavor. Some cereal chemists, while admitting its favorable influence on flavor, say that if a shortening such as lard is used in bread the flavor as such does not carry through into the finished baked loaf but nevertheless improves the flavor of the finished loaf. For some consumers and for some products, such flavor as is contributed by lard to other baked products is undesirable, and under such circumstances quite bland products like some vegetable shortenings are preferred.

For cakes and similar products in which the shortening is customarily creamed with sugar, hydrogenated products are very largely used. Lard is less used because it does not cream well, and butter, because it is expensive. In Europe, margarine is used to a very large extent. In the last few years, packers have modified lard by refining and partial hydrogenation, so that it may be

<sup>1</sup> J. Stewart, "The Making of Slab Cakes," *British Baker*, December 14, 1928, LXVIII, 17.

<sup>2</sup> *Idem*; D. M. Hopkins, "Progress of Cake Baking. The Top Is the Last to Bake," *Bakers' Helper*, December 21, 1929, LII, 1544.

<sup>3</sup> C. L. Brooke, "The Vanilla Wafer," *Cracker Baker*, December 1927, XVI, 59.

used like hydrogenated shortening. These modified lards have been on the market so short a time that it is uncertain, as yet, what favor they will find among commercial cake bakers.

For pies, a considerable variety of shortening is used. The preferred shortening is apparently lard, although vegetable shortenings are also widely used.

For bread, as above stated, lard is widely used, but vegetable shortening and vegetable oils, like cottonseed oil, are also employed.

## TRADE-MARKS OF COMPOUNDED COOKING FATS REGIS

For whom registered	Year	Title (and/or picture)
Hannah E. Kriel, Baltimore, Md. ....	1918	White Oak .....
N. K. Fairbank Co., Chicago.....	1906	Fairbank's .....
John Hobbs, Boston.....	1874	Cream-Suet .....
Christr. Thomas & Bros., Ltd., Bristol, England .....	1900	(Assyrian bull) .....
Miami Oil and Soap Works, Cincinnati..	1881	Cookolene .....
W. Butcher's Sons, Philadelphia.....	1882	Olive Butter .....
W. Butcher's Sons, Philadelphia.....	1882	Olivene .....
W. Butcher's Sons, Philadelphia.....	1882	(Olive) .....
S. H. Cochran, Everett, Mass. ....	1882	Purola .....
W. Butcher's Sons, Philadelphia.....	1882	(Olive gatherer) .....
W. Butcher's Sons, Philadelphia.....	1882	(Olive branch) .....
N. K. Fairbank Co., Chicago.....	1915	Snow White .....
N. K. Fairbank Co., Chicago.....	1912	Victoria .....
N. K. Fairbank Co., Chicago.....	1887	Cottolene .....
N. K. Fairbank Co., Chicago.....	1906	Cottolene .....
Cotton Oil Product Co., New York.....	1889	C.O.P. (Chef and pig).....
N. K. Fairbank Co., Chicago.....	1901	(Wreath of sprigs and blossoms)
N. K. Fairbank Co., Chicago.....	1906	(Bovine's head partially inclosed by a wreath of sprigs and blossoms)
N. K. Fairbank Co., Chicago.....	1903	(Bovine's head partially inclosed by a wreath of sprigs and blossoms)
N. K. Fairbank Co., Chicago.....	1906	(Two sprays, presumably cotton)
N. K. Fairbank Co., Chicago.....	1906	(Steer's head) .....
N. K. Fairbank Co., Chicago.....	1889	Golden Cottolene .....
George C. Napheys & Son, Philadelphia.	1895	Royal .....
Armstrong Packing Co., Dallas, Tex. ...	1917	Bird (Plover in a circle).....
W. J. Wilcox Lard and Refining Co., Gut- tenberg, N.J., and New York, N.Y. ....	1892	La Inmejorable [unimprovable].
Anglo-American Provision Co., Chicago.	1894	Royal Brand (Fleur de lis).....
Anglo-American Provision Co., Chicago.	1895	Royal Lily .....

\* Compiled from Patent Office records and from the *Patent Gazette*. This list may include a few liquid cooking fats, for the description of articles has not always been full enough to permit one to distinguish with certainty liquid cooking fats from compounds as we have interpreted the term.

## REGISTERED IN THE UNITED STATES PATENT OFFICE, TO 1930\*

Date begun	Character of article	Number
... 1820 <sup>a</sup>	Lard substitute composed of cottonseed oil and other ingredients .....	123,826
... 1868	Lard and lard compound.....	49,694
... 1873	Tallow compounds <sup>b</sup> .....	1,842
... 1873	Edible fats .....	34,195
Aug. 1881	Culinary oil .....	8,917
Feb. 1882	Substitute for lard.....	9,524
Feb. 1882	Substitute for lard.....	9,525
Feb. 1882	Substitute for lard.....	9,814
May 1882	Compound to be used in place of butter and lard for cooking purposes .....	9,565
July 1882	Substitute for lard and butter.....	9,815
July 1882	Substitute for lard and butter.....	9,816
May 1884	Cooking compound containing cottonseed oil and oleostearin	102,744 <sup>c</sup>
Mar. 1886	Cooking compound containing cottonseed oil and oleostearin	86,045
July 1887	Fatty, oleaginous, or unctuous food substances.....	14,808
July 1887	Prepared fatty, oleaginous, or unctuous food substances...	52,787
June 1888	Cottonseed lard .....	16,549
July 1888	Prepared fatty, oleaginous, or unctuous food products....	37,425
July 1888	Prepared fatty, oleaginous, or unctuous food substances... ..	39,673
July 1888	Prepared fatty, oleaginous, or unctuous food substances... ..	50,430
July 1888	Prepared fatty, oleaginous, or unctuous food substances... ..	55,216
July 1888	Prepared fatty, oleaginous, or unctuous food substances... ..	58,985
Aug. 1888	Oleaginous food substances.....	16,201
Sept. 1889	Lard and lard compounds and substitutes.....	26,373
... 1889	Shortening composed of cottonseed oil and oleostearin.....	118,485
Nov. 1891	Lard and its substitutes.....	21,440
Jan. 1892	Lard compound .....	24,820
Jan. 1892	Lard compound .....	25,947

\* The date is uncertain.

<sup>b</sup> Contents not stated: "used instead of butter, to shorten and enrich biscuits and other products of cookery."

<sup>c</sup> Applicant is owner of registered trade-mark No. 11,773.

## TRADE-MARKS OF COMPOUNDED

For whom registered	Year	Title (and/or picture)
W. J. Wilcox Lard and Refining Co., Guttenberg, N.J., and New York, N.Y. . . .	1892	Rosalinda (Two moss roses and twig) . . . . .
Robert B. Brown, New York . . . . .	1892	Suetine . . . . .
Gudahy Packing Co., Chicago and Los Angeles . . . . .	1907	Suetene . . . . .
N. K. Fairbank Co., Chicago . . . . .	1893	Golden Cottolene, etc. . . . .
W. J. Wilcox Lard and Refining Co., Guttenberg, N.J., and New York, N.Y. . . .	1892	Canario (Canary) . . . . .
W. J. Wilcox Lard and Refining Co., Guttenberg, N.J., and New York, N.Y. . . .	1892	Colibri (Humming bird) . . . . .
W. J. Wilcox Lard and Refining Co., Guttenberg, N.J., and New York, N.Y. . . .	1892	Los Tres Castillos (Three castles)
W. J. Wilcox Lard and Refining Co., Guttenberg, N.J., and New York, N.Y. . . .	1892	La Puertorriquena . . . . .
W. J. Wilcox Lard and Refining Co., Guttenberg, N.J., and New York, N.Y. . . .	1892	El Clavel (Pink and bud) . . . . .
Samuel H. Read, New Haven, Conn. . . .	1892	Lardene (inclosed in a diamond-shaped panel) . . . . .
Samuel H. Read, New Haven, Conn. . . .	1906	Lardene (inclosed in a diamond-shaped panel) . . . . .
W. J. Wilcox Lard and Refining Co., Guttenberg, N.J., and New York, N.Y. . . .	1892	Columbus (Portrait) . . . . .
T. M. Sinclair & Co., Ltd., Cedar Rapids, Ia. . . . .	1904	Palm Leaf (Palm leaf) . . . . .
Anglo-American Provision Co., Chicago.	1893	Fowler Bros. Neutraline . . . . .
Swift & Co., Chicago . . . . .	1893	Cotosuet . . . . .
W. J. Wilcox Lard and Refining Co., Guttenberg, N.J., and New York, N.Y. . . .	1893	El Libertador (Bolivar's head) . .
Armour & Co., Chicago . . . . .	1893	Vegetole . . . . .
Shipton Green, New York . . . . .	1894	Tropical . . . . .
Parker, Webb & Co., Detroit . . . . .	1893	Golden Shortening . . . . .
Anglo-American Provision Co., Chicago.	1893	La Palma (Palm tree) . . . . .
Nelson Morris & Co., Chicago . . . . .	1894	Supreme Shortening . . . . .
Fowler Bros. Ltd., New York and Chicago	1895	Acme . . . . .
Swift & Co., Chicago . . . . .	1915	Crescent (Crescent and star) . . .
Loders & Nucoline, Ltd., Silvertown, England . . . . .	1903	Nucoline . . . . .
George Fowler, Son & Co., Ltd., Kansas City, Kan. . . . .	1894	Three Stars (Three stars) . . . . .
Filbert Manufacturing Co., Baltimore . .	1895	Oxola . . . . .
Oxola Manufacturing Co., Baltimore . . .	1914	Oxola . . . . .
Minnesota Packing and Provision Co., South St. Paul, Minn. . . . .	1895	Crystal . . . . .

\* Used by predecessor since December 1894 and registered in 1895 under No. 26,141.

COOKING FATS (*Cont.*)

Case begun	Character of article	Number
ib. 1892	Lard and its substitutes.....	21,441
ib. 1892	Compound of suet or beef fat and cottonseed oil for cooking purposes .....	20,944
ib. 1892	Lard substitute .....	64,962
ib. 1892	Oleaginous food substances.....	23,697
iar. 1892	Lard and its substitutes.....	21,438
iar. 1892	Lard and its substitutes.....	21,439
ily 1892	Lard and its substitutes.....	21,603
ily 1892	Lard and its substitutes.....	21,675
ily 1892	Lard and its substitutes.....	21,980
iug. 1892	Substitute for lard.....	21,769
iug. 1892	Substitute for lard.....	55,186
ict. 1892	Lard and its substitutes.....	22,211
ict. 1892	Lard substitute and lard compound.....	42,548
in. 1893	Substitute for lard.....	22,537
ieb. 1893	Substitute for lard.....	22,797
iar. 1893	Lard and its substitutes.....	22,911
iar. 1893	Substitute for lard and butter.....	23,291
iy. 1893	Canned meats, lard, and substitutes for lard.....	25,514
iy. 1893	Compound used as a substitute for butter and lard.....	23,432
iy. 1893	Substitute for lard.....	23,527
iec. 1893	Lard substitute .....	24,253
iar. 1894	Lard compounds .....	25,773
ipr. 1894	Compound of cottonseed oil and oleostearin.....	105,926
iy. 1894	Fats and mixtures thereof used as foods or as ingredients in food .....	40,705
iug. 1894	Lard and compound lard.....	25,324
iec. 1894	Shortenings .....	26,141
iec. 1894	Shortening compound of refined beef fat and cottonseed oil	100,146*
ian. 1895	Lard compounds .....	26,087

## TRADE-MARKS OF COMPOUNDED

For whom registered	Year	Title (and/or picture)
Schwarzschild & Sulzberger Co., Kansas City, Kan., Chicago, and New York...	1907	S&S .....
Braun & Fitts, Chicago.....	1895	Fruit of the Meadow.....
Georgia Mills and Elevator Co., Macon, Ga. ....	1895	Plantene .....
McCaw Manufacturing Co., Macon, Ga....	1905	Plantene .....
Armstrong Packing Co., Dallas, Tex. ....	1912	Oak Leaf .....
Procter & Gamble Co., Cincinnati.....	1921	Flakewhite .....
Swift & Co., Chicago.....	1896	Cremol .....
N. K. Fairbank Co., Union Township, N.J., and Chicago, Ill. ....	1916	Los Tres Amigos (Three birds)..
Procter & Gamble Co., Cincinnati.....	1922	Invincible .....
India Refining Co.,* Philadelphia.....	1908	Ko-Nut .....
Southern Cotton Oil Co., Jersey City and Bayonne, N.J.; New York, N.Y.; Gretna, La.; Savannah, Ga.; and Chicago, Ill. ....	1921	Wesson .....
Christr. Thomas & Bros., Ltd., Bristol, England .....	1900	Coconea .....
Christr. Thomas & Bros., Ltd., Bristol, England .....	1900	Christholine .....
Galban & Co., Inc., New York and Havana .....	1912	Competencia .....
Wesson Co., Jersey City, N.J., and Savannah, Ga. ....	1903	Palmatina .....
Wesson Co., Jersey City and Savannah..	1903	Paimatina (Palm tree).....
Wesson Co., Jersey City.....	1908	Palmatina .....
Wesson Co., Jersey City.....	1908	Palmatina (Palm tree).....
W. R. Grace & Co., New York.....	1915	El Ciervo .....
Cudahy Packing Co., Chicago, Ill., and S. Omaha, Neb. ....	1901	Reina .....
Southern Cotton Oil Co., Jersey City, N.J., Savannah, Ga., Gretna, La.....	1902	Snowdrift .....
Southern Cotton Oil Co., Jersey City and Bayonne, N.J.; New York, N.Y.; Gretna, La.; Savannah, Ga.; and Chicago, Ill. ....	1919	Snowdrift .....
Southern Cotton Oil Co., Jersey City and Bayonne, N.J.; New York, N.Y.; Gretna, La.; Savannah, Ga.; and Chicago, Ill. ....	1920	Snowdrift .....
Getz Bros. & Co., Inc., San Francisco....	1912	Triumph .....
Swift & Co., Chicago.....	1906	La Vencedora .....
Armstrong Packing Co., Dallas, Tex. ....	1910	Bob White .....
Cudahy Packing Co., Chicago, Ill., and S. Omaha, Neb. ....	1901	Princesa .....

\* Renewed by Palmolive Peet Co.



COOKING FATS (*Cont.*)

Use begun	Character of article	Number
Feb. 1895	Certain named meats, lard, lard substitutes, and unctuous food substances .....	61,045
Apr. 1895	Prepared fatty oleaginous food substances.....	27,352
Sept. 1895	Substitute for lard.....	27,186
Sept. 1895	Substitute for lard.....	47,524
Jan. 1896	Compound of pure lard, edible fat, and cottonseed oil....	87,404
Apr. 1896	Cooking fats .....	147,672
July 1896	Oleaginous food substances.....	28,781
... 1897	Lard substitute consisting of cottonseed oil and beef fat..	112,045
Apr. 1898	Cooking fats .....	156,736
June 1899	Certain vegetable fat or oil.....	69,456
June 1899	Prepared fatty, oleaginous, or unctuous food substance....	145,013
Nov. 1899	Edible fats .....	34,193
Nov. 1899	Edible fats .....	34,194
... 1899	Imitation lard .....	84,826
Jan. 1900	Prepared fatty, oleaginous, or unctuous food substances...	40,004
Jan. 1900	Prepared fatty, oleaginous, or unctuous food substances....	40,210
Jan. 1900	Mixture containing vegetable oil and animal fat.....	69,719
Jan. 1900	Mixture containing vegetable oil and animal fat.....	69,720
June 1900	Lard substitute composed of cottonseed oil and beef fat....	104,509
Oct. 1900	Lard, lard compounds, and lard substitutes.....	36,567
Nov. 1900	Lard compound .....	38,065
Nov. 1900	Cottonseed oil shortening compound composed of fatty, oleaginous, or unctuous food substances... ..	127,143
Nov. 1900	Vegetable shortening compound composed of fatty, oleaginous, or unctuous food substances.....	136,636
Dec. 1900	Oleaginous cooking compound.....	87,203
... 1900	Lard and lard compounds.....	56,976
Jan. 1901	Compound of oleostearin and cottonseed oil.....	76,267
Mar. 1901	Lard, lard compounds, and lard substitutes.....	36,568

## TRADE-MARKS OF COMPOUNDED

For whom registered	Year	Title (and/or picture)
Streett & Corkran Co., Baltimore.....	1907	Diamond .....
Hauser Packing Co., Los Angeles.....	1916	Violet .....
Southern Cotton Oil Co., Jersey City, N.J., Savannah, Ga., Gretna, La.....	1902	Snowdrop .....
Armour & Co., Chicago, Ill. ....	1902	White Cloud (Head of Indian)..
Cudahy Packing Co., Chicago, Ill., and S. Omaha, Neb. ....	1904	Infante .....
Swift & Co., Chicago.....	1902	Jewel .....
Southern Cotton Oil Co., Jersey City, N.J., Savannah, Ga., Gretna, La. ....	1903	La Veronica .....
Schwarzschild & Sulzberger Co., Kansas City, Kan., Chicago, Ill., and New York, N.Y. ....	1903	Silver Star (Two stars).....
Cudahy Packing Co., Chicago, Ill., and S. Omaha, Neb. ....	1906	White Ribbon .....
Cudahy Packing Co., Chicago, Ill., and Omaha, Neb. ....	1902	White Ribbon .....
Sherman Oil & Cotton Co., Sherman, Tex. ....	1903	Jack Frost .....
W. S. Forbes & Co., Richmond, Va.....	1916	Ladina .....
Sherman Oil & Cotton Co., Sherman, Tex. ....	1903	Dixie .....
Schwarzschild & Sulzberger Co., Kansas City, Kan., Chicago, and New York...	1903	Crispene .....
Schwarzschild & Sulzberger Co., Kansas City, Kan., Chicago, and New York...	1907	Crispene .....
Procter & Gamble Co., Cincinnati.....	1917	Crispene .....
Western Meat Co., San Francisco.....	1929	Arrow .....
Cudahy Bros. Co., Cudahy, Wis. ....	1905	Peacock (Peacock) .....
Cudahy Bros. Co., Cudahy, Wis. ....	1904	Peacock (Peacock) .....
Kingan & Co., Ltd., Belfast, Ireland, and Indianapolis, Ind. ....	1918	Sea Foam (Sea foam).....
N. K. Fairbank Co., Chicago.....	1908	(Snowcapped mountains) .....
Cudahy Bros. Co., Cudahy, Wis. ....	1905	Snowball .....
Cudahy Bros. Co., Cudahy, Wis. ....	1904	Snowball .....
Cudahy Bros. Co., Cudahy, Wis. ....	1904	White Champion .....
Cudahy Bros. Co., Cudahy, Wis. ....	1905	White Champion .....
Southern Cotton Oil Co., Jersey City, N.J., Savannah, Ga., and Gretna, La. ...	1908	Neutralina .....
Sherman Cotton Oil Provision Co., Sher- man, Tex. ....	1908	Dixie .....
Sherman Cotton Oil Provision Co., Sher- man, Tex. ....	1908	Jack Frost .....
Charles S. Hardy, San Diego, Calif. ....	1904	Cotoe .....
Geo. P. Braun Co., Chicago.....	1917	Cream-Flake .....
Swift & Co., Chicago.....	1906	(Conventionalized cut jewel with radiating rays) .....

\* The month is uncertain.

COOKING FATS (Cont.)

Year begun	Character of article	Number
... 1901	Substitute for lard.....	65,075
Jan. 1902	Shortening compound .....	110,045
Jan. 1902	Lard compound .....	38,066
Feb. 1902	Lard and lard compounds.....	38,039
Mar. 1902	Lard and lard compounds.....	42,304
Apr. 1902	Certain named packing-house products.....	38,538
Apr. 1902	Lard compound .....	40,982
Aug. 1902	Lard substitute .....	40,491
Sept. 1902	Lard and lard compound.....	49,170
Sept. 1902	Lard and lard compounds.....	39,338
Dec. 1902	Cooking fats and lard.....	39,824
... 1902	Compound lard .....	112,497
Jan. 1903	Cooking fats and lard.....	39,894
Mar. 1903	Oleaginous or unctuous food substances.....	40,317
Mar. 1903	Oleaginous food substances, viz., lard substitute or lard compound .....	59,931
Mar. 1903	Lard compound of cottonseed oil and hard fat.....	119,372
May 1903	Bacon, picnics, and compound shortening.....	256,016
July 1903	Lard, tallow, lard compounds, and substitutes for lard....	47,631
July 1903	Lard, tallow, lard compounds, and substitutes for lard....	41,897
Sept. 1903	Compound, a substitute for lard.....	120,266
Nov. 1903	Edible fats and oils.....	69,362
Dec. 1903	Lard, lard compounds, tallow, and substitutes for lard....	47,772
Dec. 1903	Lard, tallow, lard compounds, and substitutes for lard....	41,870
Dec. 1903	Lard, tallow, lard compounds, and substitutes for lard....	41,871
Dec.* 1903	Lard, tallow, lard compounds, and substitutes for lard....	47,217
... 1903	Vegetable oil and animal fat.....	67,062
... 1903	Lard substitutes .....	68,154
... 1903	Lard substitutes .....	68,155
May 1904	Certain named substitute for lard.....	43,110
Dec. 1904	Lard substitute .....	117,514
Mar. 1905	Lard and lard compounds.....	51,051

## TRADE-MARKS OF COMPOUNDED

For whom registered	Year	Title (and/or picture)
Ammon & Person, Jersey City, N.J. ....	1906	Ba-ko .....
High Grade Lard Co., Baltimore.....	1908	Shortine .....
E. D. Cook & Co., Binghamton, N.Y. ....	1907	Cream Dove (Dove).....
India Refining Co., Philadelphia.....	1908	Inreco .....
India Refining Co., Philadelphia.....	1908	Parasub .....
Cream Dove Mfg. Co., Inc., Binghamton, N.Y. ....	1928	Cream Dove (Dove).....
N. K. Fairbank Co., Chicago.....	1919	El Tigre (Tiger's head in circle)
T. M. Sinclair & Co., Ltd., Cedar Rapids, Ia. ....	1907	Cottofat .....
George & Co., Ltd., Baltimore.....	1914	Old Plantation .....
Miner, Read & Garrette, New Haven, Conn. ....	1907	Cotsok .....
Schwarzschild & Sulzberger Co., Kansas City, Kan., Chicago, and New York...	1907	Advance .....
Southern Cotton Oil Co., Jersey City and Bayonne, N.J., New York, N.Y., Savannah, Ga., Gretna, La., and Chicago, Ill. ....	1923	Carnaval .....
Geo. P. Braun Co., Chicago.....	1917	Liona .....
Sherman Cotton Oil Provision Co., Sherman, Tex. ....	1908	Blue Jay .....
T. M. Sinclair & Co., Ltd., Cedar Rapids, Ia. ....	1907	Frosto .....
Charles H. Brunier, Baltimore.....	1914	Extra Family Beauty.....
Blayne-Murphy Co., Denver, Colo. ....	1925	Silver Seal .....
Nuckolls Packing Co., Pueblo, Colo. ...	1928	Little Chief .....
Halstead & Co., Jersey City, N.J. ....	1910	Vesuvio .....
John H. Filbert, Baltimore.....	1908	Filburta .....
Interstate Cotton Oil Refining Co., Sherman, Tex. ....	1918	Dixie .....
T. M. Sinclair & Co., Ltd., Cedar Rapids, Ia. ....	1909	Tryit .....
Texas Refining Co., Greenville, Tex. ....	1914	(Certain words in circular drawing of man knocking out a pig)
Southern Cotton Oil Co., Jersey City, N.J., New York, N.Y., Savannah, Ga., and Gretna, La. ....	1908	Snowdrift .....
H. T. Cottam & Co., Ltd., New Orleans..	1910	El Toro .....
Western Meat Co., South San Francisco, Calif. ....	1925	Califene .....
Columbia Cotton Oil and Provision Corp., Relec, Va. ....	1911	Pi Crus (Chef and pie).....
Magnolia Cotton Oil Co., Houston, Tex.	1911	Crusto .....

\* The date is uncertain.

## COOKING FATS (Cont.)

Use begun	Character of article	Number
May 1905*	Shortening for pastry.....	51,010
Dec. 1905	Compound used as substitute for lard.....	67,158
Jan. 1906	Cooking compound made from vegetable oils and beef fats	63,390
Jan. 1906	Vegetable fat or oil compound.....	69,454
Jan. 1906	Certain vegetable fat or oil compound.....	69,455
Jan. 1906	Cooking compounds composed of cottonseed oil, oleostearin, and beef fats .....	250,101
Mar. 1906	Cooking compound containing cottonseed oil and oleostearin	85,905
Oct. 1906	Lard compound .....	60,711
Oct. 1906	Lard substitute .....	95,538
Nov. 1906	Substitute for lard (cottonseed oil and oleostearin).....	62,042
Dec. 1906	Lard compound .....	64,928
Dec. 1906	Lard substitute and shortening composed of fatty, oleagi- nous, or unctuous food substances.....	169,222
Jan. 1907	Lard compound .....	117,411
May 1907	Lard substitutes .....	68,156
July 1907	Lard compound .....	66,312
Oct. 1907	Compound of cottonseed oil, oleostearin, and pure lard....	95,885
Nov. 1907	Shortening .....	200,863
... 1907	Compound lard substitute composed of refined vegetable oil and tallow .....	238,179
... 1907*	Compound composed of beef fat and cottonseed oil.....	76,589
Jan. 1908	Compound of refined beef fat and cottonseed oil.....	70,787
Mar. 1908	Cottonseed-oil shortening .....	121,449
Sept. 1908	Compound of lard, beef fat, and cottonseed oil.....	73,119
Oct. 1908	Cooking oil containing cottonseed oil and beef stearin.....	96,466
Nov. 1908	Vegetable oil and animal fat.....	67,061
Jan. 1909	Certain foods (a compound of cottonseed oil and stearin)..	78,230
June 1909	Cottonseed and oleostearin shortening.....	195,460
Oct. 1909	Oleaginous compound for pastry shortening.....	82,762
Oct. 1909	Cottonseed oil and an oleaginous compound for cooking purposes .....	82,809

## TRADE-MARKS OF COMPOUNDED

For whom registered	Year	Title (and/or picture)
Columbia Cotton Oil and Provision Corp., Relee, Va. ....	1910	Blue Bell .....
N. K. Fairbank Co., Chicago.....	1914	Snowlene .....
Armour & Co., Chicago.....	1911	La Caravela (Sailboat).....
Southern Cotton Oil Co., Jersey City and Bayonne, N.J., New York, N.Y., Gretna, La., Savannah, Ga., Chicago, Ill. ....	1920	Kneedit .....
Columbia Cotton Oil and Provision Corp., Relee, Va. ....	1911	Velvet .....
Natchez Packing Co., Natchez, Miss. ....	1911	White Mountain .....
Procter & Gamble Co., Cincinnati.....	1917	Crisco .....
Southern Cotton Oil Co., Jersey City and Bayonne, N.J., New York, N.Y., Gretna, La., Savannah, Ga., Chicago, Ill. ....	1920	Scoco .....
Jaburg Brothers, New York.....	1916	J.B. Special .....
Hammond Standish & Co., Detroit.....	1913	Oleard .....
J. B. Camors & Co., New Orleans.....	1913	El Gallito .....
Sears, Roebuck & Co., Chicago.....	1913	White Cliff .....
Interstate Cotton Oil Refining Co., Sherman, Tex. ....	1914	(Head of a middle-aged woman)
Capitol Refining Co., Inc., S. Washington, Va. ....	1915	White Dome .....
Berlin Mills Co., Berlin.....	1915	Kream Krisp (Kettle over fire)..
Interstate Cotton Oil Refining Co., Sherman, Tex. ....	1917	(Middle-aged woman) .....
Interstate Cotton Oil Refining Co., Sherman, Tex. ....	1920	Mrs. Tucker's (Woman).....
Interstate Cotton Oil Refining Co., Sherman, Tex. ....	1914	Log Cabin (Log cabin).....
Interstate Cotton Oil Refining Co., Sherman, Tex. ....	1917	Log Cabin (Log cabin).....
Interstate Cotton Oil Refining Co., Sherman, Tex. ....	1914	Jack Rabbit (Jack rabbit).....
Interstate Cotton Oil Refining Co., Sherman, Tex. ....	1917	Jack Rabbit (Jack rabbit).....
Corkran Hill & Co., Roland Park and Baltimore, Md. ....	1915	Terrapin (Terrapin) .....
Cudaby Packing Co., Chicago.....	1923	Flako .....
Atlanta Refining and Manufacturing Co., Atlanta, Ga. ....	1915	Cotton Bloom (Cotton bloom)..
Southern Lard and Provision Co., Norfolk, Va. ....	1915	Old Glory .....
Sauté Products Corporation, New York.	1915	Sawtay .....

COOKING FATS (*Cont.*)

Use begun	Character of article	Number
Jan. 1910	Compound of cottonseed oil, beef fat, and oleostearin.....	80,345
Jan. 1910	Cooking compound containing cottonseed oil and oleostearin	101,276
June 1910	Compound of cottonseed oil and oleostearin used as a substitute for lard.....	83,126
Oct. 1910	Cottonseed oil shortening composed of fatty, oleaginous, or unctuous food substances.....	129,222
Nov. 1910	Oleaginous compound for cooking purposes.....	82,138
Jan. 1911	Lard compound consisting of refined cottonseed oil and oleostearin .....	82,165
June 1911	Cooking fat .....	117,704
Nov. 1911	Shortening composed of fatty, oleaginous, or unctuous food substances .....	136,635
Dec. 1912	Bakers' shortening .....	109,322
Feb. 1913	Lard substitute (cottonseed oil, vegetable coloring, and beef fat) .....	92,978
Feb. 1913	Cooking compound composed of cottonseed oil, cottonseed oil stearin, and oleostearin.....	93,229
Feb. 1913	Substitute for lard.....	94,401
Aug. 1913	Lard substitute composed of cottonseed oil and oleostearin	96,419
Aug. 1913	Combination of animal fats used for shortening.....	102,557
Aug. 1913	Vegetable fats .....	105,415
Aug. 1913	Lard substitute composed of cottonseed oil and oleostearin	117,149
Aug. 1913	Shortening for cooking and oil for cooking or salad purposes .....	133,999
Oct. 1913	Shortening .....	98,531
Oct. 1913	Shortening compound .....	118,783
Feb. 1914	Lard substitute composed of cottonseed oil and oleostearin	98,288
Feb. 1914	Lard substitute composed of cottonseed oil and oleostearin	117,151
Mar. 1914	Cooking grease composed of cottonseed oil and oleostearin	103,610
June 1914	Shortening compound .....	168,335
Sept. 1914	Oleaginous compound for use as pastry shortening.....	103,844
Nov. 1914	Lard substitute .....	104,965
Dec. 1914	Pure butter of coconut for frying, baking, and shortening..	104,549

## TRADE-MARKS OF COMPOUNDED

For whom registered	Year	Title (and/or picture)
D. D. Metcalf, Greenville, Ala. ....	1919	Met (Over calf's head).....
D. D. Metcalf, Greenville, Ala. ....	1920	White Way .....
Kosher Products Co., Chattanooga, Tenn.	1916	Parafat .....
N. K. Fairbank Co., Union Township, N.J., and Chicago, Ill. ....	1916	Hydora .....
Florida Cotton Oil Co., Jacksonville, Fla.	1916	Flaco .....
Armstrong Packing Co., Dallas, Tex. ...	1916	El Pitorre (Picture).....
Armstrong Packing Co., Dallas, Tex. ...	1916	El Pajarito (Picture).....
De Jarnette Refining Co., Montgomery, Ala. ....	1916	King Cotton (Crown).....
Capitol Refining Co., South Washing- ton, Va. ....	1920	Combatiente (Gladiator) .....
Atlanta Refining and Manufacturing Co., Atlanta, Ga. ....	1917	Imperial (Crown) .....
Interstate Cotton Oil Refining Co., Sherman, Tex. ....	1916	White Beauty (Cotton boll)....
Interstate Cotton Oil Refining Co., Sherman, Tex. ....	1917	White Beauty (Cotton boll)....
Dixie Refining Co., Memphis, Tenn. ....	1916	Ole Mammy (Negress) .....
Procter & Gamble Co., Cincinnati.....	1917	Selex .....
Hodgson Oil Refining Co., Athens, Ga. ...	1919	Crystal Flake .....
Interstate Cotton Oil Refining Co., Sherman, Tex. ....	1917	Velvet .....
Ward Baking Co., New York.....	1919	Florolene .....
Armstrong Packing Co., Dallas, Tex. ...	1917	Nutrol .....
Haug & Co., New York.....	1922	High Point .....
Interstate Cotton Oil Refining Co., Sherman, Tex. ....	1925	Southern Queen .....
Interstate Cotton Oil Refining Co., Sherman, Tex. ....	1919	Phoebe Snow .....
Wyatt Bros., Chicago.....	1920	High Point .....
W. S. Forbes & Co., Richmond, Va. ....	1917	Polly-anna .....
W. S. Forbes & Co., Inc., Richmond, Va.	1919	Gladdens the Cook (Parrot)....
Superior Products Co., St. Louis, Mo. ...	1918	Bakrite .....
Magnolia Provision Co., Houston, Tex..	1919	Crustene .....
Armstrong Packing Co., Dallas, Tex. ....	1918	Nutrola .....
Magnolia Provision Co., Houston, Tex....	1918	Pindapan .....
Magnolia Provision Co., Houston, Tex...	1918	Pindapan, the fat of the land (Peanut) .....



COOKING FATS (Cont.)

Use begun	Character of article	Number
.... 1914	Shortening compound .....	128,248
.... 1914	Shortening compound consisting of a mixture of fats and oils of approximately lard-like consistency.....	129,027
Jan. 1915	Cooking fats .....	108,476
Jan. 1915	Cooking compound made from cottonseed oil.....	110,492
Apr. 1915	Lard compound .....	108,637
June 1915	Pure lard and compound lard.....	109,056
June 1915	Pure lard and compound lard.....	109,057
Dec. 1915	Shortening composed of cottonseed oil and cottonseed-oil stearin .....	111,197
Mar. 1916	Shortening or artificial lard in two forms: (1) Cottonseed oil and stearin, and (2) Vegetable oil.....	137,572
May 1916	Oleaginous compound for use as pastry shortening.....	115,923
June 1916	Shortening .....	113,740
June 1916	Shortening .....	117,150
Aug. 1916	Shortening composed of cottonseed oil and cottonseed stearin .....	114,149
Sept. 1916	Cooking fat .....	114,822
Sept. 1916	Shortening composed of cottonseed oil and cottonseed-oil stearin .....	126,013
Oct. 1916	Shortening composed of cottonseed oil and oleostearin....	117,868
Nov. 1916	Shortening composition consisting of flour, cornmeal, corn-starch, or like pulverulent carrier impregnated with hard fat .....	124,907
Jan. 1917	Lard substitute composed of cottonseed oil and oleostearin	118,484
Jan. 1917	Hydrogenated vegetable oil.....	154,566
Mar. 1917	Shortening made from cottonseed oil.....	205,183
Apr. 1917	Shortening composed of cottonseed oil and beef stearin....	128,244
May 1917	Cottonseed stearin .....	129,106
June 1917	Shortening composed of cottonseed oil and cottonseed stearin .....	119,955
June 1917	Vegetable shortening .....	125,639
Oct. 1917	Baking compound . . . having as its base peanut oil and coconut oil .....	121,733
Nov. 1917	Oleaginous compound, a substitute for lard.....	126,179
Dec. 1917	Compound of peanut oil and oleostearin.....	123,966
Feb. 1918	An oleaginous compound produced from peanuts for cooking purposes .....	122,803
Feb. 1918	An oleaginous compound produced from peanuts for cooking purposes .....	123,617

## TRADE-MARKS OF COMPOUNDED

For whom registered	Year	Title (and/or picture)
Magnolia Provision Co., Houston, Tex...	1918	The Fat of the Land.....
N. K. Fairbank Co., Union Township, N.J., and Chicago, Ill. ....	1919	Fairco .....
Morris & Co., Chicago.....	1918	Domino (Border of dominoes)..
Wyatt Bros., Chicago.....	1922	High Melt .....
Dixie Refining Co., Memphis, Tenn. ....	1920	White Cross .....
King R. Graham, Inc., New York.....	1919	Kubo .....
Dixie Refining Co., Memphis, Tenn. ....	1919	Kotawhite .....
F. E. Patrick-Young Co., Richmond, Va.	1922	Snowcream .....
John Morrell & Co., Ottumwa, Ia. ....	1919	Allrite (Two signals down, all within a heart).....
Swift & Co., Chicago .....	1930	Vream .....
Edible Oil Co., Inc., Louisville, Ky. ....	1919	Needo .....
Procter & Gamble Co., Cincinnati.....	1920	Nutex .....
Chapman & Smith Co., Chicago.....	1921	Bakeree .....
Hannah E. Kriel, Baltimore.....	1919	Cosedo .....
Wisconsin Butterine Co., Milwaukee...	1919	Nudoo .....
International Vegetable Oil Co., Atlanta	1920	Ivoco .....
W. S. Forbes & Co., Inc., Richmond, Va.	1922	Swan (Swan) .....
Aspegren & Co., New York.....	1920	Fluffo .....
Abraham Cohen, Baltimore.....	1921	Star Light .....
Southern Cotton Oil Co., Jersey City and Bayonne, N.J., New York, N.Y., Gretna, La., Savannah, Ga., Chicago, Ill. ....	1921	Cocobianca .....
Hodgson Oil Refining Co., Athens, Ga. ..	1920	Gem White .....
Philippine Mfg. Co., Manila, P.I. ....	1925	Purico (In oval with sunset and sea background) .....
Wm. Schluderberg-T. J. Kurdle Co., Baltimore .....	1928	Southern Rose .....
Lever Bros. Co., Cambridge, Mass. ....	1920	Cooket .....
Boyd Packing Co., Richmond, Va. ....	1925	Cremo .....
Lever Bros. Co., Cambridge, Mass. ....	1921	Holsum (Spoon and shortening)
Kaufman Packing Co., Inc., Baltimore..	1921	Blue Seal .....
Dry Oil Products, Ltd., London, England, New York and Trout Creek, N.Y. ....	1921	Dacko .....

COOKING FATS (Cont.)

Use begun	Character of article	Number
Feb. 1918	An oleaginous compound produced from peanuts for cooking purposes .....	123,618
Feb. 1918	Shortening compound containing cottonseed oil and oleostearin .....	126,274
Apr. 1918	Vegetable shortening .....	128,260
May 1918	Cottonseed-oil stearin .....	156,973
June 1918	Lard compound of cottonseed oil and cotton-oil stearin....	130,174
June 1918	Margarin cooking compound .....	125,644
July 1918	Vegetable shortening composed of cottonseed oil and hardened cottonseed oil .....	124,233
July 1918	Lard substitute composed of cottonseed oil and oleo beef stearin .....	154,803
Oct. 1918	Vegetable shortening .....	127,641
Oct. 1918	Shortening made of vegetable oil.....	278,830
Nov. 1918	Vegetable shortening .....	126,271
Dec. 1918	Cooking fat, namely lard substitute made from cottonseed oil .....	128,488
Feb. 1919	Shortening compound .....	147,081
Mar. 1919	Lard substitute composed of cottonseed oil and other ingredients .....	126,942
Mar. 1919	Lard substitute . . . . peanut oil, coconut oil, and beef stearin .....	127,557
Mar. 1919	Certain named foods (among others, lard compound of cottonseed oil, oleostearin, and cottonseed-oil stearin)....	136,479
Mar. 1919	Lard substitute or compound composed of cottonseed oil and oleostearin .....	154,547
July 1919	Shortening and frying medium.....	131,026
Aug. 1919	Cooking and shortening compound.....	146,201
Oct. 1919	Edible oil compound of fatty, oleaginous, or unctuous food substances .....	138,708
Oct. 1919	Lard substitute .....	133,261
.... 1919	Vegetable lard compound.....	204,840
Jan. 1920	Packers' products (lards and lard compounds made from cottonseed oil and other oils).....	238,495
Mar. 1920	Cooking compound of oils and hydrogenated oils.....	134,252
Mar. 1920	Lard compound composed of vegetable oil, oleostearin, pure lard, and cheese .....	194,794
Apr. 1920	Cooking compound comprising oils and hydrogenated oils..	141,161
May 1920	Lard substitute containing cottonseed oil.....	138,651
Sept. 1920	Dry pulverulent mixtures containing fats and oils for a shortening in cooking.....	146,082

## TRADE-MARKS OF COMPOUNDED

For whom registered	Year	Title (and/or picture)
Oliver Wynne, Norfolk, Va. ....	1921	Wynne's Winner .....
Oliver Wynne, Norfolk, Va. ....	1921	Pride of Norfolk .....
South Texas Cotton Oil Co., Houston, Tex. ....	1925	Pancrust .....
Eney Shortening Co., Chicago.....	1921	En-Co .....
Eney Shortening Co., Chicago.....	1921	Baker Maid (Baker made).....
Oliver Wynne, Norfolk, Va. ....	1921	Faultless .....
Globe Cotton Oil Mills, Los Angeles....	1921	"A1" Brisq .....
Nucoa Butter Co., New York.....	1921	Nuflake, Pure Vegetable Com- pound (In circle with head)..
Nucoa Butter Co., New York.....	1925	Golden Flake—Pure Vegetable Shortening (Chef's head)....
Oliver Wynne, Norfolk, Va. ....	1922	Wynne's Wynner .....
Oliver Wynne, Norfolk, Va. ....	1922	Armco Special .....
Hedwig R. Elish, Philadelphia.....	1921	Miskca .....
Procter & Gamble Co., Cincinnati.....	1921	Fritina .....
Wynne Lard & Provision Co., Inc., Norfolk, Va. ....	1923	Albemarle Brand .....
Wynne Lard & Provision Co., Inc., Norfolk, Va. ....	1923	A No. 1 Brand .....
Wynne Lard & Provision Co., Inc., Norfolk, Va. ....	1924	Great Southern .....
Wynne Lard & Provision Co., Inc., Norfolk, Va. ....	1924	Old Mill (Windmill).....
Wynne Lard & Provision Co., Inc., Norfolk, Va. ....	1924	Ermco Brand .....
Wynne Lard & Provision Co., Inc., Norfolk, Va. ....	1924	Silver Bell .....
Procter & Gamble Co., Cincinnati.....	1922	Savora .....
Jefferson Co., Inc., Richmond, Va. ....	1923	Snow Queen .....
N. K. Fairbank Co., Union Township, N.J., and Chicago, Ill. ....	1923	Cream of Vegetable Oil.....
Central Food Products Co., Chicago....	1924	Light House .....
Southern Cotton Oil Co., Jersey City, N.J., New York, N.Y., New Orleans, La., Savannah, Ga., Chicago, Ill. ....	1923	MFB, a special vegetable fat (In circle) .....
David A. Blanton, St. Louis, Mo. ....	1922	Excello .....
Swift & Co., Chicago, Ill. ....	1923	La Princessa (Woman).....
Wynne Lard & Provision Co., Inc., Norfolk, Va. ....	1923	Pure Gold Brand.....

COOKING FATS (*Cont.*)

Use begun	Character of article	Number
Sept. 1920	Lard substitute composed of cottonseed oil and other ingredients .....	145,211
Sept. 1920	Lard substitute composed of cottonseed oil and other ingredients .....	145,213
Sept. 1920	Vegetable shortening .....	206,198
Oct. 1920	Shortening .....	142,515
Oct. 1920	Shortening .....	142,995
Nov. 1920	Lard substitute composed of cottonseed oil and other ingredients .....	148,773
Nov. 1920	Vegetable compounds for shortening and cooking purposes .....	144,776
Dec. 1920	Vegetable shortening .....	146,827
Dec. 1920	Vegetable shortening .....	200,886
Dec. 1920	Lard substitute composed of cottonseed oil and other ingredients .....	154,746
Jan. 1921	Lard substitute composed of cottonseed oil and other ingredients .....	152,011
Jan. 1921	Lard substitutes .....	149,373
Feb. 1921	Cooking fats .....	147,810
Mar. 1921	Lard substitute .....	176,804
Mar. 1921	Lard substitute made from cottonseed oil and oleo stearin .....	176,940
Mar. 1921	Lard substitute .....	180,296
Mar. 1921	Lard substitute .....	180,297
Mar. 1921	Lard substitute .....	180,298
Mar. 1921	Lard substitute .....	180,299
Mar. 1921	Cooking fats .....	150,524
June 1921	Vegetable shortening, lard substitute.....	170,221
June 1921	Vegetable shortening compound.....	172,051
July 1921	Shortening compound composed of beef fat and corn oil....	190,686
Aug. 1921	Shortening or fat composed of fatty, oleaginous, or unctuous food substances .....	167,017
Sept. 1921	Shortening .....	156,568
Nov. 1921	Lard substitutes .....	167,712
Nov. 1921	Lard substitute .....	176,807

## TRADE-MARKS OF COMPOUNDED

For whom registered	Year	Title (and/or picture)
Higgins Manufacturing Co., Providence, R.I. ....	1924	Higgins Nut Product.....
Higgins Manufacturing Co., Providence, R.I. ....	1924	(Two-lined triangle) .....
Van Camp Packing Co., Indianapolis, Ind. ....	1926	Van-Co .....
Aspegren & Co., Inc., New York.....	1925	Crackerjack .....
Brown Orcola Co., Chicago.....	1923	Ocro .....
John Morrell & Co., Ottumwa, Iowa....	1926	Airship (Airship) .....
Associated Meat Co., Los Angeles.....	1929	Laverne .....
Cooknut Corporation, Baltimore.....	1923	Kukul .....
Cooknut Corporation, Baltimore.....	1923	Bakwell .....
Société de Stéarinerie et Savonnerie de Lyon, Lyon, France.....	1924	Chocolite .....
American Cotton Oil Co., New York.....	1924	Sierra (Mountain peaks).....
Alberto Valez Co., New Orleans.....	1924	Selvaco .....
Aspegren & Co., Inc., New York.....	1925	Superla .....
Hauser Packing Co., Los Angeles, Calif.	1925	Kreamola .....
Anaheim Beef Co., Anaheim, Calif. ....	1925	Krispy Krust .....
I. Rokeach & Sons, Inc., Brooklyn, N.Y.	1925	Nyafat .....
I. Rokeach & Sons, Inc., Brooklyn, N.Y.	1925	(Hebrew characters meaning neither milk nor meat).....
I. Rokeach & Sons, Inc., Brooklyn, N.Y.	1928	(Hebrew characters meaning Rokeach's Nyafat Kosher)....
Baltimore Butterine Co., Baltimore, Md.	1925	Nu-lne .....
Chiknut Corporation, Brooklyn, N.Y. ...	1925	Chiknut .....
Paul A. Sherikjian, Holyoke, Mass. ....	1926	Golden Eagle Rico (Eagle)....
Aspegren & Co., Inc., New York.....	1925	Quix .....
Best Foods Inc., New York.....	1925	Best Foods Shortening.....
David A. Blanton for The Blanton Co., St. Louis, Mo. ....	1925	Blanton's Bond .....
Danish Packing Co., Ltd., Providence, R.I. ....	1927	Penobscot .....
Portsmouth Cotton Oil Refining Corp., Portsmouth, Va. ....	1926	Primex .....
K & F Vegetable Products Co., Phila- delphia .....	1927	Shekedol .....
Armstrong Packing Co., Dallas, Tex. ....	1926	Cooklite .....
Virginia Lard and Provision Co., Inc., Norfolk and Portsmouth, Va. ....	1928	Sunnyland .....

\* Use begun not less than one year before date of registration.

COOKING FATS (Cont.)

Use begun	Character of article	Number
Jan. 1922	Solid cooking or shortening compound of vegetable or nut oil .....	190,635
Jan. 1922	Solid cooking or shortening compound of vegetable or nut oil .....	191,756
Jan. 1922	Vegetable shortening .....	212,292
Feb. 1922	Lard substitutes in the nature of solid cooking fat for shortening and frying mediums.....	207,111
Apr. 1922	Shortening: a greasy, pasty substance used in mixing dough for baking and cooking.....	170,580
June 1922	Lard, shortening composed of vegetable oils and animal fats	212,191
July 1922	Vegetable shortening .....	264,153
Oct. 1922	Vegetable lard substitute.....	171,127
Oct. 1922	Vegetable lard substitute.....	173,774
Feb. 1923	Artificial lard and cooking oil prepared by hydrogenation..	186,085
Mar. 1923	Hard fats and cottonseed oils.....	179,043
Aug. 1923	Vegetable shortening .....	179,056
Oct. 1923	Lard substitutes for shortening and frying mediums.....	199,817
Jan. 1924	Lard substitutes, viz., vegetable shortening compounds.....	204,030
Mar. 1924	Shortening made of vegetable and animal oils and fats....	198,954
May 1924	Vegetable fat .....	203,870
.... 1924*	Vegetable fat including solidified vegetable fat.....	206,851
May 1924	Vegetable fat .....	246,328
Jan. 1925	Compound for shortening, baking, and cooking composed in part of coconut oil and a small amount of peanut oil...	199,535
Jan. 1925	Pure vegetable fat for cooking.....	203,244
Feb. 1925	Solid cooking fat and shortening composed of animal fats	211,903
Mar. 1925	Vegetable shortening .....	202,692
May 1925	Shortening .....	207,025
June 1925	Prepared shortening, oleomargarine, and salad oil.....	206,360
Aug. 1925	Solid cooking or shortening compound of vegetable oil.....	223,496
May 1926	Vegetable shortening .....	218,925
July 1926	Pure vegetable fat for baking, frying, cooking, and shortening .....	224,894
Aug. 1925	Cottonseed oil shortening.....	216,783
Sept. 1926	Lard substitute composed of vegetable fats, oleostearin, beef fat, pure lard .....	244,599

## 304 AMERICAN VEGETABLE-SHORTENING INDUSTRY

### TRADE-MARKS OF COMPOUNDED

For whom registered	Year	Title (and/or picture)
E. F. Drew & Co., Inc., New York.....	1929	Xtra Fine .....
Musher and Co., Washington, D.C. ....	1928	Shortnaise .....
Vegetable Products, Inc., Newark, N.J. ...	1928	O-Veg .....
Vejola Co., Inc., Philadelphia, Pa. ....	1928	Vejola .....
Arizona Packing Co., Phoenix.....	1929	Fenix .....
Wilson & Co., Inc., Chicago.....	1928	Hydro-fat .....
Ida Kossoff, New York.....	1928	Kossofat .....
Swift & Co., Chicago.....	1928	Fryene .....
Baltimore Butterine Co., Baltimore.....	1928	Nut-le .....
Texas Vegetable Oil Co., San Antonio, Tex.	1928	Suncrisp .....
Musher and Co., Washington, D.C. ....	1928	Saba, Jose Sabate .....
Swift & Co., Chicago.....	1929	Sanco .....
Edwardsville Creamery Co. (Ill-Mo Nut Margarine Co.), Edwardsville, Ill. ...	1929	Ill-Mo Shortening .....
J. E. Duffner (Southern Products Co.), Oklahoma City, Okla. ....	1929	Preferd-Nut .....
Van Camp Packing Co., Indianapolis, Ind.	1930	Creamtex .....
Gulf & Valley Cotton Oil Co., Inc., New Orleans .....	1930	Blue Plate Shortening (Three plates) .....
Lyto Corporation, New York.....	1929	Lyto .....
Vegetable Oil Products Co., Inc., Los Angeles .....	1930	White Cap (Chef's head).....
Corn Products Refining Co., New York..	1930	Mazola Shortening .....
Globe Grain & Milling Co., Los An- geles, Calif. ....	1930	Bestola .....
Glidden Co., Cleveland, Ohio.....	1930	Durko .....



COOKING FATS (*Concluded*)

Use begun	Character of article	Number
Nov. 1926	Vegetable compound for baking, shortening, and cooking...	255,305
Sept. 1927	Vegetable shortening and vegetable shortening with milk used as a baking compound.....	238,190
Oct. 1927	Vegetable shortening .....	238,715
Nov. 1927	Compound of vegetable fat, . . . principally coconut oil, for frying, baking, and shortening.....	243,981
Nov. 1927	Pure-food vegetable shortening composed of cottonseed oil and other ingredients .....	255,862
Nov. 1927	Hydrostearoleine composed of hydrogenated vegetable oil of lard-like appearance and consistency.....	245,631
Jan. 1928	Vegetable fat .....	246,828
Jan. 1928	Frying fat .....	249,695
Jan. 1928	Lard substitute .....	242,787
May 1928	Vegetable shortening .....	247,150
May 1928	Shortening consisting of blended or mixed hardened oils and fats .....	247,002
Sept. 1928	Vegetable shortening .....	257,763
Nov. 1928	Nut shortening .....	257,742
Dec. 1928	Nut product used as a shortening.....	256,315
Jan. 1929	Vegetable shortening .....	267,425
Feb. 1929	Shortening or cooking fat composed of fatty, oleaginous, or unctuous food substances.....	274,578
Mar. 1929	Vegetable fat in the nature of a lard substitute.....	260,275
May 1929	Vegetable shortening .....	270,159
Aug. 1929	Pure vegetable fat for shortening and frying.....	266,390
Mar. 1930	Oil shortening .....	277,878
June 1930	Pure vegetable shortening.....	278,831

## APPENDIX E

### EXCERPTS FROM UNITED STATES FOOD ADMINISTRATION REPORTS AND REGULATIONS

**"Fats.**—The importance of fats and oils in the diet of the people, together with the scarcity of these products in all the belligerent countries except the United States, caused the Food Administration to lay particular stress upon their conservation. No complete survey of the fat situation had ever been made and under Food Administration control it was necessary to make such a survey with special reference to vegetable oils. With the knowledge of the supply thus obtained, special attention was given to the control of the supply through a control over exports and imports. Through the action of the War Trade Board exports of fats to neutrals were greatly restricted and where allowed were generally limited to the minimum requirements of the importing country.

"The increased production of animal fats through the stimulation of hog production is hereinafter referred to. A few compulsory measures were adopted to prevent waste in the use of fats. Cottonseed crushers and refiners were required by regulation to extract the greatest possible amount of edible oil. The use of shortening in bread was limited by the bakery regulations so that no more than two pounds of vegetable shortening could be used to one barrel of flour. The use of lard in bread was entirely forbidden and the amount of fat used in other bakery products was also limited. These regulations merely insured that no more shortening could be used by bakers than was in fact necessary. As elsewhere noted, careful attention was also given to the conservation of fats through the increased utilization of garbage. The conservation of butter also held an important place in the conservation program.

"The special license regulations referring to vegetable oils will be found in Exhibit Q."<sup>1</sup>

**"Cotton seed and its products.**—Prior to Food Administration control merchandizing methods were conspicuously absent in this industry and at each turnover of seed or oil or meal the speculative feature was more often than not present. It was

<sup>1</sup> *Annual Report of the United States Food Administration for the Year 1918* (Washington, D.C., 1919), 13.

characteristic of both small and large dealers as in no other industry, and in equal measure created the necessity for and the difficulty of control. The Food Administration rules were aimed at hoarding, speculation, and resales. The resulting decrease in speculation, combined with several agreements between the Food Administration and the trades, resulted in a price stabilization for the 1917 crop after the greater part of the crop had been marketed and the costs of the raw materials thereby determined. In addition for the 1917 crop the Food Administration prescribed maximum spreads for cottonseed dealers and crushers and for refiners of oil, and for lard substitute manufacturers. The success of this action is indicated by the fact that although the farmer received approximately \$10 per ton more for his cotton seed than in the previous year the lard substitutes and cottonseed meal were delivered to the consumer at no greater cost than in 1917.

"For the 1918 crop, after conferences with producers, dealers, and refiners, the Food Administration announced a stabilized price for cotton seed of \$70 per ton in car lots f.o.b. cars, based on a yield of 41 gallons per ton of seed, and a price varying above and below this basis according to the quality of the seed measured by its yield in products in the different zones established by the Food Administration. Analyses were made from time to time in the various sections to determine the quality of the seed. This stabilization has proven satisfactory and has met the approval of producers generally.

"Copy of the regulations governing dealers and brokers in cotton seed and its products and manufacturers of oleomargarine and other butter substitutes, etc., is attached as Exhibit Q."<sup>1</sup>

.....  
 "EXHIBIT Q.

"UNITED STATES FOOD ADMINISTRATION—SPECIAL LICENSE REGULATIONS NO. IX.

*"Dealers and Brokers in Cotton Seed and Peanuts and Cotton Ginners—Crushers of Cotton Seed, Peanuts, Soya Beans, Palm Kernels, and Copra—Importers of Peanuts, Peanut Oil, Soya Beans, Soya-Bean Oil, Palm Kernels, Palm-Kernel Oil, Copra, Copra Oil, and Palm Oil, and Dealers and Brokers in Such Imported Products—Refiners of, and Dealers and Brokers in, Cotton-Seed Oil, Peanut Oil, Soya-Bean Oil, Palm-Kernel Oil, and Copra Oil.*

"Effective July 1, 1918.

"This pamphlet contains all special regulations applying to the licensees named above, issued up to and including July 1, 1918. All licensees are also subject to General License Regulations No. 1, issued

<sup>1</sup> *Ibid.*, 20-21.

in a separate pamphlet. General and special regulations of this series supersede all regulations of series B as for the above licensees on July 1, 1918.

"[IX—A—1, 2, 3, 4.]

"SPECIAL LICENSE REGULATIONS NO. IX. . . .

"A. *Special Regulations Governing Licensees Dealing in Cotton Seed and Peanuts, Brokers, in Such Commodities, and Cotton Ginners.* . . .

"RULE 2. *Cotton seed not to be sold for feed or fertilizers.*—The licensee shall not, without the written consent of the United States Food Administrator, sell or use cotton seed for feed or fertilizers. . . .

"[IX—A—1, 2, 3, 4, 5, 6, 7. Dec. 13, 1918. Substitute this for IX—A—1, 2, 3, 4 and IX—A—5, 6, 7 (a).] . . .

"RULE 5. *Cotton seed or peanuts to be sold at not more than reasonable advance over cost.*—The licensee shall sell cotton seed and peanuts at not more than a reasonable advance over the actual cost to him of the particular cotton seed or peanuts sold without regard to the market or replacement value at the time of sale.

"NOTE.—Effective July 1, 1918, and until further notice the United States Food Administration will regard any sale of cotton seed at advances greater than those indicated below over the prices paid for such cotton seed as a violation of the above rule:

"(1) Purchase and sale of cotton seed where the licensee provides the necessary facilities and capital, and bears the expenses and risks incident to the business, \$3 per ton (including delivery and loading of seed into cars at mills.)

"(2) Purchase and sale of cotton seed where the licensee operates as principal but his capital is furnished by another and his expenses and business risks and facilities in whole or in part are borne by another, or where the licensee operates as agent under his own license or under the license of another, \$1.50 for each ton of cotton seed negotiated by him. The remainder of the margin as provided for in paragraph 1 shall be retained by the party or parties furnishing the capital and facilities and assuming the risks and expenses in whole or in part.

"(3) Any margin or commission in excess of 25 cents per ton to a licensee operating either as broker or as dealer who buys and sells cotton seed in car lots will be regarded as unreasonable. Any commission must be paid by either the seller or final buyer out of his spread or margin, and if any dealer in car lots takes a margin for such handling the person who buys from him shall deduct such margin from his own permissible spread or margin unless it has already been deducted by the original seller. . . ."<sup>1</sup>

"[IX—D—1, 2, 3, 4, 5, 6.]

"D. *Special Regulations Governing Refiners of Cottonseed Oil, Peanut Oil, Soya-Bean Oil, Palm-Kernel Oil, Palm Oil, and Copra Oil, and Dealers and Brokers in Such Refined Oil.*

"RULE 1. *Cottonseed oil or peanut oil not to be bought or sold before August 1.*—The licensee shall not buy or sell any cottonseed oil

<sup>1</sup> Annual Report of the United States Food Administration . . . 1918, 155, 156-57.

or peanut oil made or to be made from new-crop cotton seed or peanuts grown in the United States before August 1 of the year when such crops are grown.

"**RULE 2. Refiners must use efficient methods.**—The licensee shall refine in an efficient method to produce the largest yield of [e]dible oil.

"**RULE 3. Contracts must provide for delivery in four months.**—The licensee shall not make any contract for the sale of refined cottonseed oil, refined peanut oil from domestic peanuts, or refined soya-bean oil from domestic soya beans for shipment or delivery more than four months after the making of such contract.

"**RULE 4. Imported oil to be sold only against actual purchases.**—The licensee shall not contract to sell refined oil made from imported commodities except against actual purchases of the imported material.

"**RULE 5. Domestic oil to be sold at reasonable advance over cost.**—The licensee shall sell cottonseed oil, peanut oil manufactured from domestic peanuts, and soya-bean oil manufactured from domestic soya beans, at not more than a reasonable advance over the average cost to licensee of the crude oil from which such oil was refined. The licensee may consider all refining plants operated by or controlled by such licensees as a single unit. Licensees who control mills crushing oleaginous materials must credit all raw materials obtained from such crushing mills at the same price at which they could purchase the same products in the open market at the time of transfer.

"**NOTE.**—The United States Food Administration will indicate from time to time what margins it considers fair.

"**RULE 6. Carload shipments—Minimum weights.**—All carload shipments of cotton seed oil when in tank cars shall be loaded to capacity unless different minimum is authorized by special written permission of the United States Food Administrator."<sup>1</sup>

.....

"**Wholesalers and jobbers of nonperishable food commodities.**—Wholesalers and jobbers and those retailers subject to license were required to apply for a license on or before November 1, 1917, by the proclamation, copy of which was included in our last annual report. One of the basic regulations governing these licenses required them to sell nonperishable food commodities at not more than a reasonable margin over their average invoice cost. The purpose of the rule was to protect the consumer from the inflated market values then existing, due to speculation and the extraordinary conditions prevailing. The Food Administration ruled that a reasonable margin did not exceed the margin customarily enjoyed before the war or an even market under free competitive conditions. The result was the sale of these stocks in most instances at a reasonable profit, but at prices far below the replacement value, and the saving to consumers of sums which in the aggregate were enormous.

<sup>1</sup> *Ibid.*, 163.

"Later, maximum margins were prescribed for the more important nonperishable commodities, such as sugar, flour, ham, bacon, lard, sirups, canned fish and vegetables, and dried fruits. A full list of these commodities and the maximum margins fixed therefor will be found in the special license regulations governing dealers in nonperishable food commodities, attached hereto as Exhibit R.

"The regulations further provided that goods should be kept moving in a direct line from the producer to the consumer. No resales within the same class of trade were allowed except for justifiable causes where some special economic service was performed, and in such cases the parties to the transaction were as a rule held to a joint profit which could not exceed that allowed to a single dealer."<sup>1</sup>

. . . . .

**"EXHIBIT R.**

**"UNITED STATES FOOD ADMINISTRATION SPECIAL LICENSE REGULATIONS NOS. XI AND XII.**

*"Wholesalers, Jobbers, Importers, Retailers, and Brokers of Licensed Nonperishable Food Commodities (Including Official Interpretations).*

**"Effective June 15, 1918.**

"This pamphlet contains all special regulations applying to the above licensees issued up to June 15, 1918. Such licensees are also subject to General Regulations No. I, dated May 3, 1918, which, together with this pamphlet, supersede, as to the above licensees, all regulations of Series B on June 15, 1918. . . . .

**"XI. WHOLESALERS, JOBBERS, IMPORTERS, RETAILERS.**

**"A. Special Rules Applying to Licensed Nonperishable Food Commodities . . . . .**

. . . . .

**"Maximum Margins on Sales by Wholesalers to Retailers. . . . .**

**"[XI—A—5, note, continued (1) (a). Nov. 1, 1918. Substitute this for pages XI—A—5—note, continued (1) and XI—A—5—note, continued (2).] . . . . .**

**"Margins and profits.— . . . .**

**"Sale of lard substitutes:**

**"The following ruling has been made by the law department in reply to an inquiry regarding jobbers' margins on lard substitute:**

**"We beg to acknowledge your letter of September 28 in which you inquire whether it is against the Food Administration regulations for a wholesale jobber to sell lard substitute at less than 24 1/2 cents, tierce basis, which under the stabilized program he purchases at 23**

<sup>1</sup> *Op. cit.*, 24.

cents. The Food Administration regulations provide a maximum margin for the wholesaler of  $1\frac{1}{4}$  to 2 cents per pound over the purchase price delivered at railroad station. A general stabilization program affecting lard substitute and other cottonseed products has now been adopted by the Food Administration for the purpose of eliminating speculation and reducing the margin between the producer of cottonseed and the consumer of lard substitute, and this program has been approved by representatives of all interests concerned who have expressed their desire to cooperate. In view of the circumstances surrounding this program, it will hereafter be considered an unfair practice for any jobber to sell lard substitutes or lard compound in lots of less than 5,000 pounds at a margin over his delivered purchase price less than  $1\frac{1}{4}$  cents (or  $1\frac{1}{2}$  cents where the jobber purchases in lots of 30,000 pounds or more and receives a concession of one-fourth cent).

"It should be pointed out that this action rests solely on the peculiar circumstances surrounding the cottonseed program. The reasons applying to lard substitute do not apply to any other commodity handled by wholesale grocers; and the policy of the Food Administration and its Distribution Division is decidedly opposed to the application of any similar principle to other commodities.

"It should further be pointed out that the 2-cent maximum margin for jobbers applies on the actual purchase price. The jobber who purchases in lots of 30,000 pounds at 22 $\frac{1}{2}$  cents must sell at not to exceed 24 $\frac{1}{2}$  cents."

"The maximum margins permitted on sales of nonperishables by wholesalers to retailers prescribed in the announcement of June 6, 1918, and in the note to Rule XI—A—5 include local cartage, but does not include delivery charges incurred by the wholesaler in delivering by truck to points to which shipment might be made by rail. The actual expenses of making such deliveries by truck may be charged by the seller to the parties to whom the sale is made after the price has been fixed by the seller in conformity with said Rule A—5 and announcement of June 6. In no case, however, shall the added charge be in excess of the freight charge. (Opinion A—113, July 26, 1918.)

"A brokerage may be paid to a broker in a permissible resale from one jobber or wholesaler to another. The brokerage must, however, be deducted from the profit of either the buyer or seller, so that the price of the goods in the course of further distribution shall not bear such brokerage. (Opinion A—118, Aug. 26, 1918.)"

. . . . .  
"EXHIBIT 5.

**"UNITED STATES FOOD ADMINISTRATION, SPECIAL LICENSE  
REGULATIONS NO. XIII—MANUFACTURERS OF BAKERY  
PRODUCTS (INCLUDING OFFICIAL INTERPRETATIONS.)**

"This pamphlet contains all special regulations applying to manufacturers of bakery products issued up to and including May 3, 1918,

<sup>1</sup> *Ibid.*, 167, 168, 175, 176, 177-8.

312 AMERICAN VEGETABLE-SHORTENING INDUSTRY

and supersedes Bakers' Regulations, Series D. Such licensees are also subject to General Regulations No. 1, issued as a separate pamphlet. . . .

"SPECIAL LICENSE REGULATIONS NO. XIII.

"A. *Special Regulations Applying to All Licensees Manufacturing Bakery Products. . . .*

"[XIII—A—5, 6, 7.]

"RULE A—5. *Stocks of wheat flour, sugar, and shortening, limited.*—The licensee shall not, without the written consent of the United States Food Administrator, or his duly authorized representative, keep on hand or have in possession or under control, by contract or other arrangement, at any time, wheat flour or sugar in a quantity in excess of the reasonable requirements of his business for use by him during a period of 30 days, or shortening in a quantity in excess of the reasonable requirements of his business for use by him during a period of 60 days: *Provided, however,* That this rule shall not prevent the licensee having in transit sufficient flour or sugar or shortening to maintain the licensee's stock within the limits herein fixed.

"NOTE.—Only in cases in which peculiar circumstances demand it, will permission be given to a licensee to keep more than 30 days' supply of flour or sugar or more than 60 days' supply of shortening on hand or under control. A licensee who desires to make an application for such permission should present his case to the Federal Food Administrator for the state in which the bakery for which permission is asked is located.

"This rule does not prohibit a licensee who is entitled to use butter from holding or arranging for a season's supply. . . ."1

*Special Regulations for Licensees Engaged in the Business of Manufacture and Dealing in Lard Substitutes*

*Special Permits May Be Issued in Special Cases*

RULE 1.—Every licensee engaged in the manufacture of lard substitutes shall be subject to the following rules, provided, that in any special instance the United States Food Administrator may issue a special permit authorizing an exception to be made:

*Hoarding—Season's Supply.*

a) He shall not store, keep on hand, or have in his possession or under control by contract, or other arrangement, at any time: . . . (2) Any lard substitute, other than of his own manufacture.

b) He shall not carry in stock any lard substitute for a period exceeding thirty days.

<sup>1</sup> *Annual Report of the United States Food Administration . . . 1918, 223, 225.*



*Contracts for Delivery Beyond Thirty Days, Prohibited. . . .*

*Contracts in Excess Manufacturing Capacity, Prohibited. . . .*

*Sales to Certain Concerns, Prohibited. . . .*

e) He shall not knowingly make any sales of lard substitutes to any firm, corporation, association or individual who is not regularly engaged in the necessary distribution or in the use or consumption of lard substitutes.

*Purchase of Raw Material. . . .*

f) He shall not knowingly make any purchases of the raw materials entering into the manufacture of lard substitutes from any firm, corporation, association or individual who is not regularly engaged in the necessary distribution or in the production of said commodities.

*Manufacturer's Price; Differential. . . .*

RULE 6.—No manufacturer engaged in the manufacture of lard substitutes shall, without the written permission of the United States Food Administrator, sell or offer to sell lard substitutes at higher prices in one market than he is selling or offering to sell the same quality or brand in any other market on the same day.

*Differentials. . . .*

NOTE.—The selling price of lard substitute, delivered, tierce basis, is 22½ ¢ per pound in lots of 5,000 pounds or more and 23¼ ¢ per pound in lots of less than 5,000 pounds, based upon the customary terms of payment within 30 days, with privilege to the buyer of ½ of 1% discount for payment within 10 days. An additional discount of ¼ of 1% shall be made to buyers of 30,000 pounds gross or over. These prices, when for export, apply delivered at American seaport. The following differentials shall apply to package or case goods, over and above the base price as specified above.

d) These findings are based upon the price received by the producer for his cotton seed translated into the fair price of cotton seed oil, which oil you have been requested to purchase, treat and store in order that it may, without advance in price, be available to the consumer as cooking fat in the approaching period of scarcity due to cessation of production.

Wholesalers, jobbers, importers, retailers, and brokers of lard and lard substitutes are governed by special rules applying to licensed non-perishable food commodities. The maximum margins on sales by wholesalers to retailers is named as 1¼ ¢ to 2 ¢ per pound.<sup>1</sup>

<sup>1</sup> *United States Food Administration Laws and Ratings, Commerce Clearing House, Chicago, New York (Chicago, Hillison and Etten Company, 1918).*

## APPENDIX F

## TABLES

TABLE I.—COTTONSEED PRODUCED AND CRUSHED, CRUDE OIL PRODUCED, AND OIL EXPORTED, ANNUALLY, FROM 1874-75\*

(Seed in thousand tons; oil in million pounds)

Year	Cottonseed produced	Cottonseed crushed	Percentage crushed	Crude oil produced	Oil exported	Percentage exported <sup>a</sup>
1874-75...	1,687	84	5.0	25	3.1	12.4
1875-76...	2,057	123	6.0	37	2.1	5.7
1876-77...	1,969	98	5.0	30	12.8	43.3
1877-78...	2,148	150	7.0	45	37.4	82.9
1878-79...	2,268	181	8.0	54	40.1	73.7
1879-80...	2,616	235	9.0	71	52.5	74.3
1880-81...	3,039	182	6.0	55	25.8	47.2
1881-82...	2,455	295	12.0	88	5.4	6.1
1882-83...	3,266	392	12.0	118	3.1	2.7
1883-84...	2,639	396	15.0	119	27.0	22.8
1884-85...	2,625	499	19.0	150	47.7	31.9
1885-86...	3,045	578	19.0	174	46.8	27.0
1886-87...	3,018	694	23.0	208	30.5	14.6
1887-88...	3,291	823	25.0	247	33.4	13.5
1888-89...	3,310	794	24.0	238	20.2	8.5
1889-90...	3,495	874	25.0	262	100.4	38.3
1890-91...	4,093	1,023	25.0	307	82.5	26.9
1891-92...	4,274	1,068	25.0	321	103.9	32.4
1892-93...	3,183	1,050	33.0	315	71.0	22.5
1893-94...	3,579	1,431	40.0	429	112.2	26.1

\* Production data are official estimates for years ending July 31; export data are official data for years ending June 30; here taken mainly from Bureau of the Census, *Cotton Production and Distribution, Season of 1931-32* (Bulletin 169), 72, and *ibid.*, *Seasons of 1932-33* (Bulletin 170), 36. A headnote to the table states that in its preparation "a number of sources of information have been utilized, but it has been found impracticable to secure in all instances satisfactory data for the years indicated, and only an approximation to the facts is claimed. . . ." Exports include both crude and refined oil, for which separate statistics are available only from 1922 (see Table I A).

<sup>a</sup> These percentages are rendered slightly inaccurate by the lack of identity in 12-month periods covered by production and export data; they are also too low because a more or less considerable part consists of refined oil.

TABLE I (Continued)

Year	Cottonseed produced	Cottonseed crushed	Percentage crushed	Crude oil produced	Oil exported	Percentage exported <sup>a</sup>
1894-95...	4,792	1,677	35.0	503	158.9	31.6
1895-96...	3,416	1,435	42.0	430	145.8	33.9
1896-97...	4,070	1,628	40.0	488	204.0	41.8
1897-98...	5,253	2,101	40.0	630	301.7	47.9
1898-99...	5,472	2,353	43.0	706	379.7	53.8
1899-1900.	4,668	2,479	53.1	700	351.8	50.3
1900-01...	4,830	2,415	50.0	725	370.2	51.1
1901-02...	4,630	3,154	68.1	890	247.8	27.9
1902-03...	5,092	3,269	64.2	922	267.3	29.0
1903-04...	4,716	3,241	68.7	914	217.6	23.8
1904-05...	6,427	3,345	52.0	1,004	386.5	38.5
1905-06...	5,060	3,131	61.9	943	328.5	34.8
1906-07...	5,913	3,844	65.0	1,153	314.1	27.2
1907-08...	4,952	2,565	51.8	773	307.6	39.8
1908-09...	5,904	3,670	62.2	1,101	383.2	34.8
1909-10...	4,462	3,269	73.3	982	224.0	22.8
1910-11...	5,175	4,106	79.3	1,260	225.5	17.9
1911-12...	6,997	4,921	70.3	1,512	399.5	26.4
1912-13...	6,104	4,580	75.0	1,393	315.2	22.6
1913-14...	6,305	4,848	76.9	1,450	193.0	13.3
1914-15...	7,186	5,780	80.4	1,719	318.4	18.5
1915-16...	4,992	4,202	84.2	1,253	266.5	21.3
1916-17...	5,113	4,479	87.6	1,408	159.0	11.3
1917-18...	5,040	4,252	84.4	1,312	100.8	7.7
1918-19...	5,360	4,479	83.6	1,325	178.7	13.5
1919-20...	5,074	4,013	79.1	1,211	159.4	13.2
1920-21...	5,971	4,069	68.2	1,309	283.3	21.6
1921-22...	3,531	3,008	85.2	930	91.6	9.8
1922-23...	4,336	3,242	74.8	1,003	64.3	6.4
1923-24...	4,502	3,308	73.5	980	39.4	4.0
1924-25...	6,051	4,605	76.1	1,404	53.3	3.8
1925-26...	7,150	5,558	77.7	1,617	63.2	3.9
1926-27...	7,989	6,306	78.9	1,888	57.6	3.0
1927-28...	5,758	4,654	80.8	1,477	61.5	4.2
1928-29...	6,435	5,061	78.6	1,604	29.5	1.8
1929-30...	6,590	5,016	76.1	1,572	32.0	2.0
1930-31...	6,191	4,715	76.2	1,442	26.4	1.8
1931-32...	7,602	5,328	70.1	1,694	41.0	2.4
1932-33...	5,782	4,621	79.9	1,446	44.4	3.1

## 316 AMERICAN VEGETABLE-SHORTENING INDUSTRY

TABLE I A.—EXPORTS OF COTTONSEED OIL, CRUDE AND REFINED,  
1922-33\*

(Thousand pounds)

Calendar year	Crude	Refined	Total	Percentage crude	Percentage refined
1922 .....	31,712	43,591	75,303	42.1	57.9
1923 .....	27,782	21,826	49,608	56.0	44.0
1924 .....	18,948	24,394	43,342	43.7	56.3
1925 .....	33,553	28,862	62,415	53.8	46.2
1926 .....	27,357	13,544	40,901	66.9	33.1
1927 .....	51,407	16,575	67,982	75.6	24.4
1928 .....	41,126	10,576	51,702	79.5	20.5
1929 .....	19,292	67,783	26,075	74.0	26.0
1930 .....	16,394	11,903	28,297	57.9	42.1
1931 .....	9,733	12,845	22,578	43.1	56.9
1932 .....	44,855	10,913	55,768	80.6	19.4
1933 .....	26,143	9,392	35,535	73.6	26.4

\* Basic data from *Commerce and Navigation of the United States*. Total and percentages computed from the other two columns. Data for 1933 are preliminary, direct from the Bureau of Foreign and Domestic Commerce.

TABLE II.—ASPEGREN ESTIMATES OF DOMESTIC USES OF COTTONSEED OIL, ANNUALLY FROM 1874-75 TO 1911-12\*

(Million pounds)

Year Sept.-Aug.	Total	Soap making	Salad oil	Cooking and baking	Lard com- pound	Oleomar- garine	Packing sardines	Other pur- poses
1874-75.....	15.4	10.0	4.0	...	...	...	...	1.4
1875-76.....	24.9	15.9	6.0	...	...	...	...	3.0
1876-77.....	10.1	1.2	6.0	...	...	...	...	2.9
1877-78.....	11.8	4.0	6.0	...	...	...	...	1.8
1878-79.....	8.1	4.0	3.2	...	...	...	...	0.9
1879-80.....	8.4	4.0	3.2	...	...	...	...	1.2
1880-81.....	18.9	7.9	4.0	...	4.0	2.0	...	1.0
1881-82.....	61.5	31.8	6.0	...	19.9	2.0	...	1.8
1882-83.....	103.3	47.8	7.9	2.0	39.8	4.0	...	1.8
1883-84.....	72.5	23.9	11.9	2.0	29.9	4.0	...	0.8
1884-85.....	70.4	19.9	8.0	2.0	29.8	6.0	2.0	2.7
1885-86.....	111.2	47.8	9.9	3.2	39.8	6.0	2.0	2.5
1886-87.....	150.0	63.7	9.9	3.2	59.7	8.0	3.2	2.4
1887-88.....	181.4	71.6	11.9	4.0	79.6	8.0	3.2	3.1
1888-89.....	195.0	79.6	11.9	4.0	79.6	9.9	4.0	6.0
1889-90.....	128.3	35.8	11.9	4.0	59.7	9.9	4.0	3.0
1890-91.....	188.4	51.7	11.9	4.8	99.5	11.9	2.0	6.6
1891-92.....	198.0	59.7	11.9	4.8	99.5	11.9	4.0	6.2
1892-93.....	177.9	35.8	13.9	4.8	99.5	13.9	4.0	6.0
1893-94.....	231.2	67.7	13.9	6.0	119.4	13.9	4.0	6.3
1894-95.....	322.2	71.6	15.9	6.0	199.0	15.9	6.0	7.8
1895-96.....	212.4	39.8	17.9	6.0	119.4	15.9	6.0	7.4
1896-97.....	277.6	43.8	19.9	7.9	171.1	19.9	6.0	9.0
1897-98.....	299.0	39.8	21.9	11.9	167.2	27.9	11.9	18.4
1898-99.....	298.1	39.8	29.8	13.9	179.1	19.9	6.0	9.6
1899-1900.....	359.2	47.8	31.8	15.9	238.8	10.0	6.0	8.9
1900-01.....	419.7	55.7	39.8	17.9	286.5	8.0	6.0	5.8
1901-02.....	722.5	131.3	51.7	33.8	477.6	8.0	6.0	14.1
1902-03.....	718.5	119.4	61.7	45.8	457.7	8.0	9.9	16.0
1903-04.....	810.8	129.4	95.5	59.7	437.8	6.0	13.9	68.5
1904-05.....	837.9	179.1	111.4	67.7	398.0	4.0	13.9	63.8
1905-06.....	797.6	119.4	107.5	79.6	437.8	4.0	11.9	37.4
1906-07.....	682.6	99.5	87.6	99.5	358.2	4.0	9.9	23.9
1907-08.....	477.6	79.6	59.7	79.6	238.8	2.0	8.0	9.9
1908-09.....	600.0	87.5	59.7	79.6	338.3	6.0	6.0	22.9
1909-10.....	887.8	159.2	79.6	159.2	398.0	15.9	8.0	67.9
1910-11.....	929.2	179.1	99.5	159.2	437.8	19.9	11.9	21.8
1911-12.....	936.7	179.1	79.6	179.1	445.8	27.9	11.9	13.3

\* Data (converted from barrels at 398 pounds to the barrel) from Aspegren and Company, *Cotton Oil* (3d ed., New York, 1909, 6th ed., New York, 1913).

318 AMERICAN VEGETABLE-SHORTENING INDUSTRY

TABLE III.—ASPEGREN ESTIMATES OF USES OF EXPORTED COTTONSEED OIL, ANNUALLY FROM 1874-75 TO 1911-12\*

(Barrels)

Year ending Aug. 31	As salad oil	For cooking and baking	For soap making	In compound lard	In artificial butter	For packing sardines and other fish	For other purposes	Total
1875.....	4,000	...	2,000	...	...	...	1,850	7,850
1876.....	2,500	...	1,500	...	...	200	1,110	5,300
1877.....	20,000	...	10,000	...	...	500	1,600	32,100
1878.....	50,000	...	35,000	...	500	750	7,550	93,800
1879.....	53,000	...	40,000	...	500	750	6,750	101,000
1880.....	60,000	500	60,000	...	1,000	1,000	9,100	131,600
1881.....	30,000	500	25,000	...	1,000	500	7,600	64,600
1882.....	6,000	300	5,700	...	800	200	400	13,400
1883.....	3,000	...	3,000	...	500	300	1,000	7,800
1884.....	35,000	500	25,000	500	1,000	500	5,300	67,800
1885.....	60,000	1,000	50,000	500	1,000	500	7,000	120,000
1886.....	60,000	1,000	48,000	500	1,000	500	6,600	117,600
1887.....	40,000	500	30,000	500	1,000	500	4,000	76,500
1888.....	44,000	500	34,000	500	1,000	500	4,200	84,700
1889.....	24,000	500	20,000	500	1,000	500	4,000	50,500
1890.....	150,000	2,000	80,000	2,000	5,000	1,500	10,500	251,000
1891.....	100,000	3,000	70,000	4,000	10,000	2,000	18,000	207,000
1892.....	120,000	4,000	100,000	6,000	15,000	3,000	13,000	261,000
1893.....	100,000	4,000	30,000	8,000	15,000	3,000	18,000	178,000
1894.....	100,000	5,000	120,000	10,000	20,000	4,000	22,000	281,000
1895.....	150,000	6,000	160,000	15,000	35,000	6,000	28,000	400,000
1896.....	130,000	7,000	140,000	20,000	40,000	7,000	22,000	366,000
1897.....	170,000	8,000	200,000	25,000	70,000	10,000	29,000	512,000
1898.....	200,000	9,000	220,000	30,000	150,000	15,000	32,000	756,000*
1899.....	300,000	10,000	400,000	50,000	150,000	20,000	32,000	962,000
1900.....	230,000	11,000	320,000	50,000	180,000	20,000	33,000	874,000*
1901.....	300,000	12,000	280,000	75,000	200,000	25,000	38,000	930,000
1902.....	160,000	13,000	50,000	60,000	100,000	20,000	20,000	423,000
1903.....	250,000	14,000	130,000	80,000	150,000	20,000	26,000	670,000
1904.....	220,000	15,000	90,000	80,000	150,000	30,000	25,000	600,000*
1905.....	360,000	16,000	200,000	100,000	250,000	30,000	44,000	1,000,000
1906.....	230,000	20,000	150,000	100,000	260,000	30,000	50,000	840,000
1907.....	220,000	25,000	140,000	100,000	235,000	20,000	60,000	800,000
1908.....	210,000	30,000	130,000	100,000	225,000	20,000	59,000	774,000
1909.....	350,000	35,000	170,000	140,000	250,000	30,000	19,000	994,000
1910.....	120,000	40,000	50,000	80,000	130,000	20,000	10,000	450,000
1911.....	180,000	45,000	100,000	90,000	120,000	20,000	9,000	564,000
1912.....	200,000	60,000	250,000	200,000	180,000	35,000	25,000	950,000

\* Source as for Table II.

\* Correct totals of items shown are 656,000 for 1898, 844,000 for 1900, and 610,000 for 1904. The errors may be in totals or in one or more components.

TABLE IV.—CLASSIFICATION OF TRADE-MARK REGISTRATIONS OF COMPOUND, 1868-1930\*

Year	Number registered	Number of which use began	Year	Number registered	Number of which use began
1820 (?) .....	..	1	1901.....	3	3
1868.....	..	1	1902.....	5	11
1873.....	..	2	1903.....	9	15
1874.....	1	..	1904.....	6	2
1875.....	..	..	1905.....	4	3
1876.....	..	..	1906.....	9	10
1877.....	..	..	1907.....	9	7
1878.....	..	..	1908.....	12	5
1879.....	..	..	1909.....	1	4
1880.....	..	..	1910.....	4	5
1881.....	1	1	1911.....	5	3
1882.....	6	6	1912.....	4	1
1883.....	..	..	1913.....	3	10
1884.....	..	1	1914.....	8	10
1885.....	..	..	1915.....	9	6
1886.....	..	1	1916.....	12	8
1887.....	1	1	1917.....	14	10
1888.....	..	7	1918.....	9	15
1889.....	2	2	1919.....	16	11
1890.....	..	..	1920.....	12	19
1891.....	..	1	1921.....	22	18
1892.....	10	15	1922.....	10	9
1893.....	7	8	1923.....	12	4
1894.....	4	6	1924.....	10	5
1895.....	7	5	1925.....	18	8
1896.....	1	3	1926.....	5	4
1897.....	..	1	1927.....	2	5
1898.....	..	1	1928.....	14	8
1899.....	..	5	1929.....	8	5
1900.....	3	11	1930.....	7	2

\* Based on list in Appendix D.

320 AMERICAN VEGETABLE-SHORTENING INDUSTRY

TABLE V.—EXPORTS OF COMPOUND, ANNUALLY FROM 1892-93, AND OF LARD, ANNUALLY FROM 1873-74\*

Fiscal or Calendar Year	Thousand pounds		Thousand dollars		Average price (cents per pound)	
	Compound	Lard	Compound	Lard	Compound	Lard
1873-74.....	... <sup>a</sup>	205,527	... <sup>a</sup>	19,308	...	9.4
1874-75.....	...	166,869	...	22,901	...	13.7
1875-76.....	...	168,406	...	22,429	...	13.3
1876-77.....	...	234,741	...	25,563	...	10.9
1877-78.....	...	342,668	...	30,014	...	8.8
1878-79.....	...	326,659	...	22,857	...	7.0
1879-80.....	...	374,979	...	27,920	...	7.4
1880-81.....	...	378,142	...	35,227	...	9.3
1881-82.....	...	250,368	...	28,976	...	11.6
1882-83.....	...	224,718	...	26,618	...	11.8
1883-84.....	...	265,095	...	25,306	...	9.5
1884-85.....	...	283,216	...	22,595	...	8.0
1885-86.....	...	293,728	...	20,362	...	6.9
1886-87.....	...	321,534	...	22,704	...	7.1
1887-88.....	...	297,740	...	22,751	...	7.6
1888-89.....	...	318,243	...	27,329	...	8.6
1889-90.....	...	471,084	...	33,456	...	7.1
1890-91.....	...	498,344	...	34,414	...	6.9
1891-92.....	...	460,046	...	33,202	...	7.2
1892-93.....	912 <sup>b</sup>	365,694	73 <sup>b</sup>	34,644	8.0	9.5
1893-94.....	1,022 <sup>b</sup>	447,567	78 <sup>b</sup>	40,090	7.6	9.0
1894-95.....	504 <sup>b</sup>	474,895	38 <sup>b</sup>	36,822	7.6	7.8
1895-96.....	1,710 <sup>b,c</sup>	509,534	102 <sup>b</sup>	33,590	6.0	6.6
1896-97.....	16,262 <sup>d</sup>	568,316	858 <sup>d</sup>	29,126	5.3	5.1
1897-98.....	21,343	709,344	1,119	39,711	5.2	5.6
1898-99.....	22,145	711,260	1,200	42,208	5.4	5.9
1899-1900...	25,853	661,814	1,475	41,939	5.7	6.3
1900-01.....	23,360	611,358	1,450	46,560	6.2	7.6
1901-02.....	36,202	556,840	2,688	52,376	7.4	9.4
1902-03.....	46,130	490,756	3,608	50,855	7.8	10.4

\* Basic data from *Commerce and Navigation of the United States*, except for 1933, which are direct from the Bureau of Foreign and Domestic Commerce. Average prices are computed from the other two series. The figures for "lard" are exclusive of "neutral lard," which up to 1909-10 was included in "oleo oil and neutral lard," and since 1910-11 has been reported separately.

<sup>a</sup> Prior to 1892-93, exports of compound were presumably reported as lard.

<sup>b</sup> Cottolene and lardine only; see p. 97 for subdivision and comment.

<sup>c</sup> Erroneously given in later volumes as 500 less.

<sup>d</sup> From 1896-97 to 1907-08 the item read: "Lard compounds and substitutes for (cottolene, lardine, etc.)."



TABLE V (Continued)

Fiscal or Calendar Year	Thousand pounds		Thousand dollars		Average price (cents per pound)	
	Compound	Lard	Compound	Lard	Compound	Lard
1903-04.....	53,604	561,303	3,582	46,348	6.7	8.3
1904-05.....	61,215	610,239	3,613	47,243	5.9	7.7
1905-06.....	67,621	741,517	4,154	60,132	6.1	8.1
1906-07.....	80,149	627,560	6,167	57,498	7.7	9.2
1907-08.....	75,183	603,414	6,035	54,790	8.0	9.1
1908-09.....	75,183*	528,723	6,115*	52,713	8.1	10.0
1909-10.....	74,557	362,928	6,888	43,301	9.2	11.9
1910-11.....	73,754	476,108	7,071	52,509	9.6	11.0
1911-12.....	62,523	532,256	5,184	52,090	8.3	9.8
1912-13.....	67,457	519,025	5,916	58,187	8.8	11.2
1913-14.....	58,304	481,458	5,489	54,403	9.4	11.3
1914-15.....	69,981	475,532	6,046	52,440	8.6	11.0
1915-16.....	52,843	427,011	5,147	47,634	9.7	11.2
1916-17.....	56,359	444,770	8,270	77,009	14.7	17.3
1917-18.....	31,278	392,506	6,624	98,217	21.2	25.0
1918.....	43,977	548,818	10,259	144,933	23.3	26.4
1919.....	124,963	760,902	31,606	237,983	25.3	31.3
1920.....	32,051	612,250	7,219	143,371	22.5	23.4
1921.....	48,207	868,942	5,549	112,533	11.5	13.0
1922.....	41,764 <sup>f</sup>	766,950	4,921 <sup>f</sup>	91,485	11.8	11.9
1923.....	17,068	1,035,381	2,354	130,172	13.8	12.6
1924.....	14,371	994,095	1,999	125,728	13.9	12.6
1925.....	22,314	688,229	3,270	118,090	14.7	17.2
1926.....	18,167	698,961	2,582	108,600	14.2	15.5
1927.....	14,419	681,303	1,799	92,035	12.5	13.5
1928.....	10,394	759,722	1,373	98,701	13.2	13.0
1929.....	9,975	829,328	1,324	105,530	13.3	12.7
1930.....	8,790	642,486	1,136	73,434	12.9	11.4
1931.....	5,994	568,708	705	51,069	11.8	9.0
1932.....	3,498	546,202	301	31,885	8.6	5.8
1933.....	2,602 <sup>g</sup>	579,072	226	34,095	8.7	5.9

\* From 1908-09 to 1921 the item read: "Lard compounds and other substitutes for lard."

<sup>f</sup> From 1922 to 1932, this represents the sum of two items separately reported: "Lard compounds containing animal fats," and "vegetable oil lard compounds." See Table XVI for quantity of each, 1922-32.

<sup>g</sup> "Cooking fats other than lard."

322 AMERICAN VEGETABLE-SHORTENING INDUSTRY

TABLE VI.—EXPORTS OF COMPOUND TO PRINCIPAL AREAS OF REPORTED DESTINATION, ANNUALLY FROM 1896-97\*  
(Thousand pounds)

Year	Total	Europe	Northern North America	Mexico and Central America	West Indies, etc.	South America	All other countries
1896-97 .....	16,262	15,284	11	418	412	104	33
1897-98 .....	21,343	20,168	80	576	412	69	38
1898-99 .....	22,145	18,315	195	913	374	1,033	1,315
1899-1900 ...	25,853	19,673	394	684	556	1,404	3,142 <sup>a</sup>
1900-01 .....	23,360	18,508	577	754	1,639	645	1,237
1901-02 .....	36,202	20,939	185	1,445	12,573	590	470
1902-03 .....	46,130	26,388	642	1,812	14,437	2,029	822
1903-04 .....	53,604	25,958	628	3,114	21,387	918	1,599
1904-05 .....	61,215	27,392	518	4,455	23,208	475	5,167 <sup>b</sup>
1905-06 .....	67,621	37,505	804	10,015	17,478	696 <sup>c</sup>	1,123
1906-07 .....	80,149	38,091	676	11,681	27,018	790	1,893
1907-08 .....	75,183	31,543	1,249	7,938	26,918	2,853	4,682 <sup>d</sup>
1908-09 .....	75,183	30,773	879	7,548	31,833	1,603	2,547 <sup>e</sup>
1909-10 .....	74,557	31,038	1,678	8,575	28,416	3,423	1,427
1910-11 .....	73,754	26,225	2,228	9,784	30,302	3,040	2,175 <sup>f</sup>
1911-12 .....	62,523	22,903	1,132	9,249	23,044	2,069	4,126 <sup>f</sup>
1912-13 .....	67,457	25,225	651	7,157	23,912	4,503	6,009 <sup>f</sup>
1913-14 .....	58,304	24,161	927	5,190	20,875	2,753	4,398 <sup>f</sup>
1914-15 .....	69,981	33,179	883	5,961	24,502	2,074	3,382 <sup>f</sup>
1915-16 .....	52,843	21,617	415	7,850	17,775	2,788	2,398 <sup>f</sup>
1916-17 .....	56,359	21,077	843	10,276	20,416	1,447	2,300 <sup>g</sup>
1917-18 .....	31,278	12,646	293	6,067	10,497	953	822
1918.....	43,977	22,800	339	7,608	11,871	983	376
1919.....	124,963	103,157	748	5,641	13,832	1,105	480
1920.....	32,051	8,774	876	7,357	12,864	1,407	773
1921.....	48,207	19,524	1,087	11,706	14,972	245	673

\* Based on data in *Commerce and Navigation of the United States*.  
<sup>a</sup> Including 2,528 to British East Indies. In the four years following, exports to British East Indies averaged only 817.  
<sup>b</sup> Including 4,364 and 1,919 to Straits Settlements for 1904-05 and 1907-08, respectively. In the latter year exports to Asiatic Russia and British South Africa also bulked relatively large.  
<sup>c</sup> Prior to 1905-06 Brazil was in most years the chief single South American country of destination for compound exports. Thereafter exports to Brazil were negligible, and Chile and Colombia provided the principal South American markets in most years (Table VI B), though exports to Ecuador, Peru, and British Guiana were larger than exports to Colombia in some of the war and post-war years.  
<sup>d</sup> Accounted for chiefly by exports to Straits Settlements, 610; Asiatic Russia, 302; British South Africa, 771; and French Africa, 176.  
<sup>e</sup> Including 1,093 to British South Africa.  
<sup>f</sup> Including relatively large exports to the Philippines (Table VI B); exports to Straits Settlements and British Africa were also relatively large in some years.  
<sup>g</sup> Including relatively large exports to Japan, 411; Japanese leased territory in China, 704; and Asiatic Russia, 224.

TABLE VI (Continued)

Year	Total	Europe	Northern North America	Mexico and Central America	West Indies, etc.	South America	All other countries
1922.....	41,764	24,204 <sup>a</sup>	538	7,021	9,282	183	536
1923.....	17,068	4,653	420	4,160	6,573	650	612
1924.....	14,371	3,145	578	3,098	6,549	359	642
1925.....	22,314	1,854	403	4,100	12,771	2,597	589
1926.....	18,167	2,652	764	3,735	8,587	1,769	660
1927.....	14,419	2,229	317	2,905	7,244	932	792
1928.....	10,394	1,329	362	3,125	3,733	700	1,145
1929.....	9,975	1,565	391	3,102	2,802	1,141	974
1930.....	8,790	2,028	650	2,113	2,175	1,046	778
1931.....	5,994	1,747	462	1,182	1,695	336	572
1932.....	3,498	698	172	702	1,199	337	390

<sup>a</sup> Including 10,450 to Russia in Europe, presumably largely for famine relief. In no other year have reported exports to Russia in Europe reached 1 million pounds, and in most of the post-war years the items have been negligible.

TABLE VI A.—EXPORTS OF COMPOUND TO PRINCIPAL EUROPEAN COUNTRIES OF REPORTED DESTINATION, ANNUALLY FROM 1896-97\*

(Thousand pounds)

Year	United Kingdom	Denmark	Germany	lands Nether-	Belgium	France	Europe Other
1896-97.....	4,295	917	3,924	250	743	4,619	536
1897-98.....	6,331	1,130	5,495	4,244	431	2,159	378
1898-99.....	5,694	1,204	5,685	2,954	619	1,282	877
1899-1900....	5,951	1,268	5,570	3,914	1,158	643	1,169
1900-01.....	6,771	1,434	4,593	4,222	530	185	773
1901-02.....	10,200	900	3,116	5,441	601	30	651
1902-03.....	14,265	1,612	4,145	2,385	1,527	1,548	906
1903-04.....	10,691	895	7,017	5,499	613	63	1,180
1904-05.....	10,815	1,255	8,792	3,738	1,318	51	1,423
1905-06.....	16,667	2,684	3,758	6,512	3,229	2,497	2,158
1906-07.....	19,803	4,034	4,343	6,888	929	11	2,083
1907-08.....	20,777	4,223	2,604	1,044	572	188	2,135
1908-09.....	22,469	2,084	1,140	2,310	167	27	2,576*
1909-10.....	26,425	606	1,038	706	113	64	2,086
1910-11.....	18,827	309	4,005	1,266	1	85	1,732

\* Data from *Commerce and Navigation of the United States*.

\* Including 1,232 to Norway, an amount larger than usual, and also moderately large exports to European Russia, Sweden, and Italy, 986, 179, and 130, respectively.

## 324 AMERICAN VEGETABLE-SHORTENING INDUSTRY

TABLE VI A (Continued)

Year	United Kingdom	Denmark	Germany	Netherlands	Belgium	France	Other Europe
1911-12.....	17,854	770	622	1,384	39	5	2,229
1912-13.....	21,116	739	475	695	2	2	2,196
1913-14.....	19,930	571	256	668	...	7	2,729 <sup>b</sup>
1914-15.....	26,357	1,376	258	1,353	299	189	3,347 <sup>b</sup>
1915-16.....	18,486	553	...	710	...	160	1,708 <sup>b</sup>
1916-17.....	13,508	65	...	295	5,810	34	1,365 <sup>b</sup>
1917-18.....	4,416	...	...	...	6,620	1,085	525 <sup>b</sup>
1918.....	4,346	...	...	...	14,379	3,441	634
1919.....	62,739	585	1,229	887	22,645	630	14,442 <sup>c</sup>
1920.....	4,009	159	1,747	212	452	2	2,193
1921.....	7,376	412	5,029	265	38	10	6,394 <sup>d</sup>
1922.....	2,895	...	8,323	73	2	7	12,904 <sup>d</sup>
1923.....	499	...	493	119	1	...	3,541
1924.....	457	10	2,120	14	161	28	355
1925.....	738	...	197	19	13	...	887
1926.....	1,000	...	341	585	138	10	578
1927.....	1,365	...	13	253	46	...	552
1928.....	380	...	71	126	3	52	697
1929.....	672	27	224	93	101	6	442
1930.....	1,397	23	137	23	47	4	397
1931.....	1,485	17	34	17	4	2	188
1932.....	476	...	51	52	5	2	112

<sup>b</sup> Norway was the principal single market among the group of countries from 1912-13 to 1916-17; Sweden took sizable quantities in 1914-15; and in 1917-18 Switzerland took the bulk of these exports.

<sup>c</sup> Including 9,320 to Gibraltar and 2,704 to Norway. Exports to European Russia, Italy, Sweden, Turkey, and Switzerland were also relatively large.

<sup>d</sup> Including 3,817 to Poland and Danzig.

<sup>e</sup> Including 10,450 to Russia in Europe, presumably largely for famine relief. In no other year have reported exports to Russia in Europe reached 1 million pounds, and in most of the post-war years the item has been negligible.

TABLE VI B.—EXPORTS OF COMPOUND TO PRINCIPAL EX-EUROPEAN COUNTRIES OF REPORTED DESTINATION, ANNUALLY FROM 1896-97\*

(Thousand pounds)

Year	Mexico	Panama	Cuba	Haiti	British West Indies <sup>a</sup>	Chile	Colombia	Philippines
1896-97.....	395	...	246	11	83	...	24	...
1897-98.....	558	...	217	...	105	2	23	...
1898-99.....	799	...	131	31	118	296	71	...
1899-1900.....	579	...	375	41	87	391	14	3
1900-01.....	533	...	1,458	49	80	2	28	9
1901-02.....	1,019	...	12,395	28	115	...	87	...
1902-03.....	1,247	...	14,029	50	298	16	153	14
1903-04.....	2,325	113	20,655	27	480	58	152	...
1904-05.....	3,486	423	22,165	34	637	64	86	186
1905-06.....	6,946	2,119	15,056	255	1,060	237	133	73
1906-07.....	9,164	1,813	23,688	208	1,994	234	33	289
1907-08.....	5,867	1,049	22,466	296	2,722	1,205	250	232
1908-09.....	5,467	1,008	28,024	622	2,296	511	581	437
1909-10.....	5,768	1,397	24,379	1,265	2,581	1,365	288	160
1910-11.....	7,212	1,565	25,175	1,762	2,878	1,324	694	312
1911-12.....	6,769	1,762	17,214	2,261	2,970	559	855	2,621
1912-13.....	4,128	1,524	17,526	2,210	3,591	1,792	1,333	3,768
1913-14.....	3,119	1,333	14,673	1,670	3,923	1,411	579	2,596
1914-15.....	3,773	1,441	19,046	1,215	3,556	1,223	42	2,424
1915-16.....	4,598	2,203	11,895	1,812	3,381	2,320	18	1,584
1916-17.....	6,863	2,190	14,165	1,499	3,864	789	23	376
1917-18.....	4,442	1,055	7,735	262	1,751	363	2	621
1918.....	6,887	353	8,608	224	2,188	453	2	257
1919.....	4,620	414	8,611	1,604	2,727	111	3	247
1920.....	6,217	450	6,918	2,126	2,933	998	13	341
1921.....	10,213	731	8,116	2,412	3,391	27	8	308
1922.....	5,710	563	3,761	2,320	2,439	70	7	229
1923.....	2,820	366	2,269	2,529	1,092	225	74	208
1924.....	1,937	343	2,540	2,478	881	143	57	250
1925.....	2,798	477	8,561	2,606	737	844	52	162
1926.....	2,868	344	6,323	852	773	548	35	241
1927.....	1,838	416	5,070	641	814	390	38	267
1928.....	2,021	369	2,019	211	834	297	147	277
1929.....	1,847	423	1,068	65	955	379	297	236
1930.....	986	452	560	9	762	183	251	144
1931.....	231	402	150	11	561	90	156	140
1932.....	120	260	229	1	424	6	26	88

\* Data from *Commerce and Navigation of the United States*.

<sup>a</sup> From 1910-11 (when exports to some of the British West Indies were first reported separately) to 1922, Trinidad and Tobago took over half the exports to the British West Indies. Thereafter the proportion taken by Trinidad and Tobago has been small; Jamaica and "Other British West Indies" have taken larger proportions.

326 AMERICAN VEGETABLE-SHORTENING INDUSTRY

TABLE VII.—SHIPMENTS OF COMPOUND AND LARD TO POSSESSIONS, ANNUALLY FROM 1896-97\*

(Thousand pounds)

Year	Compound				Lard			
	Alaska	Hawaii	Puerto Rico	Total	Alaska	Hawaii	Puerto Rico	Total
1896-97.....	...	...	... <sup>a</sup>	...	...	...	4,573 <sup>a</sup>	...
1897-98.....	...	...	2 <sup>a</sup>	...	...	...	3,609 <sup>a</sup>	...
1898-99.....	...	...	10 <sup>a</sup>	...	...	...	4,742 <sup>a</sup>	...
1899-1900.....	...	...	6 <sup>a</sup>	...	...	...	5,984 <sup>a</sup>	...
1900-01.....	...	...	121	...	...	...	4,086	...
1901-02.....	...	...	68	...	...	...	5,488	...
1902-03.....	13	159	2,148	2,320	278	688	3,791	4,757
1903-04.....	45	151	2,484	2,680	458	713	3,272	4,443
1904-05.....	59	536	3,618	4,213	594	320	3,841	4,755
1905-06.....	84	846	4,126	5,056	659	108	3,704	4,471
1906-07.....	98	789	5,231	6,118	630	170	3,106	3,906
1907-08.....	81	915	6,462	7,458	494	171	2,232	2,897
1908-09.....	105	1,303	6,865	8,273	726	154	1,941	2,821
1909-10.....	187	1,177	8,525	9,889	663	142	1,912	2,717
1910-11.....	159	1,167	9,041	10,367	426	157	2,190	2,773
1911-12.....	162	1,101	7,039	8,302	663	257	2,882	3,802
1912-13.....	207	1,305	8,668	10,180	584	309	3,013	3,906
1913-14.....	268	1,478	7,404	9,150	606	197	4,514	5,317
1914-15.....	...	1,576	7,425	9,001	616	354	3,685	4,655
1915-16.....	...	1,712	6,142	7,854	683	347	4,729	5,759
1916-17.....	...	1,561	7,734	9,295	930	481	3,625	5,036
1917-18.....	...	1,332	6,165	7,497	646	57	2,700	3,403
1918.....	...	1,409	6,313	7,722	304	33	2,800	3,217
1919.....	...	1,563	5,551	7,114	344	51	3,379	3,774
1920.....	...	1,313	5,103	6,416	396	41	6,524	6,961
1921.....	...	1,775	4,883	6,658	268	108	9,546	9,922
1922.....	...	1,813	5,231	7,044	409	376	9,195	9,980
1923.....	411	1,625	1,495	3,531	446	266	13,552	14,294
1924.....	224	1,224	2,593	4,041	471	228	13,740	14,439
1925.....	237	1,111	3,227 <sup>b</sup>	4,575	379	109	10,984	11,472
1926.....	209	1,278	1,260 <sup>b</sup>	2,747	389	131	15,559	16,079
1927.....	190 <sup>b</sup>	1,397 <sup>b</sup>	388 <sup>b</sup>	1,975	406	154	14,952	15,514
1928.....	215 <sup>b</sup>	2,430	1,882	4,527	391	280	17,336	18,007
1929.....	219 <sup>b</sup>	2,402	1,594	4,215	370	184	17,937	18,491
1930.....	226 <sup>b</sup>	3,090	1,467	4,783	372	145	17,705	18,222
1931.....	154 <sup>b</sup>	3,230	1,311	4,695	347	209	21,991	22,547
1932.....	154 <sup>b</sup>	3,543	682	4,379	352	159	23,224	23,735
1933.....	483 <sup>b</sup>	3,415 <sup>b</sup>	781 <sup>b</sup>	4,679 <sup>b</sup>	373	248	26,833	27,454

\* Data from *Commerce and Navigation of the United States and Monthly Summary of Foreign Commerce of the United States*, except for 1933, which are direct from the Bureau of Foreign and Domestic Commerce. Shipments to Alaska and Hawaii prior to 1902-03 were presumably not reported in published documents. *Monthly Summary of Foreign Commerce of the United States*, December 1924, Pt. II, 97, which includes data for 1922-24, leads one to believe that figures for shipments of lard to Alaska for 1914-15 to 1922 may also include shipments of lard compounds.

<sup>a</sup> Included in "exports of domestic merchandise" through 1899-1900.

<sup>b</sup> Specifically designated as "lard compounds containing animal fats." Vegetable oil-lard compounds not reported separately; presumably included in "other vegetable oils and fats."

<sup>c</sup> "Cooking fats other than lard."

TABLE VIII.—FACTORY PRODUCTION OF LARD, COMPOUND, AND COTTONSEED OIL, QUARTERLY, 1922-33\*

(Million pounds)

Year	Jan.- Mar.	Apr.- June	July- Sept.	Oct.- Dec.	Jan.- Mar.	Apr.- June	July- Sept.	Oct.- Dec.
	EDIBLE LARD (OTHER THAN NEUTRAL LARD)				LARD COMPOUNDS AND OTHER LARD SUBSTITUTES			
1922.....	416	397	341	421	188	146	207	243
1923.....	527	489	430	499	208	135	193	215
1924.....	591	509	402	433	178	181	192	279
1925.....	466	366	294	381	258	253	306	336
1926.....	446	403	367	363	289	271	242	339
1927.....	426	444	366	373	326	255	348	250
1928.....	593	430	317	460	307	237	302	297
1929.....	523	433	395	462	280	297	326	317
1930.....	451	405	336	383	280	283	317	331
1931.....	482	403	339	435	294	285	283	309
1932.....	487	405	343	437	221	221	277	227
1933.....	451	479	415	412	204	245	248	238
Average 1922-33.....	488	430	362	422	253	234	270	282
	CRUDE COTTONSEED OIL				REFINED COTTONSEED OIL			
1922.....	267	44	118	505	283	87	58	398
1923.....	307	71	94	501	330	120	64	343
1924.....	290	96	117	652	276	166	92	523
1925.....	485	146	188	692	454	203	143	546
1926.....	568	163	172	857	501	190	100	680
1927.....	642	205	248	712	578	273	165	577
1928.....	434	95	159	773	406	169	109	647
1929.....	523	143	203	716	499	203	135	614
1930.....	499	153	239	725	447	215	160	636
1931.....	396	94	160	766	398	143	92	662
1932.....	523	222	248	577	456	273	167	486
1933.....	387	210	282	520	334	276	193	431
Average 1922-33.....	443	137	186	666	414	193	123	545

\* Data from annual reports of the Bureau of Census, *Animal and Vegetable Fats and Oils*, and for 1933 preliminary quarterly reports, *Statistics of Fats and Oils*.

## 328 AMERICAN VEGETABLE-SHORTENING INDUSTRY

TABLE IX.—LARD PRODUCTION, EXPORTS, AND APPARENT DOMESTIC CONSUMPTION, 1900-32\*

(Million pounds)

Calendar Year	Production			Exports <sup>a</sup>	Percentage exported <sup>b</sup>	Apparent consumption	
	Federally inspected	Other (estimated)	Total (estimated)			Total	Pounds per capita
1900.....	821 <sup>c</sup>	796	1,617	615	38.0	1,002	13.2
1901.....	829 <sup>c</sup>	785	1,614	612	37.9	1,002	12.9
1902.....	737 <sup>c</sup>	702	1,439	507	35.2	932	11.7
1903.....	766 <sup>c</sup>	730	1,496	541	36.2	955	11.8
1904.....	841 <sup>c</sup>	755	1,596	571	35.8	1,025	12.4
1905.....	799 <sup>c</sup>	752	1,551	708	45.6	843	10.0
1906.....	882 <sup>c</sup>	762	1,644	685	41.7	959	11.2
1907.....	1,137	640	1,777	594	33.4	1,183	13.5
1908.....	1,171	619	1,790	587	32.8	1,203	13.5
1909.....	886	618	1,504	462	30.7	1,042	11.5
1910.....	792	642	1,434	382	26.6	1,052	11.4
1911.....	1,010	663	1,673	610	36.5	1,063	11.3
1912.....	965	661	1,626	558	34.3	1,068	11.2
1913.....	1,006	675	1,681	581	34.6	1,100	11.4
1914.....	969	688	1,657	465	28.1	1,192	12.2
1915.....	1,081	694	1,775	494	27.8	1,281	12.9
1916.....	1,159	690	1,849	463	25.0	1,368	13.6
1917.....	926	631	1,557	388	24.9	1,195	11.7
1918.....	1,260	723	1,983	559	28.2	1,374	13.3
1919.....	1,323	716	2,039	789	38.7	1,292	12.3

\* Prepared for 1900-28 by John Roberts, in the Bureau of Animal Industry, Department of Agriculture, and published in mimeographed bulletins of that Bureau entitled *Meat Production, Consumption and Foreign Trade in United States*. . . . Methods used are explained in John Roberts, *Food Animals and Meat Consumption in the United States* (Department Circular 241), revised April 1929. Estimates for 1900-06, before federal inspection was in force, were made "with the co-operation of C. L. Harlan and other specialists of the Bureau of Agricultural Economics." From 1929 the Bureau of Agricultural Economics has continued the series, in preliminary mimeographed reports of *Statistics of Meat Production, Consumption and Foreign Trade of the United States*. . . . A revision of the series with the aid of 1930 census data is promised.

<sup>a</sup> Including neutral lard, and shipments to possessions. No imports are recorded.

<sup>b</sup> Computed by Food Research Institute.

<sup>c</sup> Estimated for comparison with later inspection data.



TABLE IX (Continued)

Calendar Year	Production			Exports <sup>a</sup>	Percentage exported <sup>b</sup>	Apparent consumption	
	Federally inspected	Other (estimated)	Total (estimated)			Total	Pounds per capita
1920.....	1,321	735	2,056	643	31.3	1,416	13.3
1921.....	1,379	735	2,114	903	42.7	1,223	11.3
1922.....	1,575	782	2,357	799	33.9	1,558	14.2
1923.....	1,971	812	2,783	1,075	38.6	1,707	15.3
1924.....	1,923	823	2,746	986	35.9	1,749	15.4
1925.....	1,452	771	2,223	719	32.3	1,522	13.2
1926.....	1,513	811	2,324	733	31.5	1,584	13.5
1927.....	1,557	799	2,356	717	30.4	1,634	13.8
1928.....	1,750	844	2,594	801	30.9	1,763	14.7
1929.....	1,763	835	2,598	866	33.3	1,735	14.3
1930.....	1,521	823	2,344	674	35.1	1,701	13.8
1931.....	1,554	831	2,385	601	25.2	1,784	14.4
1932.....	1,573	...	2,404 <sup>d</sup>	576	24.0	.....	....
1933.....	1,679	...	2,510 <sup>d</sup>	612	24.4	.....	....

<sup>d</sup> Preliminary, assuming lard not produced under Federal inspection in 1932 and 1933 was the same as in 1931. See *Fats and Oils, Statistics of United States Production, Trade, and Consumption* (Bureau of Agricultural Economics, March 1, 1934), Table 50.

330 AMERICAN VEGETABLE-SHORTENING INDUSTRY

TABLE X.—COMPOUND PRODUCTION, 1908-33, ACCORDING TO AVAILABLE DATA AND ESTIMATES\*  
(Thousand pounds)

Year	U.S. Dept. of Agriculture estimates <sup>a</sup>	U.S. Tariff Commission estimates <sup>b</sup>	Census quarterly reports <sup>c</sup>	Census of Manufactures <sup>d</sup>		U.S. Dept. of Agriculture: federally inspected <sup>e</sup>
				Total	By meat-packers	
1908...	.....	.....	.....	.....	.....	436,448
1909...	.....	.....	.....	.....	.....	488,249
1910...	.....	.....	.....	.....	.....	671,526
1911...	.....	.....	.....	.....	.....	672,845
1912...	876,927	.....	.....	.....	.....	648,443
1913...	.....	.....	.....	.....	.....	670,802
1914...	1,136,522	.....	.....	(1,074,000) <sup>f</sup>	396,398	590,409
1915...	.....	.....	.....	.....	.....	520,899
1916...	1,027,133	.....	.....	.....	.....	397,244
1917...	1,173,446	.....	.....	.....	.....	466,198
1918...	1,146,236	.....	.....	.....	.....	463,165
1919...	.....	1,350,000	.....	(1,352,000) <sup>f</sup>	521,122	469,732
1920...	.....	747,255	.....	.....	.....	328,567
1921...	.....	811,095	.....	(916,000) <sup>f</sup>	377,051	339,366
1922...	.....	.....	784,180	.....	.....	312,014
1923...	.....	.....	750,522	(783,000) <sup>f</sup>	287,735	336,843
1924...	.....	.....	830,435	.....	.....	363,180
1925...	.....	.....	1,152,600	1,129,390	450,922	458,518
1926...	.....	.....	1,140,708	.....	.....	543,913
1927...	.....	.....	1,178,995	1,239,087	438,037	535,175

\* Sources as indicated in footnotes a to e below. The products covered constitute practically the same group throughout, though the name applied has been changed from time to time. "Lard substitute," "Lard compounds and other lard substitutes," "Lard substitutes and cooking fats," and "Shortenings other than lard" are the principal variants.

<sup>a</sup> Supplement to Bulletin No. 769 (Contribution from the Bureau of Chemistry), October 29, 1919, p. 6; compiled from data collected by the Fats and Oils Division of the U.S. Food Administration, chiefly in its fats and oils survey in 1917 and 1918.

<sup>b</sup> U.S. Tariff Commission, *Report to the Congress on Certain Vegetable Oils, Whale Oil, and Copra* (Report No. 41, Second Series, Washington, 1932), 159-60. Estimated for 1920 and 1921 on the basis of data obtained by questionnaire from producers of all types representing 80 per cent of the total lard-compound production. Cf. the same Commissioner's *Certain Vegetable Oils, Part 2* . . . . (Washington, 1926), 161, for lower estimates for 1920-23.

<sup>c</sup> Bureau of the Census, *Animal and Vegetable Fats and Oils* . . . .; quarterly and annual data in annual reports, 1923-32.

<sup>d</sup> See Table XII.

<sup>e</sup> *Annual Report of the Chief of the Bureau of Animal Industry, covering fiscal years ending June 30 of calendar years designated.*

<sup>f</sup> Our computations from value data given in Table XII, using the unit value shown by data for the meat-packing industry. The results afford a rough check upon other quantity estimates for these years.

TABLE X (Continued)

Year	U.S. Dept. of Agriculture estimates <sup>a</sup>	U.S. Tariff Commission estimates <sup>b</sup>	Census quarterly reports <sup>c</sup>	Census of Manufactures <sup>d</sup>		U.S. Dept. of Agriculture: federally inspected <sup>e</sup>
				Total	By meat-packers	
1928...	.....	.....	1,143,349	.....	.....	472,604
1929...	.....	.....	1,220,102	1,256,836	405,150	467,077
1930...	.....	.....	1,211,268	.....	.....	433,495
1931...	.....	.....	1,171,559	1,207,858	348,574	482,482
1932...	.....	.....	945,441	.....	.....	411,935
1933...	.....	.....	934,808 <sup>f</sup>	.....	.....	322,146

<sup>f</sup> Preliminary.

TABLE XI.—COMPOUND AND LARD PRODUCTION IN THE MEAT-PACKING INDUSTRY, COMPARED WITH TOTAL OUTPUT OF THE INDUSTRY, CENSUS YEARS, 1899-1931\*

Census year	Production (million dollars)				Percentage of total			Percentage of compound to lard and compound
	Compound <sup>a</sup>	Lard	Lard and compound	All products	Compound <sup>a</sup>	Lard	Lard and compound	
1899...	....	61.1 <sup>b</sup>	.....	784	...	7.8 <sup>b</sup>	...	....
1904...	....	82.5 <sup>b</sup>	.....	914	...	9.0 <sup>b</sup>	...	....
1909...	....	134.4 <sup>b</sup>	.....	1,356	...	9.9 <sup>b</sup>	...	....
1914...	33.0	120.4	153.4	1,652	2.0	7.3	9.3	21.5
1919...	123.7	415.8	539.5	4,246	2.9	9.8	12.7	22.9
1921...	39.7	190.4	230.1	2,201	1.8	8.7	10.5	17.3
1923...	37.2	263.9	301.1	2,586	1.4	10.2	11.6	12.4
1925...	59.6	279.6	339.2	3,050	1.9	9.2	11.1	17.6
1927...	50.3	234.9	285.2	3,057	1.6	7.7	9.3	17.6
1929...	46.9	248.0	294.9	3,435	1.4	7.2	8.6	15.9
1931...	31.3 <sup>c</sup>	149.4 <sup>d</sup>	180.7 <sup>e</sup>	2,177 <sup>d</sup>	1.4	6.9	8.3	21.1

\* Basic data from *Census of Manufactures, 1914*, II, 318, 333; *Fourteenth Census of the United States (1920)*, X, *Manufactures*, 46, 56; *Biennial Census of Manufactures, 1921*, pp. 124, 128; *ibid.*, 1923, pp. 141, 144; *ibid.*, 1925, pp. 158, 183, 187; *ibid.*, 1927, pp. 150, 173, 175; *Fifteenth Census of the United States, Manufactures (1929)*, II, 176-77; and mimeographed releases of the Bureau of the Census. Where figures first published were altered in subsequent reports, the latest source has been used.

<sup>a</sup> See Table XII, footnote \*, for designations in successive reports.

<sup>b</sup> Before compound production was separately reported, all or part of the compound manufactured was probably reported under lard.

<sup>c</sup> Data from condensed final report of the preliminary report of November 4, 1932.

<sup>d</sup> Data from preliminary report issued December 17, 1932.

<sup>e</sup> Sum of two columns preceding.

332 AMERICAN VEGETABLE-SHORTENING INDUSTRY

TABLE XII.—CENSUS OF MANUFACTURES DATA ON PRODUCTION OF COMPOUND, 1914-31\*

Year*	Meat-packing industry	All other industries	Shortening (ex-lard) industry	Other industries	Total reported
	QUANTITY PRODUCED (thousand pounds)				
1914 .....	396,398 <sup>b</sup>	(677,000)	(572,000)	(105,000)	(1,074,000)
1919 .....	521,122	(831,000)	(511,000) <sup>c</sup>	(320,000)	(1,352,000)
1921 .....	377,054	(539,000)	(318,000) <sup>c</sup>	(221,000)	(916,000)
1923 .....	287,735	(495,000)	(328,000) <sup>d</sup>	(167,000) <sup>d</sup>	(783,000)
1925 .....	450,880	678,510	622,795 <sup>d</sup>	55,715 <sup>d</sup>	1,129,390
1927 .....	438,037	801,050	775,006	26,044	1,239,087
1929 .....	405,150	851,686	832,354	19,332	1,256,836
1931 .....	364,271 <sup>e</sup>	843,587 <sup>e</sup>	833,291 <sup>e</sup>	10,296 <sup>e</sup>	1,207,858 <sup>e</sup>

\* *Census of Manufactures, 1914*, II, 333-34; *ibid.*, 1919, pp. 56-57; *Biennial Census of Manufactures, 1921*, pp. 128-29; *ibid.*, 1923, pp. 144-45; *ibid.*, 1925, pp. 158, 187; *ibid.*, 1927, pp. 150, 176; and mimeographed releases of the Bureau of the Census. Average f.o.b. factory prices are computed from the two published series. Figures in parentheses are our calculations from value data shown and the average prices for corresponding years indicated by data for the meat-packing industry.

What we have here termed simply "Compound" has been variously designated, apparently without change in scope or connotation, as follows: "Lard compounds and substitutes"—1914, 1919; "Lard compounds and other lard substitutes"—1921, 1923; "Lard substitutes and cooking fats"—1925, 1927, 1929; "Shortenings (other than lard)"—1931.

Because of changes in classification of establishments (see footnotes c and d below), the figures in the third and fourth columns are less comparable prior to 1927 than their sum here shown in the second column.

\* The figures shown do not relate precisely to the calendar year, for some establishments elect to report for their fiscal year conforming most closely to the calendar year. Hence quantity totals shown by the Census of Manufactures should not agree with those of the quarterly census of animal and vegetable fats and oils in Table X.

<sup>b</sup>The data for 1914 are presumably incomplete, even for meat-packers. The note which introduces the tabulation in which the value data appear reads in part:

"Many establishments in the slaughtering and meat-packing industry make large quantities of subsidiary products, some of which form the chief product of other industries distinguished by the census. A number of the large concerns kept separate accounts and made separate reports for the branches or departments making certain of these subsidiary products, such as soap; fertilizers; lard compound and substitutes; . . ."

\* A footnote to the census table for 1919 states that the total for industries "engaged primarily in manufacturing the product specified . . . includes in some cases products other than those specified." A similar note appears for 1921, and it may hold for other years as well.

<sup>d</sup>For 1923 and 1925, a footnote to this heading, there called "Establishments in other classifications," states that, "because of changes in classification, this figure is not comparable with those published for previous years." The same certainly applies also to 1927, when for the first time "establishments engaged primarily in the manufacture of vegetable cooking oils, most of which were formerly assigned to the 'Oils, not elsewhere classified' industry," were included in the "Lard substitutes and vegetable cooking oils" industry (previously the "Lard substitutes and cooking fats" industry). Figures for the years 1927-31 are presumably fully comparable, despite the change of name in 1931 to the "Shortenings (other than lard), vegetable cooking oils, and salad oils" industry.

<sup>e</sup> Preliminary data.

TABLES

333

TABLE XII (Continued)

Years	Meat-packing industry	All other industries	Shortening (ex-lard) industry	Other industries	Total reported
VALUE OF PRODUCT (thousand dollars)					
1914 .....	33,037 <sup>b</sup>	56,404	47,662	8,742	89,441
1919 .....	123,724	197,165	121,249 <sup>c</sup>	75,916	320,889
1921 .....	39,706	56,718	33,488 <sup>c</sup>	23,230	96,424
1923 .....	37,198	64,077	42,488 <sup>c</sup>	21,589 <sup>d</sup>	101,275
1925 .....	59,563	88,008	81,051 <sup>e</sup>	6,957 <sup>d</sup>	147,571
1927 .....	50,331	92,246	89,320	2,926	142,577
1929 .....	46,938	100,714	98,341	2,373	147,652
1931 .....	31,340 <sup>e</sup>	74,840 <sup>e</sup>	73,807 <sup>e</sup>	1,033 <sup>e</sup>	106,180 <sup>e</sup>
AVERAGE F.O.B. FACTORY PRICE (cents per pound)					
1914 .....	8.33	.....	.....	.....	.....
1919 .....	23.74	.....	.....	.....	.....
1921 .....	10.53	.....	.....	.....	.....
1923 .....	12.93	.....	.....	.....	.....
1925 .....	13.21	12.97	13.01	12.49	13.07
1927 .....	11.49	11.52	11.53	11.23	11.51
1929 .....	11.59	11.83	11.81	12.27	11.75
1931 .....	8.60	8.87	8.86	10.03	8.79

334 AMERICAN VEGETABLE-SHORTENING INDUSTRY

TABLE XIII.—CENSUS OF MANUFACTURES CLASSIFIED DATA ON COMPOUND PRODUCED IN THE SHORTENINGS (OTHER THAN LARD) INDUSTRY, 1925-31\*

Year	Package goods, 8 pounds and under			Other, over 8 pounds			Total from vegetable oils and fats only	Total from animal and vegetable oils and fats
	From vegetable oils and fats only	From animal and vegetable oils and fats	Total	From vegetable oils and fats only	From animal and vegetable oils and fats	Total		
<b>QUANTITY (thousand pounds)</b>								
1925	126,381	77,040	(203,421)	264,122	155,252	(419,374)	390,503	232,292
1927	205,144	80,580	(285,724)	332,194	157,088	(489,282)	537,338	237,668
1929	212,629	70,840	(283,469)	445,842	103,043	(548,885)	658,471	173,883
1931	218,768	106,248	(325,015)	381,405	126,870	(508,275)	600,173	233,118
<b>VALUE (thousand dollars)</b>								
1925	17,298	10,626	(27,924)	33,386	19,741	(53,127)	50,684	30,367
1927	26,019	10,159	(36,178)	35,838	17,304	(53,142)	61,857	27,463
1929	27,700	8,762	(36,462)	50,467	11,412	(61,879)	78,167	20,174
1931	21,804	9,646	(31,450)	32,068	10,289	(42,357)	53,872	19,935
<b>AVERAGE F.O.B. FACTORY PRICE (cents per pound)</b>								
1925	13.7	13.8	13.7	12.6	12.7	12.7	13.0	13.0
1927	12.7	12.6	12.7	10.8	11.0	10.9	11.5	11.6
1929	13.0	12.4	12.9	11.3	11.1	11.3	11.9	11.6
1931	10.0	9.1	9.7	8.4	8.1	8.3	9.0	8.6

\* See Table XII, footnote \*, for sources and its footnote d for lack of comparability of 1925 data with those for subsequent years. No corresponding data are available before 1925.

TABLE XIV.—SHORTENING MATERIALS USED IN THE COMMERCIAL BAKING INDUSTRY, CENSUS YEARS 1923-31\*

Year	Total	Butter and substitutes	All other shortenings	Lard	Other shortening	Lard substitutes
QUANTITY (million pounds)						
1923.....	423.2	33.4*	389.8	271.3	118.5	....
1925.....	398.9	30.1	368.8	....	....	....
1927.....	450.5	46.8	403.7	176.7	227.0	133.6
1929.....	562.8	50.1	512.7	253.4	259.3	117.8
1931.....	509.6	48.4	461.2	219.8	241.4	....
Cost (thousand dollars)						
1923.....	64,791	13,419*	51,372	35,238	16,134	....
1925.....	65,875	11,508	54,367	....	....	....
1927.....	70,245	14,869	55,376	25,837	29,539	17,365
1929.....	79,267	16,005	63,262	30,947	32,315	14,741
1931.....	51,978	10,382	41,596	19,459	22,137	....
AVERAGE COST PER POUND (cents)						
1923.....	15.3	40.1	13.2	13.0	13.6	....
1925.....	16.5	38.2	14.7	....	....	....
1927.....	15.6	31.8	13.7	14.6	13.0	13.0
1929.....	14.1	31.9	12.3	12.2	12.5	12.5
1931.....	10.2	21.5	9.0	8.9	9.2	....
PERCENTAGE OF TOTAL QUANTITY OF SHORTENING USED						
1923.....	....	7.9	92.1	64.1	28.0	....
1925.....	....	7.5	92.5	....	....	....
1927.....	....	10.4	89.6	39.2	50.4	29.7
1929.....	....	8.9	91.1	45.0	46.1	20.9
1931.....	....	9.5	90.5	43.1	47.4	....

\* Sources cited under Table XIV.

• Butter only.

### 336 AMERICAN VEGETABLE-SHORTENING INDUSTRY

TABLE XV.—COST OF PRINCIPAL MATERIALS USED IN THE COMMERCIAL BAKING INDUSTRY, CENSUS YEARS 1923-31\*

(Thousand dollars, except as noted)

Materials	1923	1925	1927	1929	1931
Flour .....	233,859	272,227	271,924	277,820	164,800
Sugar .....	61,448	40,707	48,536	52,701	39,511
Eggs .....	21,702	29,950	31,685	42,770	26,093
Milk .....	22,919	18,940	21,862	26,735	17,557
Yeast .....	18,828	16,404	17,917	20,104	18,094
Butter and substitutes....	13,419*	11,508	14,869	16,005	10,382
Lard .....	35,238	} 54,367	25,837	30,947	19,459
Lard substitutes.....	} 16,134*		17,365	14,741	} 22,137
Other shortenings .....			12,174	17,574	
<b>Total shortenings .....</b>	<b>64,791</b>		<b>65,875</b>	<b>70,245</b>	<b>79,267</b>
<b>Comparable total .....</b>	<b>423,547</b>	<b>444,103</b>	<b>462,169</b>	<b>498,397</b>	<b>318,033</b>
Fruits and nuts.....	18,761	.....	.....	.....	.....
Chocolate and cocoa.....	4,109	.....	.....	.....	.....
Malt extract .....	.....	2,968	3,172	3,601	2,855
All other .....	37,550	45,297	.....	.....	.....
<b>Reported total .....</b>	<b>483,967</b>	<b>492,369</b>	.....	.....	.....
<b>Cost of shortenings as percentage of—</b>					
Comparable totals .....	15.3	14.8	15.2	15.9	16.3
Reported totals .....	13.4	13.4	.....	.....	.....
<b>Percentage of total value of output produced by plants reporting above details .....</b>	<b>80.6</b>	<b>86.4</b>	<b>87.9</b>	<b>90.8</b>	<b>85.3</b>

\* Basic data from *Biennial Census of Manufactures, 1923*, p. 32; *ibid.*, 1925, p. 43; *ibid.*, 1927, p. 40; and *Fifteenth Census of the United States (1930), Manufactures (1929)*, II, 59-60; *Census of Manufactures, 1931, Bread and Other Bakery Products . . .*, 10. No corresponding data available prior to 1923.

\* Butter only.

\* Presumably including butter substitutes.



TABLE XVI.—RELATIVE IMPORTANCE OF VEGETABLE OIL COMPOUNDS AND COMPOUNDS CONTAINING ANIMAL FATS IN EXPORTS, 1922-32, AND IN PRODUCTION IN PART OF THE INDUSTRY, CENSUS YEARS 1925-31\*

Calendar year	Thousand pounds			Percentage of total	
	Vegetable oil compound	Containing animal fats	Total	Vegetable oil compound	Containing animal fats
EXPORTS OF COMPOUND					
1922.....	25,478	16,286	41,764	61.0	39.0
1923.....	9,617	7,451	17,068	56.3	43.7
1924.....	6,989	7,382	14,371	48.6	51.4
1925.....	8,223	14,091	23,314	36.9	63.1
1926.....	7,586	10,581	18,167	41.8	58.2
1927.....	5,431	8,988	14,419	37.7	62.3
1928.....	5,681	4,713	10,394	54.7	45.3
1929.....	6,343	3,632	9,975	63.6	36.4
1930.....	6,354	2,436	8,790	72.3	27.7
1931.....	4,348	1,646	5,994	72.5	27.5
1932.....	2,404	1,094	3,498	68.7	31.3
PRODUCTION IN SHORTENINGS (OTHER THAN LARD) INDUSTRY ONLY					
1925.....	390,503	232,292	622,795	62.7	37.3
1927.....	537,338	237,668	775,006	69.3	30.7
1929.....	658,471	173,883	832,354	79.1	20.9
1931.....	600,173	233,117	833,291	72.0	28.0

\* Export data from *Foreign Commerce and Navigation of the United States*; production data from sources noted in Table XII, the footnotes to which give certain explanations affecting the comparability of 1925 data with those for 1927-31 and indicate that 1931 data are preliminary.

## 338 AMERICAN VEGETABLE-SHORTENING INDUSTRY

TABLE XVII.—RAW MATERIALS USED IN MANUFACTURE OF COMPOUND, IN SPECIFIED YEARS, 1912-33\*

Calendar year	Materials used (million pounds)				Percentages of total		
	Cotton-seed oil	Other vegetable oils	Animal fats and oils	Total	Cotton-seed oil	Other vegetable oils	Animal fats and oils
1912.....	866.7	8.3	69.7	944.7	91.7	0.9	7.4
1914.....	1,053.1	9.9	80.2	1,143.2	92.2	0.8	7.0
1916.....	919.4	63.5	60.4	1,043.3	88.1	6.2	5.7
1917.....	1,069.2	87.0	65.9	1,222.1	87.5	7.1	5.4
1918.....	1,015.1	139.5	67.8	1,222.4	83.0	11.4	5.6
1920.....	605.3	89.4	61.5	756.2	80.1	11.8	8.1
1921.....	709.1	37.3	72.2	818.6	86.6	4.6	8.8
1922.....	655.7	49.3	68.9	773.9	84.7	6.3	9.0
1923.....	640.6	40.9	76.4	757.9	84.5	5.4	10.1
1929.....	1,083.2 <sup>a</sup>	21.6	115.3	1,220.1 <sup>b</sup>	88.8 <sup>c</sup>	1.8	9.4
1931.....	928.5	144.6	135.0	1,208.1	76.9	12.0	11.1
1932.....	834.4	50.7	83.5	968.6	86.2	5.2	8.6
1933.....	852.8	43.0	76.3	972.1	87.7	4.4	7.9

\* Retabulated from data assembled in U.S. Tariff Commission, *Report to the Congress on Certain Vegetable Oils, Whale Oil, and Copra* (Report No. 41, Second Series, Washington, 1932), 159-61, giving sources and qualifications partially discussed above, p. 117, and in footnotes to Table XVIII, with 1931, 1932, and 1933 data from annual mimeographed releases of the Census Bureau, "Factory Consumption of Animal and Vegetable Fats and Oils by Classes of Products" for 1931, 1932, and 1933.

<sup>a</sup> "Obtained by subtracting from the lard-compound production in 1929 the estimated consumption of other oils used in their manufacture." This may result in a slight understatement of the total. Since, however, the estimates of quantities of other vegetable oils used may be too low (see footnotes to Table XVIII), the figure for cottonseed oils may be too high, in percentage terms at least.

<sup>b</sup> Production of compound as reported by Bureau of the Census, *Animal and Vegetable Fats and Oils*. . . .

TABLE XVIII. — ANIMAL AND VEGETABLE FATS AND OILS (OTHER THAN COTTONSEED OIL) USED IN MANUFACTURE OF COMPOUND, IN SPECIFIED YEARS, 1912-33\*  
(Thousand pounds)

Calendar year	Tallow, edible	Oleostearin	Oleo oil	Pork fat and lard	Fish oils
1912.....	10,834	57,644	.....	1,200	.....
1914.....	13,945	64,926	.....	1,290	.....
1916.....	9,852	49,493	.....	1,069	.....
1917.....	9,953	54,959	.....	1,004	.....
1918.....	11,361	54,598	.....	1,850	.....
1920.....	9,925	41,871	97	9,604	.....
1921.....	10,142	46,779	235	15,042	.....
1922.....	10,683	43,916	2,791	11,489	.....
1923.....	23,408	43,075	2,655	7,066	.....
1929.....	25,556	44,138	7,553	23,123	14,921
1931.....	69,548	27,220	10,004	8,860	19,384
1932.....	45,708	17,357	1,134	5,636	13,705
1933.....	46,437	17,105	294	3,171	9,272

Calendar year	Peanut oil	Soy bean oil	Corn oil	Coconut oil	Other oils*
1912.....	1,687	.....	.....	.....	6,598
1914.....	2,144	1,585	.....	.....	6,158
1916.....	17,869	14,247	13,105	.....	30,715
1917.....	12,209	34,351	4,166	5,545	12,742
1918.....	27,912	56,517	2,288	13,408	39,426

\* Sources as for Table XVII. See text, pp. 119, 125, for corresponding percentages of total materials used. Fish oils include marine animal oils, such as whale oil.

\* Including vegetable stearin (1912—180; 1914—611; 1916—4,007; 1917—17,140; 1918—14,904), palm oil, sesame oil; also hydrogenated oils as follows: 1914—83; 1916—778; 1917—333; 1918—18,172. The last, according to Department of Agriculture Bulletin 769, Supplement, p. 6, "represent largely the amount of hydrogenated oil purchased by the smaller substitute makers for combining with the other ingredients."

## 340 AMERICAN VEGETABLE-SHORTENING INDUSTRY

TABLE XVIII (Continued)

Calendar year	Peanut oil	Soy bean oil	Corn oil	Coconut oil	Other oils <sup>a</sup>
1920.....	48,209	17,607	7,095	9,714	6,720
1921.....	15,761	8,166	2,960	3,014	7,449
1922.....	9,841	.....	14,200	16,099	9,149
1923.....	3,813	681	6,721	21,205	8,404
1929.....	..... <sup>b</sup>	.....	..... <sup>b</sup>	20,000 <sup>c</sup>	1,608 <sup>d</sup>
1931.....	5,960	10,869	6,616	34,132	87,060 <sup>e</sup>
1932.....	3,502	4,889	3,067	8,332	30,880 <sup>f</sup>
1933.....	3,330	489	1,128	7,112	30,956 <sup>f</sup>

<sup>b</sup> "Peanut and corn oils shown by the Bureau of the Census as used in 1929 in food industries other than the margarine industry were regarded as used solely in making salads and table oil. This involves a slight error, for it is probable that small but indeterminate quantities of these oils were used in lard compounds."

<sup>c</sup> "From the quantities of coconut and palm-kernel oils shown by the Bureau of the Census as consumed in 1929 in food industries other than margarine, there were deducted sales of these oils to the confectionery and baking trades by six leading refiners. The remainder, which is the figure given, is probably only a slight overstatement of the consumption of those oils in lard compounds."

<sup>d</sup> Including palm oil, 1,191. "Palm oil shown by the Bureau of the Census as used in 1929 in food industries other than the margarine was taken as used entirely in lard compounds. An estimate made by one of the leaders in the trade showed 10,000,000 instead of a little over 1,000,000 pounds." The Tariff Commission's report, cited above, gives on p. 31 a figure of 5.2 million pounds of sesame oil for 1929; but this does not appear in the table on p. 160 from which the above data are taken.

<sup>e</sup> Including palm oil, 34,536; sesame oil, 33,817; palm-kernel oil, 158; other, 18,549.

<sup>f</sup> Including palm oil, 22,126; sesame oil, 7,797; other, 957.

<sup>g</sup> Including palm oil, 21,116; sesame oil, 7,371; and sunflower oil, 2,469.

TABLE XIX.—TARIFF DUTIES ON FATS AND OILS AND THEIR FOOD PRODUCTS, 1883-1932\*

(Cents per pound)

Date effective	Lard	Lard com- pounds	Oleo- stearin	Cotton- seed oil	Peanut oil	Soy bean oil	Coconut oil <sup>a</sup>
1882, July 1.....	2.0	...	...	3.3 <sup>b</sup>	...	...	free
1890, Oct. 6.....	2.0	...	...	1.3 <sup>b</sup>	...	...	free
1894, Aug. 1.....	1.0	...	...	free	...	...	free
1897, July 25.....	2.0	...	...	0.5 <sup>b</sup>	...	...	free
1909, Aug. 6.....	1.5	...	free	free	free	free	free
1913, Oct. 4.....	free	free	free	free	0.8 <sup>c</sup>	free	free
1921, May 28.....	free	free	...	2.7 <sup>b</sup>	3.5 <sup>f</sup>	2.7 <sup>b</sup>	2.7 <sup>b</sup>
1922, Sept. 22...	1.0	4.0	1.0	3.0	4.0	2.5	2.0
1930, June 15....	3.0	5.0	1.0	3.0	4.0	3.5 <sup>f</sup>	2.0

\* Basic data from *United States Statutes at Large*, XXII, 491-526; XXVI, 567-617; XXVIII, 509-71; XXX, 151-213; XXXVI, Pt. I, 11-118; XXXVIII, Pt. I, 114-66; XLII, Pt. I, 9-11, 858-990; XLVI, Pt. I, 590-763. Palm oil and vegetable tallow, and copra, palm nuts, palm kernel nuts, and sesame seed have been duty-free throughout. Under the Act of 1930 duties are imposed on cottonseed, peanuts (shelled and unshelled), and soy beans (prepared and unprepared). Additional fats and oils dutiable under the Act of 1930 are:

	Cents per pound		Cents per gallon
Palm kernel oil, edible.....	1.0	Cod, herring, and men- haden oil .....	5.0
Sesame oil, edible.....	3.0	Whale and seal oil.....	6.0
Animal tallow .....	0.5	Sperm oil, crude.....	10.0
		Sperm oil, refined.....	14.0

Under the Act of 1930, unspecified animal and fish oils, and unspecified expressed or extracted vegetable oils, are dutiable at 20 per cent ad valorem.

<sup>a</sup> Crude or refined. The duty does not apply to imports from the Philippine Islands. Copra has always been admitted duty-free.

<sup>b</sup> Expressed in the Tariff Act in cents per gallon: 1883-25; 1890-10; 1897-4; 1921-20.

<sup>c</sup> Under the Tariff Act of 1894, oleostearin was dutiable as a non-enumerated manufactured article, and not free under Paragraph 645 as tallow, according to Treasury Decision No. 16534 (G.A. 3252), in *Compilation of Customs Laws and Digest of Decisions Thereunder*, 1908, p. 848.

<sup>d</sup> Not enumerated, but presumably free under "other nut oils."

<sup>e</sup> Expressed as 6 cents per gallon; also rapeseed oil.

<sup>f</sup> Expressed as 26 cents per gallon.

<sup>g</sup> "... but not less than 45 per centum ad valorem."

## 342 AMERICAN VEGETABLE-SHORTENING INDUSTRY

**TABLE XX.—APPROXIMATE PER CAPITA CONSUMPTION OF LARD, COMPOUND, BUTTER, AND MARGARINE, ANNUALLY, 1900-32\***  
(Pounds)

Year	Lard	Compound	Lard and compound	Butter and margarine <sup>a</sup>	Butter	Margarine <sup>b</sup>	Four fats <sup>c</sup>
1900.....	13.2	....	....	20.9	19.6	1.4	....
1901.....	12.9	....	....	21.0	19.6	1.3	....
1902.....	11.7	....	....	19.5	18.3	1.5	....
1903.....	11.8	....	....	20.2	19.5	0.8	....
1904.....	12.4	....	....	19.7	19.2	0.5	....
1905.....	10.0	....	....	21.0	20.5	0.5	....
1906.....	11.2	....	....	19.7	19.1	0.5	....
1907.....	13.5	....	....	18.2	17.4	0.8	....
1908.....	13.5	....	....	19.5	18.6	0.9	....
1909.....	11.5	....	....	19.1	17.8	1.0	....
1910.....	11.4	....	....	18.2	16.8	1.5	....
1911.....	11.3	....	....	18.2	16.9	1.3	....
1912.....	11.2	8.3 <sup>a</sup>	19.5 <sup>a</sup>	18.0	16.6	1.3	37.5 <sup>a</sup>
1913.....	11.3	....	....	18.0	16.5	1.5	....
1914.....	12.0	10.8	22.8	18.4	17.0	1.4	41.2
1915.....	12.8	....	....	18.7	17.3	1.4	....
1916.....	13.6	9.5	23.1	19.2	17.5	1.5	42.3
1917.....	11.3	10.8	22.1	18.5	15.9	2.2	40.6
1918.....	13.6	10.5	24.1	17.0	13.8	3.1	41.1
1919.....	11.9	11.6	23.5	18.8	15.4	3.3	42.3
1920.....	13.3	6.7	20.0	17.9	14.9	3.5	37.9
1921.....	11.2	7.0	18.2	18.2	16.1	2.6	36.4
1922.....	14.1	6.7	20.8	18.7	16.9	1.7	39.5
1923.....	15.2	6.5	21.7	19.9	17.9	1.8	41.6
1924.....	15.4	7.1	22.5	20.3	18.3	2.1	42.8

\* Our computations from consumption data and population estimates derived as follows: *Lard* consumption computed from production and export data in Table IX. *Compound* consumption computed from production data in Table X and exports and shipments data by calendar years from Tables V and VA and sources there cited. *Butter* consumption, 1900-11, computed from production estimates given in *Farm Economics* (Cornell University), February 1934, p. 2030; 1912-33, from U.S. Department of Agriculture, *Fats and Oils Statistics* . . . . (March 1, 1934), Table 40; and import, export, and shipments data in part from these sources and from *Commerce and Navigation of the United States* and *Monthly Summary of Foreign Commerce of the United States* (using July-June data from 1899-1900 to 1915-16). *Margarine* consumption (for fiscal years ending June 30) computed from production and trade data in Snodgrass, *op. cit.*, 312-13, and for 1929-32 from sources therein cited.

Population estimates here used are as of July 1 (for margarine, January 1), as reported for 1900-08 and 1930-32 in *Statistical Abstract of the United States*, 1933, p. 10, and for 1909-29 as estimated by the National Bureau of Economic Research, as reported for 1909-21 in W. L. King, *The National Income and Its Purchasing Power* (1930), 47, and for 1922-29 in F. C. Mills, *Economic Tendencies in the United States* (1932), 417.

The resulting per capita figures accordingly differ slightly from those given for lard in Table IX and for butter and margarine in Snodgrass, *op. cit.*, 310-11.

<sup>a</sup> Including for margarine successive two-year averages of data in the sixth column.

<sup>b</sup> For fiscal years ending June 30, 1900-32.

<sup>c</sup> We regard the 1912 estimate for compound as much too low (see text, p. 107), and consequently also the totals in which it is indicated.

TABLE XX (Continued)

Year	Lard	Compound	Lard and compound	Butter and margarine*	Butter	Margarine <sup>b</sup>	Four fats*
1925.....	13.0	9.5	22.5	19.4	17.4	1.9	41.9
1926.....	13.5	9.5	23.0	19.3	17.2	2.1	42.3
1927.....	13.7	9.7	23.4	19.7	17.4	2.2	43.1
1928.....	14.9	9.4	24.3	19.7	17.1	2.5	44.0
1929.....	14.2	9.9	24.1	20.5	17.7	2.7	44.6
1930.....	13.6	9.7	23.3	19.7	17.2	2.8	43.0
1931.....	14.4	9.4	23.8	19.7	17.7	2.2	43.0
1932.....	14.6	7.5	22.1	19.8	18.1	1.7	41.9
1933.....	15.1	7.4	22.5	20.0	18.3	1.7	42.5

TABLE XXI.—WHOLESALE PRICES OF LARD, NEW YORK,  
MONTHLY, 1875-1933\*

(Cents per pound)

Year	Av.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1875..	14.0	14.0	14.0	14.0	15.7	15.4	13.8	13.7	13.7	13.6	14.0	12.9	13.0
1876..	11.8	12.3	13.1	13.9	13.8	12.5	11.5	11.3	10.8	10.6	10.4	10.5	10.6
1877..	9.5	11.3	10.3	9.8	10.1	9.3	9.3	9.3	8.9	9.1	9.0	8.5	8.3
1878..	7.1	7.3	7.7	7.4	7.3	7.0	7.1	7.3	7.7	7.0	6.6	6.2	5.9
1879..	6.6	6.2	6.9	6.6	6.4	6.3	6.4	6.1	5.9	6.2	6.7	7.2	7.9
1880..	7.9	7.9	7.7	7.6	7.4	7.2	7.2	7.3	8.0	8.3	8.6	8.6	8.9
1881..	11.3	9.4	10.3	10.3	11.5	11.3	11.3	12.2	11.6	12.3	12.0	11.4	11.2
1882..	11.6	11.3	11.1	10.8	11.4	11.6	11.3	12.3	12.6	12.4	12.3	11.9	11.0
1883..	9.3	10.3	11.3	11.4	11.4	11.6	10.6	9.1	8.7	8.4	7.9	8.0	8.9
1884..	8.3	9.3	9.9	9.6	8.6	8.5	8.0	7.5	7.9	7.7	7.7	7.4	7.1
1885..	6.3	7.2	7.3	7.2	7.2	7.0	6.3	6.3	6.6	6.4	6.3	6.5	6.4
1886..	6.5	6.4	6.4	6.3	6.2	6.2	6.3	6.3	7.3	7.2	6.1	6.2	6.5
1887..	7.1	6.3	7.1	7.6	7.5	7.0	6.3	6.9	6.3	6.3	6.3	7.2	7.9
1888..	8.7	7.6	8.0	8.0	8.1	8.7	8.7	8.6	9.3	10.6	9.7	8.7	8.5
1889..	6.9	7.6	7.2	7.3	7.2	7.2	6.9	6.6	6.6	6.4	6.3	6.5	6.2
1890..	6.3	6.2	6.2	6.4	6.6	6.5	6.1	6.1	6.4	6.4	6.5	6.3	6.1
1891..	6.6	6.2	6.0	6.5	7.0	6.7	6.4	6.6	6.9	7.2	6.7	6.5	6.4
1892..	7.7	6.6	6.3	6.6	6.5	6.6	6.3	7.5	8.1	7.3	8.3	9.9	10.3
1893..	10.4	11.3	12.7	12.4	10.3	11.1	10.1	10.0	8.5	9.6	10.3	9.4	8.6
1894..	7.7	8.3	7.9	7.3	7.9	7.6	7.0	7.3	7.9	9.1	7.3	7.4	7.2

\* The standard grade quoted is variously termed "Western Steam" or "Prime Contract." Data from *Annual Statistical Reports of the New York Produce Exchange, 1907*, p. 110; *ibid.*, 1929, p. 103; and for 1930-33 direct from the New York Produce Exchange. Data are monthly averages of daily quotations as reported, except for 1879-83, which are our computations of means of monthly highs and lows reported. Annual averages are simple averages of monthly data.

## 344 AMERICAN VEGETABLE-SHORTENING INDUSTRY

TABLE XXI (Continued)

(Cents per pound)

Year	Av.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1895..	6.5	7.0	6.8	7.0	7.2	6.9	6.7	6.4	6.4	6.2	6.0	5.8	5.5
1896..	4.7	5.9	5.8	5.5	5.2	4.8	4.4	3.8	3.7	3.8	4.6	4.4	4.1
1897..	4.4	4.2	4.1	4.4	4.4	4.1	3.9	4.3	4.8	5.0	4.7	4.5	4.7
1898..	5.5	5.1	5.3	5.4	5.6	5.5	6.1	5.8	5.5	5.2	5.2	5.2	5.4
1899..	5.6	5.9	5.7	5.6	5.5	5.3	5.3	5.6	5.6	5.7	5.7	5.4	5.7
1900..	7.0	6.2	6.3	6.4	7.4	7.3	7.0	7.1	7.1	7.3	7.5	7.5	7.4
1901..	8.9	7.6	7.3	8.1	8.7	8.4	8.8	8.9	9.1	10.1	9.8	9.1	10.2
1902..	10.6	9.9	9.7	9.8	10.1	10.6	10.7	11.2	10.9	11.0	11.1	11.2	10.9
1903..	8.8	10.3	10.3	10.3	10.2	9.3	9.0	8.0	8.0	8.3	7.3	7.3	7.0
1904..	7.3	7.4	7.9	7.3	7.0	6.8	7.0	7.2	7.2	7.5	7.9	7.4	7.2
1905..	7.4	7.0	7.0	7.2	7.4	7.3	7.2	7.3	8.0	7.9	7.6	7.5	7.9
1906..	8.9	7.9	8.0	8.3	8.9	8.8	9.0	9.1	9.0	9.0	9.6	9.6	9.2
1907..	9.2	9.7	10.1	9.4	9.0	9.3	9.0	9.1	9.2	9.2	9.3	8.6	8.4
1908..	9.1	8.2	7.5	8.0	8.5	8.6	8.9	9.6	9.7	10.5	10.1	9.7	9.6
1909..	11.7	9.9	9.3	10.4	10.6	11.0	11.9	12.0	12.0	12.7	12.7	13.5	13.5
1910..	12.5	12.7	12.9	14.4	13.4	13.2	12.5	12.0	12.0	12.7	12.7	11.2	10.6
1911..	9.1	10.6	9.7	9.2	8.2	8.3	8.5	8.4	9.2	9.6	9.1	9.3	9.2
1912..	10.5	9.3	9.0	9.4	10.4	10.7	10.7	10.5	11.0	11.4	11.8	11.3	10.6
1913..	11.0	10.1	10.6	11.1	11.2	11.1	11.1	11.6	11.4	11.4	10.8	11.0	10.8
1914..	10.4	11.0	10.7	10.6	10.4	10.1	10.1	10.2	10.0	10.0	10.4	11.1	10.2
1915..	9.4	10.7	10.3	9.9	9.9	9.3	9.2	8.2	8.1	8.3	9.4	9.3	9.3
1916..	13.5	10.4	10.3	11.2	12.2	12.1	13.1	13.2	13.3	14.9	15.3	17.3	16.6
1917..	21.9	16.1	17.0	19.9	21.6	22.6	21.2	20.1	22.7	24.4	24.6	27.6	25.3
1918..	26.0	25.1	26.5	26.6	25.8	25.1	24.5	28.2	26.8	27.1	26.2	27.0	25.5
1919..	23.9	23.8	25.0	27.3	30.9	34.0	34.9	35.0	30.7	26.7	26.2	26.2	23.7
1920..	19.9	24.0	20.9	20.3	20.0	20.3	20.4	19.3	19.0	20.2	20.6	19.2	14.6
1921..	11.1	13.6	12.4	12.2	10.5	9.9	10.2	12.3	11.3	11.3	10.1	9.3	9.4
1922..	11.5	10.0	11.7	11.7	11.2	12.0	12.0	11.7	11.4	11.4	11.7	11.5	11.4
1923..	12.3	11.8	11.7	12.5	11.9	11.6	11.4	11.3	11.6	12.3	12.3	14.3	12.9
1924..	13.1	12.3	11.6	11.5	11.3	11.0	11.1	12.3	14.4	14.3	14.4	15.3	16.9
1925..	16.7	16.5	16.0	17.2	16.1	16.3	17.6	19.1	17.9	17.3	16.3	16.2	14.9
1926..	15.0	15.7	15.2	15.1	14.6	15.9	17.0	16.4	15.6	15.1	14.3	12.3	12.9
1927..	12.8	12.9	12.8	13.0	12.3	12.9	13.1	12.0	12.7	13.2	12.9	12.6	12.1
1928..	12.3	12.4	11.6	11.8	12.1	12.3	12.1	12.6	12.9	13.2	12.4	12.0	11.7
1929..	12.0	12.2	12.3	12.5	12.2	12.1	12.3	12.6	12.4	12.1	11.4	11.0	10.3
1930..	10.9	10.8	11.2	10.7	10.8	10.7	10.2	10.9	11.4	12.0	12.0	11.1	10.0
1931..	8.0	9.0	8.5	9.3	9.0	8.2	8.3	8.1	7.5	7.5	6.0	7.0	6.0
1932..	5.0	5.5	5.2	5.1	4.8	4.3	4.3	5.5	5.5	5.4	4.3	5.3	4.7
1933..	5.6	4.7	4.3	4.6	5.2	6.5	6.6	6.9	6.0	6.1	5.8	5.3	6.1



TABLE XXII.—WHOLESALE PRICES OF COTTONSEED OIL (PRIME SUMMER YELLOW), NEW YORK, MONTHLY, 1875-1933\*  
(Cents per pound)

Year	Av.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1875..	7.6	7.0	7.0	6.9	8.0	9.2	8.3	7.6	7.2	7.2	7.4	7.9	7.7
1876..	6.8	7.9	7.8	7.4	7.2	6.7	6.6	6.4	6.3	6.2	6.2	6.4	6.6
1877..	7.0	7.0	7.2	6.7	6.8	6.8	6.7	6.9	7.1	7.1	7.2	7.3	7.3
1878..	6.3	6.8	6.8	6.8	6.8	6.6	6.4	6.3	6.3	6.0	6.0	5.9	5.5
1879..	5.8	5.4	5.5	5.4	5.4	5.6	5.8	5.9	5.7	5.6	6.0	6.3	6.6
1880..	5.7	6.9	6.4	6.0	6.5	5.4	5.5	5.3	5.3	5.5	5.6	5.8	5.7
1881..	6.2	5.6	5.7	6.0	5.9	6.0	5.9	5.8	6.0	6.9	7.8	6.8	6.6
1882..	7.1	6.3	6.0	6.1	6.6	7.1	7.1	7.6	8.0 <sup>a</sup>	8.1	8.1	7.3	6.7
1883..	6.2	6.3	6.5	6.8	6.6	6.5	6.4	6.2	6.1 <sup>a</sup>	5.8	5.7	5.6	5.9
1884..	5.6	6.0	5.9	5.8	5.6	5.6	5.5	5.4	5.5 <sup>a</sup>	5.7	5.7	5.4	5.4
1885..	5.1	5.3	5.4	5.3	5.2	5.1	5.1	5.0	5.0	5.0	5.0	4.8	4.5
1886..	4.6	4.2	4.2	3.9	3.9	3.9	4.3	4.6	5.1	5.3	5.1	5.1	5.1
1887..	5.4	5.4	5.3	5.2	5.0	5.2	5.5	5.4	5.3	5.4	5.5	5.9	5.7
1888..	6.1	5.5	5.5	5.4	5.2	6.0	6.2	6.2	6.3	6.4	6.8	7.0	7.2
1889..	6.3	7.1	6.6	6.7	6.8	6.7	6.7	6.7	6.7	6.1	5.9	5.0	4.6
1890..	4.7	4.5	4.6	4.6	4.8	5.0	5.0	4.8	4.7	4.6	4.5	4.5	4.5
1891..	4.9	4.7	4.6	4.8	5.1	5.4	5.5	5.5	5.3	5.2	4.6	3.9	4.0
1892..	4.3	3.9	3.9	3.8	4.2	4.2	4.3	4.3	4.2	4.1	4.1	4.4	5.5
1893..	6.0	6.6	6.2	7.5	6.2	6.5	5.3	5.7	5.6	5.1	5.3	5.0	4.5
1894..	4.3	4.7	4.5	4.2	4.4	4.4	4.4	4.4	4.4	4.6	4.2	4.0	3.8
1895..	3.6	3.7	3.5	3.5	3.6	3.6	3.6	3.6	3.7	3.6	3.7	3.9	3.8
1896..	3.4	3.6	3.5	3.4	3.4	3.3	3.3	3.2	3.1	3.2	3.6	3.4	3.1
1897..	3.2	3.1	3.1	3.1	3.1	3.2	3.1	3.3	3.5	3.6	3.2	2.9	2.9
1898..	3.1	3.0	3.0	3.0	3.0	3.4	3.3	3.1	3.1	3.0	3.0	3.0	2.9
1899..	3.5	3.1	3.3	3.5	3.5	3.4	3.4	3.4	3.5	3.5	3.9	3.7	4.3
1900..	4.7	4.8	5.0	4.8	5.0	5.0	4.8	4.9	4.6	4.8	4.8	4.4	4.0
1901..	4.8	4.1	4.1	4.2	4.7	4.6	5.0	5.1	5.3	5.5	5.5	4.7	5.3
1902..	5.5	5.7	5.5	5.6	5.8	6.1	6.0	5.8	5.6	5.4	6.1	4.7	5.0
1903..	5.4	5.4	5.4	5.5	5.7	5.7	6.6	5.7	5.5	5.5	5.3	4.6	4.8
1904..	4.1	4.9	5.1	4.9	4.3	3.8	3.9	3.5	3.8	3.9	3.8	3.6	3.3
1905..	3.6	3.1	3.5	3.4	3.4	3.7	3.8	3.8	4.0	3.6	3.5	3.8	4.0
1906..	5.0	4.4	4.2	4.4	4.9	5.2	4.9	5.1	5.0	5.1	5.7	5.3	5.6
1907..	6.5	6.0	6.3	6.3	6.1	7.3	7.8	7.5	7.3	7.4	6.5	4.6	5.0
1908..	5.6	6.1	5.5	5.3	5.7	6.1	6.3	6.1	5.1	5.3	5.1	5.1	5.2
1909..	5.9	5.5	5.5	5.4	5.6	5.7	5.7	5.6	5.5	5.9	6.6	6.8	7.3

\* For 1875-90, basic data from *Oil, Paint, and Drug Reporter*. Average of prices as of the first and fifteenth of the month and the prices as of the first of the month following, the mid-month price being weighted doubly, 1875 to July 1885; averages of monthly high and low prices of "Prime Cottonseed Oil for Immediate Shipment from the Southeast," August 1885 to December 1890. For 1891-1932, monthly averages of daily quotations direct from the New York Produce Exchange, 1891-99 and 1930-33, and for 1900-29 from *Annual Statistical Reports of the New York Produce Exchange*, except as noted. These averaged about .2 cent per pound above averages of monthly price ranges as reported in the *Oil, Paint, and Drug Reporter* for 1891 and about .1 cent above for 1930. Annual averages are simple averages of monthly data.

<sup>a</sup> Average of prices as of the first of August and the first of September.

346 AMERICAN VEGETABLE-SHORTENING INDUSTRY

TABLE XXII (Continued)

(Cents per pound)

Year	Av.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1910..	8.1	7.8	7.1	7.5	7.8	8.0	8.0	8.5	10.8	10.1	8.1	7.8	7.2
1911..	6.8	7.8	7.0	6.6	6.2	6.6	6.4	5.9	5.8	7.0	6.0	5.7	5.4
1912..	6.8	5.4	5.5	5.7	6.5	7.2	6.9	6.7	6.5	6.4	6.2	6.0	5.8
1913..	7.8	6.2	6.4	6.4	7.0	7.0	7.7	9.1	8.9	7.7	7.0	7.0	6.9
1914..	6.7	7.0	7.1	7.4	7.5	7.2	7.8	7.2	6.7	5.9	5.2	5.6	5.8
1915..	6.8	6.6	7.1	6.7	6.6	6.4	6.2	6.1	5.8	6.8	7.7	7.9	8.4
1916..	10.6	8.8	9.6	10.5	10.7	10.9	10.9	10.0	9.8	10.2	11.8	12.6	12.4
1917..	15.6	12.8	12.5	13.6	15.8	16.2	15.8	14.5	14.8	15.4	18.0	18.6	18.6
1918..	20.1	20.1	20.8	19.8	19.8	19.9 <sup>b</sup>	20.2 <sup>b</sup>	20.2 <sup>b</sup>	20.2 <sup>b</sup>	20.2 <sup>b</sup>	20.2 <sup>b</sup>	20.2 <sup>b</sup>	20.2 <sup>b</sup>
1919..	22.4	20.2 <sup>b</sup>	20.2 <sup>b</sup>	20.2 <sup>b</sup>	21.2 <sup>b</sup>	21.2 <sup>b</sup>	25.0	27.4	25.9	21.8	23.5 <sup>c</sup>	22.0 <sup>c</sup>	20.8 <sup>c</sup>
1920..	15.4	21.9	19.7	19.1	18.5	19.2	16.7	18.2	12.8	18.5	11.4	10.1	8.9
1921..	8.0	8.6	7.8	6.8	6.2	7.2	7.5	8.6	8.7	9.9	8.7	6.8	8.8
1922..	10.2	8.6	9.9	11.5	11.6	11.7	11.8	10.7	10.6	8.7	8.9	9.5	9.5
1923..	11.3	10.8	10.9	11.8	11.8	11.6	11.4	10.4	10.8	11.6	12.1	11.6	11.0
1924..	10.9	11.0	10.4	9.8	10.1	9.8	10.6	12.1	13.8	10.5	11.0	10.9	11.4
1925..	10.8	11.2	10.7	11.2	11.1	10.6	10.8	11.4	11.2	10.8	9.9	10.3	10.5
1926..	11.9	11.8	11.8	12.3	12.4	14.5	15.4	14.9	13.1	11.2	9.5	8.2	8.2
1927..	9.7	8.5	9.8	9.4	8.8	9.1	9.2	9.6	10.0	10.8	10.8	10.6	10.0
1928..	9.9	10.0	9.8	9.6	10.1	10.6	10.2	10.0	9.5	10.0	9.9	9.7	10.2
1929..	9.7	10.8	10.6	10.7	10.1	9.4	9.4	9.7	9.8	9.2	9.4	9.0	8.8
1930..	8.2	8.5	8.5	8.4	8.8	8.8	8.5	8.0	8.8	8.2	7.6	7.6	7.3
1931..	6.1	7.2	7.8	7.6	7.4	6.9	6.7	7.0	5.4	4.2	4.4	4.5	4.1
1932..	8.8	4.1 <sup>d</sup>	4.1 <sup>d</sup>	4.0 <sup>d</sup>	3.4 <sup>d</sup>	3.2 <sup>d</sup>	3.2 <sup>d</sup>	3.9 <sup>d</sup>	4.5 <sup>d</sup>	4.5 <sup>d</sup>	4.0 <sup>d</sup>	3.7 <sup>d</sup>	3.5 <sup>d</sup>
1933..	4.4	3.6 <sup>d</sup>	3.5 <sup>d</sup>	3.7 <sup>d</sup>	4.2 <sup>d</sup>	5.0 <sup>d</sup>	5.6 <sup>d</sup>	8.1 <sup>d</sup>	5.2 <sup>d</sup>	4.9 <sup>d</sup>	4.2 <sup>d</sup>	3.7 <sup>d</sup>	3.4 <sup>d</sup>

<sup>b</sup> Monthly average of high and low prices as reported in *Oil, Paint, and Drug Reporter*, here compiled from *Statistics of Fats, Oils, and Oleaginous Raw Materials* (U.S. Department of Agriculture Statistical Bulletin No. 24, September 1928), 58. Corresponding prices for June to September 1919 run considerably lower than the ones here included.

<sup>c</sup> Averages of monthly high and low prices as reported in *Annual Statistical Report of the New York Produce Exchange, 1919*, p. 93. Prices were not reported continuously during these months.

<sup>d</sup> Prices of "Bleachable Prime Summer Yellow" cottonseed oil, which averaged about .1 cent above prices of "Prime Summer Yellow" from April 1931 to March 1932.

<sup>e</sup> Computed from prices of near futures, no "spot" quotations being reported.

TABLE XXIII.—WHOLESALE PRICES OF COMPOUND, NEW YORK,  
MONTHLY, 1897-1933\*

(Cents per pound)

Year	Av.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1897..	4.3	...	4.2	4.2	4.3	4.1	3.9	4.1	4.4	4.9	4.6	4.2	4.1
1898..	4.3	4.2	4.4	4.2	4.1	4.6	4.8	4.4	4.4	4.4	4.1	3.9	4.1
1899..	4.9	4.4	4.4	4.6	4.6	4.6	4.7	4.7	5.4	5.1	5.3	5.4	5.3
1900..	6.2	5.8	6.2	6.2	6.4	6.4	6.3	6.3	6.1	6.1	6.2	6.1	5.9
1901..	6.9	5.8	5.6	5.8	6.4	6.6	6.9	7.0	7.2	7.8	8.0	7.6	7.9
1902..	8.0	8.1	8.0	7.5	8.2	8.6	8.4	8.2	8.1	7.6	7.6	7.6	7.6
1906..	7.2	7.6	7.6	7.6	7.4	7.6	7.5	7.4	7.0	7.1	7.1	6.5	6.2
1904..	6.1	6.6	6.8	6.9	6.5	5.9	5.8	5.8	5.9	5.7	6.1	5.7	5.3
1905..	5.3	4.8	4.8	4.8	5.1	5.3	5.3	5.5	5.8	5.3	5.6	5.5	5.6
1906..	6.9	5.8	6.1	6.0	6.6	7.1	7.0	7.1	7.1	7.1	7.4	7.6	7.8
1907..	8.5	8.2	8.5	8.4	8.1	8.2	9.1	9.1	8.9	8.8	8.8	8.1	7.4
1908..	7.5	7.2	7.1	6.9	7.5	7.8	7.9	8.1	8.2	7.9	7.7	7.2	7.1
1909..	8.4	7.2	7.6	7.9	8.0	7.9	8.2	7.8	7.7	8.1	9.5	10.2	10.2
1910..	10.0	10.2	9.8	10.1	10.4	10.1	9.5	9.6	10.8	11.2	10.4	9.0	8.8
1911..	7.6	8.8	8.2	7.9	7.2	7.2	7.5	7.5	7.4	7.6	7.9	7.5	7.1
1912..	8.1	6.8	7.0	7.2	8.3	9.0	8.9	8.7	8.4	8.2	8.2	8.1	7.9
1913..	8.7	7.8	7.8	7.9	8.3	8.4	8.8	9.8	10.4	9.8	8.7	8.6	8.6
1914..	8.1	8.3	8.3	8.2	8.4	8.2	8.4	8.5	8.4	8.2	7.4	7.2	7.4
1915..	7.9	7.4	7.6	7.8	7.6	7.5	7.3	7.1	7.0	7.2	8.9	9.6	9.7
1916..	12.1	10.1	10.5	11.2	13.0	12.0	12.0	11.4	10.8	11.5	13.6	15.0	14.6
1917..	17.3	14.2	12.0	14.4	16.4	18.0	18.2	16.8	16.2	17.0	20.1	21.4	22.8
1918..	23.1	23.0	23.0	23.0	23.0	22.2	23.1	22.9	23.1	23.1	23.6	23.6	23.6
1919..	25.2	23.6	23.6	23.6	23.1	24.1	26.9	29.2	28.5	26.8	23.5	25.4	24.6
1920..	19.4	25.0	24.0	22.4	22.0	21.5	21.0	19.1	18.6	16.8	16.2	14.2	12.1
1921..	10.3	11.4	10.6	9.8	8.5	8.8	9.2	10.2	11.0	11.6	11.8	10.5	10.1
1922..	12.0	10.2	11.6	13.5	13.0	13.0	13.0	12.5	11.8	11.1	11.0	11.1	11.8
1923..	12.9	12.4	12.8	13.2	13.5	13.2	12.8	12.2	11.9	12.9	13.4	13.6	13.4
1924..	18.0	13.1	13.1	11.9	11.9	11.8	12.0	13.8	15.8	14.0	13.0	13.0	13.4
1925..	13.0	13.8	13.2	13.2	13.5	12.8	12.5	13.2	14.0	12.9	12.6	12.4	12.5
1926..	13.8	12.8	13.2	13.8	14.1	15.4	17.0	16.8	15.2	14.1	12.2	10.5	10.1
1927..	11.8	10.0	10.8	11.2	11.0	11.1	11.2	11.5	12.0	13.2	13.8	13.3	12.9
1928..	12.0	13.6	11.9	11.4	12.0	12.5	12.2	12.1	11.8	11.8	11.9	11.8	12.0
1929..	11.5	12.0	12.2	12.5	12.1	11.5	11.1	11.2	11.0	11.2	11.1	10.8	10.8
1930..	10.5	10.6	10.6	10.8	10.8	10.8	10.5	10.5	10.5	10.5	10.2	10.2	10.1
1931..	8.9	9.9	9.8	9.9	10.2	9.4	9.2	9.5	9.1	8.5	7.5	7.5	6.8
1932..	6.2	6.5	6.2	6.1	5.9	5.6	5.6	5.9	6.9	6.9	6.5	6.2	6.1
1933..	7.0	6.9	5.8	6.7	6.2	7.4	7.6	7.8	8.1	7.6	7.2	7.1	7.0

\* Averages of monthly high and low prices as reported in the *Oil, Paint, and Drug Reporter*; our computations for all years except 1913 to 1925, for which data are from *Statistics of Fats, Oils, and Oleaginous Raw Materials* (U.S. Department of Agriculture Statistical Bulletin No. 24, September 1928), 62. Annual averages are simple averages of monthly data.

## 348 AMERICAN VEGETABLE-SHORTENING INDUSTRY

**TABLE XXIV.—WHOLESALE PRICES OF OLEOSTEARIN, NEW YORK,  
MONTHLY, 1892-1933\***  
(Cents per pound)

Year	Av.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1892..	8.5	7.1	7.4	7.1	7.2	7.1	7.2	8.1	9.1	9.9	9.9	10.5	10.9
1893..	9.4	10.7	12.2	9.2	7.1	8.7	8.5	8.5	9.2	11.4	11.1	9.3	7.1
1894..	7.7	7.9	7.4	6.9	7.6	7.4	7.7	7.5	8.1	10.1	7.8	7.1	7.4
1895..	6.8	6.8	6.6	8.2	8.8	8.1	7.4	8.5	6.1	6.0	6.0	5.6	5.1
1896..	4.0	5.0	4.9	4.7	4.5	4.3	4.4	4.3	4.1	4.2	5.1	5.0	4.2
1897..	4.6	4.3	4.1	4.3	4.3	4.1	4.2	4.6	5.1	5.9	5.1	4.6	4.5
1898..	5.0	4.3	4.8	4.7	4.6	5.9	5.3	5.0	5.1	5.0	5.1	5.2	5.1
1899..	6.4	5.1	5.7	5.7	5.3	5.7	5.8	6.5	7.1	7.2	8.1	7.2	7.1
1900..	7.1	7.2	6.8	6.5	7.6	7.1	6.4	7.6	7.4	7.4	7.4	6.8	6.6
1901..	9.3	7.1	7.2	7.4	8.8	8.3	9.3	9.6	9.6	10.9	11.6	10.4	10.5
1902..	12.5	11.1	9.9	9.3	11.5	12.4	13.1	13.4	13.6	13.7	14.8	14.2	11.6
1903..	8.3	10.4	10.2	9.9	9.5	8.5	7.9	7.6	7.2	7.9	7.6	6.4	6.1
1904..	6.7	6.6	6.8	6.9	6.1	5.7	6.0	6.9	7.1	7.6	8.1	6.7	6.4
1905..	7.6	6.4	6.4	7.2	8.2	7.9	7.5	7.5	8.6	8.6	7.2	7.4	7.8
1906..	9.4	7.7	7.8	7.8	9.6	9.6	9.0	8.9	10.0	9.8	9.6	11.5	11.6
1907..	9.5	11.3	11.2	10.0	9.1	9.4	9.6	8.9	8.6	8.6	9.6	8.9	7.6
1908..	10.4	7.6	7.2	7.5	10.3	11.0	10.9	11.8	12.1	13.0	12.5	10.5	10.1
1909..	13.8	11.6	12.0	13.2	12.9	12.5	13.1	13.0	11.6	13.6	17.4	16.5	17.4
1910..	13.2	17.2	14.3	15.9	17.2	15.0	12.0	10.0	11.3	11.5	12.5	10.6	9.5
1911..	8.7	9.2	8.8	7.6	7.2	7.8	8.0	7.6	8.9	11.5	10.2	9.6	9.2
1912..	12.2	9.1	8.9	9.0	12.9	15.5	14.2	12.5	12.8	12.6	14.0	12.8	11.0
1913..	9.9	9.9	10.0	10.5	11.0	10.0	8.9	10.5	10.5	9.2	8.8	9.9	10.0
1914..	9.2	9.1	9.2	8.9	8.8	8.6	8.1	7.9	9.4	10.5	9.0	10.2	10.9
1915..	9.6	10.1	10.2	9.1	9.1	9.1	8.8	8.2	9.5	10.0	10.6	10.5	10.1
1916..	12.0	9.8	10.0	10.6	11.3	12.1	11.0	10.6	10.4	12.6	14.5	16.4	15.2
1917..	13.1	13.2	13.1	14.6	17.5	20.0	13.9	17.1	13.5	20.2	22.6	21.4	19.6
1918..	20.6	13.4	19.9	20.5	19.4	13.4	13.5	19.6	21.0	21.3	24.2	24.1	21.2
1919..	22.2	13.1	12.9	14.4	26.3	23.0	23.3	23.6	25.0	13.5	20.2	21.2	20.9
1920..	15.0	21.9	19.5	17.4	16.5	15.1	14.5	12.9	13.4	14.5	15.0	10.5	8.5
1921..	3.5	3.3	7.3	7.0	6.8	7.3	7.5	9.5	10.6	10.3	9.3	7.8	7.3
1922..	9.6	8.1	9.3	10.0	8.3	9.0	10.0	10.1	9.3	9.2	10.0	10.9	9.9
1923..	10.5	10.2	10.4	10.8	19.3	9.3	8.4	9.0	10.4	12.9	12.0	11.0	10.5
1924..	11.4	10.0	9.3	9.2	10.2	10.5	10.1	12.9	16.1	11.9	12.5	12.0	11.5
1925..	13.0	11.0	10.5	13.4	12.5	11.5	12.3	13.3	14.3	14.1	14.8	13.0	13.1
1926..	11.9	12.4	11.5	12.5	11.2	13.0	14.6	13.2	11.4	12.8	11.2	9.9	9.6
1927..	10.3	9.4	9.9	9.5	9.1	9.6	9.6	9.9	10.6	12.5	12.4	10.3	9.9
1928..	10.6	10.0	9.5	10.2	11.4	10.9	9.6	10.1	10.3	12.4	11.2	10.6	10.5
1929..	10.5	11.1	11.6	11.1	10.3	9.9	9.8	10.0	10.3	10.9	10.5	9.9	9.6
1930..	8.7	9.2	9.2	8.9	8.9	8.6	3.4	8.1	8.6	9.4	8.5	8.4	8.3
1931..	7.3	7.8	7.4	8.1	8.1	7.1	6.3	7.9	8.2	7.5	6.6	6.5	6.0
1932..	4.8	5.0	4.4	4.1	4.0	3.9	4.0	5.0	6.2	6.4	5.6	4.6	4.1
1933..	4.9	3.9	3.3	3.9	4.3	5.1	5.1	5.3	6.0	5.1	5.2	5.4	5.3

\* Data are monthly averages of daily prices direct from the New York Produce Exchange, 1892-99 and 1930-33, and for 1900-29 from *Annual Statistical Reports of the New York Produce Exchange*. Annual averages are simple averages of monthly data.

TABLE XXV.—EXCESS OF LARD PRICES OVER PRICES OF COTTONSEED OIL AND COMPOUND, ANNUAL AVERAGES, 1875-1933\*  
(Cents per pound)

Year	Cottonseed oil	Year	Cottonseed oil	Compound	Year	Cottonseed oil	Compound
1875.....	6.4	1895.....	2.9	...	1915.....	2.6	1.5
1876.....	5.0	1896.....	1.3	...	1916.....	2.9	1.4
1877.....	2.5	1897.....	1.2	0.1	1917.....	6.3	4.6
1878.....	0.8	1898.....	2.4	1.2	1918.....	5.9	2.9
1879.....	0.8	1899.....	2.1	0.7	1919.....	6.5	3.7
1880.....	2.2	1900.....	2.3	0.8	1920.....	4.5	0.5
1881.....	5.1	1901.....	4.1	2.0	1921.....	3.1	0.8
1882.....	4.7	1902.....	5.1	2.6	1922.....	1.3	-0.5
1883.....	3.6	1903.....	3.4	1.6	1923.....	1.0	-0.6
1884.....	2.7	1904.....	3.2	1.2	1924.....	2.2	0.1
1885.....	1.7	1905.....	3.8	2.1	1925.....	5.9	3.7
1886.....	1.9	1906.....	3.9	2.0	1926.....	3.1	1.2
1887.....	1.7	1907.....	2.7	0.7	1927.....	3.1	1.0
1888.....	2.6	1908.....	3.5	1.6	1928.....	2.4	0.3
1889.....	0.6	1909.....	5.8	3.3	1929.....	2.3	0.5
1890.....	1.6	1910.....	4.4	2.5	1930.....	2.7	0.4
1891.....	1.7	1911.....	2.8	1.5	1931.....	1.9	-0.9
1892.....	3.5	1912.....	4.2	2.4	1932.....	1.2	-1.2
1893.....	4.4	1913.....	3.7	2.3	1933.....	1.2	-1.4
1894.....	3.4	1914.....	3.7	2.3			

\* Computed from data in Tables XXI-XXIII.

350 AMERICAN VEGETABLE-SHORTENING INDUSTRY

TABLE XXVI.—PRICES OF COTTONSEED OIL AND OF COMPOUND,  
EXPRESSED AS PERCENTAGES OF LARD PRICES, ANNUAL  
AVERAGES, 1875-1933\*

Year	Cotton- seed oil	Year	Cotton- seed oil	Com- pound	Year	Cotton- seed oil	Com- pound
1875.....	54	1895.....	55	..	1915.....	72	84
1876.....	58	1896.....	72	..	1916.....	79	90
1877.....	74	1897.....	73	98	1917.....	71	79
1878.....	89	1898.....	56	78	1918.....	77	89
1879.....	88	1899.....	62	88	1919.....	78	87
1880.....	72	1900.....	67	89	1920.....	77	97
1881.....	55	1901.....	54	78	1921.....	72	93
1882.....	60	1902.....	52	75	1922.....	89	104
1883.....	63	1903.....	61	82	1923.....	92	105
1884.....	67	1904.....	56	84	1924.....	83	99
1885.....	75	1905.....	49	72	1925.....	65	78
1886.....	71	1906.....	56	78	1926.....	79	92
1887.....	76	1907.....	71	92	1927.....	76	92
1888.....	70	1908.....	62	82	1928.....	80	98
1889.....	91	1909.....	50	72	1929.....	81	96
1890.....	75	1910.....	65	80	1930.....	75	96
1891.....	74	1911.....	69	84	1931.....	76	111
1892.....	55	1912.....	60	77	1932.....	76	124
1893.....	58	1913.....	66	79	1933.....	79	125
1894.....	56	1914.....	64	78			

\* Computed from data in Tables XXI-XXIII.

## INDEX

- Adulteration:**  
of butter, 35  
of foods, 34-37  
of lard, 8-9, 18, 20-22, 23, 31, 60, 64, 115; Congressional action on, 22, 23, 48-54; early legislative action on, 40-45; McGeogh Case, 37-40; "original package" decision, 41; regional aspects of, 36-37, 48-50, 56-58; reports of Division of Chemistry on, 47-48; state and federal investigations on, 47-48  
of olive oil, 15, 20, 28  
of tallows, 21
- Advertising of compound, 185, 193, 196-97, 207**
- Agricultural Adjustment Act, 133-34, 145, 177, 217, 221-22**
- Agricultural Yearbook, 1903, 79***
- American Cotton Oil Company, 30, 80, 81, 83, 94, 113, 149, 154, 177, 259, 266; see Appendix D**
- American Cotton Oil Trust, 24, 30, 80**
- Anglo-American Packing and Provision Company, 38; see Appendix D**
- Annual Report (United States Food Administration) for 1918, The, 111***
- Armour and Company, 22-23, 32, 43, 46, 60, 72, 83, 88, 149, 150; see Appendix D**
- Armstrong Packing Company, 74; see Appendix D**
- Aspegren and Company, estimates of, cottonseed oil: in compound manufacture, 69-71; in compound manufacture, in Europe, 103 n.; consumption, 31-32, 77; production, 63-64; see Appendix D**
- Baker, Representative, 42**
- Baking, commercial, expansion of, 195; use of shortening by industry, 191-92**
- Belgium, as importer of compound, 108**
- Biennial Census of Manufactures, 138***
- "Bird," 74**
- Bleaching oil, 20-21, 253-58**
- Bradley, Henry W., 25**
- Bread, during the war, 111; use of shortening in, 6**
- Brosius, Representative, 53, 56-57**
- Brown, Dr. Campbell, 46**
- Brown, Robert B., 74; see Appendix D**
- Brown Company, 122, 267**
- Butchers' National Protective Association, 41**
- Butchers' Sons, Washington, 28; see Appendix D**
- Butter: adulteration of, 35; consumption of, in Germany, 158; cost of production, 148; as a shortening, 5, 6, 281, 282; in national economy of Denmark, 213-14**
- Butterworth bills, on lard adulteration, 41, 42, 48**

- Central America, as importer of compound, 101; as importer of lard, 102
- Charlotte Observer*, 65
- Chemistry, early use of, in England, to detect adulteration of lard, 46; in development of compound industry, 20, 87; *see* Hydrogenation
- Chicago Board of Trade, hedging in lard futures on, 183; reports of, on lard adulteration, 37-39, 42-43
- Chinese [tung] oil, 163
- Cincinnati Chamber of Commerce, 41
- Cincinnati Pork Packers Association, 41
- Cincinnati Price Current*, 32
- Cochran, Samuel H., 26, 27; *see* Appendix D
- Coconut oil: early use of, in Europe, 8; first industrial use of, 248; use of, in compound, 125, 126, 127-28, 129, 145, 157; use of, in margarine, 127-28, 129; use of, in soap industry, 127, 129
- Coconut stearin, early use of, in Europe, 8
- Conger bill, 42, 48, 51, 53
- Consumption:
- of cottonseed oil, 14, 17, 64, 67, 166
  - of lard and compound, 32-33, 126-27, 171, 176, 191, 195-96; by bakeries, 191; coefficient of correlation between, 179-80; expansion of, difficulties in, 217; in Germany, 157-59; long-time trend upward, 3; seasonal variation in, 183
  - of tallow in Germany, 158
  - See* Consumption, per capita
- Consumption, per-capita:
- of butter, 186, 188, 189, 192
  - of compound, 186, 188-89, 191; comparison of lard and, 187-89; increase in, 3
  - of fruits and vegetables, 190-91
  - of lard, 105, 112, 170, 185-86, 191, 205; comparison of compound and, 187-89; increase in, 3
  - of lard substitutes, 187-88
  - of margarine, 186, 189
  - of shortenings, 5-6
  - of vegetable oils and fats only and animal and vegetable oils and fats, 194
  - See* Consumption
- Copra, duty-free, 126, 165
- Corn (maize) oil, shortening power of, 280; use of, in compound, 125, 132; use of, in mayonnaise, 132
- "Cotosuet," 73, 76
- "Cottolene," 29, 30, 75, 258; exports of, 97
- Cottonseed oil: bleaching of, 20-21, 254-55; in compound, 2, 63-64, 117, 133, 145, 215-16; domestic retention of, early, 14; food uses of, 18, 19, 87-88; in the national economy, 214-16; process for deodorizing, etc., 25-26; shortening power of, 280-81, 283; as a stiffening agent, 21-22; as substitute for olive oil, 28; supply of, factors in, 217-18; United States Food Administration reports and regulations on, 306-09; uses of exported, 31; winterizing (demargarinating), 116
- Coumbe, Oscar H., 26
- "Crisco," 94



- Crosfield patent, 93, 267  
 Cuba, as importer of compound, 101, 108  
 Cudahy Packing Company, 73-74, 149; *see* Appendix D
- Dawes, Senator, 41, 54  
 Demand:  
   for compound, inelastic, 3, 76, 176, 179; recent independence of compound from lard, 211-12  
   for lard, relationship, 2, 3, 176  
 Denmark, relationship between butter and margarine in national economy of, 213-14  
 Deodorizing, of compound, 77; of oils, 25-26, 258-59  
 Duties, *see* Tariffs
- Eckstein, H. G., 77; *see* Appendix B  
 England: as importer of compounds, 98-99; as importer of lard, 101; legal prosecution of lard adulteration in, 23; legal prosecution of misbranding in, 46-47  
 Exports:  
   compound; of Cottolene and Lardine (Lardene), 97; by countries of destination, 98-104, 108-12; in late 'nineties, 67; to 1914, 98, 99; post-war, 112, 113, 114, 115-16, 153-59; reason for recent decline in, 154-55; to United States possessions, 154; during the war, 108-12  
   cottonseed oil, 14, 15-16; reason for decline in, 164  
   fats and oils, in the United States, 162  
   lard; annually, 1908-09 to 1932, 109; by countries of destination, 101-02; during the war, 108-09, 112; early figures on, 33, 67, 98; level of, 1920-29, 160; measures for reducing, 216; from 1900-1932, 171, 175 n.; to 1914, 98-99; post-war, 112, 155, 165; restrictions on, European countries, 40, 43; surplus for, 163; to United States possessions, 154  
   oleo oil, 165  
   peanut oil, 126  
   soy bean oil, 126  
   vegetable shortenings, 116, 155
- Fairbank, N. K., Company, 9, 20, 21, 22-23, 24, 28, 29, 32, 43, 46, 60, 75, 94, 97, 150, 254, 256, 259, 263, 266; *see* Appendix D  
 "Flakewhite," 75, 93  
 Foaming, in compounds, with coconut oil, 128  
 Food and Drugs Act, 58, 90, 94  
 Food-control bills, other than on lard adulteration, 54-56  
 Fowler Brothers, 38, 39; *see* Appendix D  
 France, as importer of compounds, 100-101, 108
- Georgia Mills and Elevator Company, 74; *see* Appendix D  
 Germany: coconut oil, use of in manufactured compounds, 128; consumption of fats in, 158; consumption of margarine in, 155-56, 158; as importer of animal fats, 158; as

- importer of compounds, 98, 100, 103; as importer of lard, 101-2; palm kernel oil, use of, in margarine, 131; as producer of compound, 157-59, 259-60; tariffs on fat in, 159  
*Grasa*, 159
- Hately, John, 43, 52
- Hawaii, shipments of compound to, 154
- Hedging, on lard and cottonseed oil futures, 183
- "Hope Butter Oil," 19
- Hope Oil Mill, 19
- Hydrogenation, 76, 88, 264-74, 282-83; cost of, 122; of cottonseed oil, 116; economic effects of, 92-94, 103; of marine oils, 123; plants specializing in, 122-23; in vegetable shortening, 116, 121-22, 142
- Imports, oils, United States, 124, 125, 126, 132, 162-63, 165
- Ingredients: in compounds, 2, 66, 85, 114-35, 142, 145; in margarine, 11-12, 21, 120-21, 129, 201
- Interstate Cotton-seed Crushers' Association, 87
- Italy, imports of cottonseed oil of, 15-16
- Jenkins, Edward H., 61
- Kunstspeisefett*, 157-59
- Lamborn, L. L., 13, 18
- Labeling: designations used, 2, 23, 46-47, 116; early legislation on, 40-45, 48-54; inaccurate and misleading, of compounds, 31; of lard compounds, 23, 46, 72-73; under Meat Inspection Act, 89; provisions on, Food and Drugs Act, 58, 90; state legislation on lard, 60; *see* Appendix D
- Lard: in compound, 119; "cotton-oil lard," 25; Cuba lard, 13; as domestic food fat, 166, 204-05; labeling, early legislation on, 40-45, 47 n.; leaf, 8-9; modified, to take on characteristics of compound, 209-10; in the national economy, 214-16; neutral, 10; preference for, as cooking fat, 159, 176; prime steam, 10; refined, 23, 46, 60, 61-62, 209, 211; "salt-trimmings lard," 211; as a shortening, 5, 6, 280, 281, 282-83; variety of products sold as, in 'nineties, 59
- Lard stearin, as hardener for steam lard, 9, 11
- Lard substitutes, classes of manufacturers, 138-39; quantity and value of, marketed, 196
- Lardine (Lardene), exports of, 97
- Licensing system: for cottonseed products, during the war, 110-11, 112; United States Food Administration, special regulations for, 308-09, 312-13
- McCaw, Wallace E., 74, 75, 93; *see* Appendix D
- McClammy bills, 49-50, 51, 53
- McGeogh Case, 37-40
- Magnolia Provision Company, 149

- Manufacture:** of compound, costs of, compared to other food industries, 146-48; compound, early progress in the United States, 263-64; lard, early history of, 244-47; of modified lard, 209-10; *see* Production
- Margarine:** early legislation against, 35, 42; early patents for, 26; the European product, 158; influence of, on exports of compound to Europe, 103; influence on development of compound industry, 10-13, 21, 261; ingredients used in, 11-12, 18, 21, 120-21, 127-28, 129, 201; in the national economy of Denmark, 213-14; as a shortening, 282
- Marine oils:** in compound, 116-17, 119, 123-24, 178; history of use of, 233-34, 249-51, 253; hydrogenation of, 123; imports of whale oil in the United States, 124; tariff on whale oil, 179
- Marketing of vegetable compound:** first, 94; after 1922, 115, 122; a method to market cottonseed oil, 178; quantity and value of, 196
- Markets for compound,** 75, 77, 193-97, 202-03, 205
- Marshall, George S.,** 26
- Mayonnaise,** use of corn oil in, 132
- Meat Inspection Act,** 62, 86, 88-90, 94, 105, 115
- Meat inspection legislation,** 55-56
- Mexico,** as importer of compound, 101, 108
- Morris and Company,** 88, 149; *see* Appendix D
- National Cottonseed Products Association,** 219
- Netherlands,** as importer of compound, 100
- Normann (Crosfield) patent,** 93, 273
- Norway,** hydrogenation of marine oils in, 123
- "Oak Leaf,"** 74
- Oil, Paint and Drug Reporter,*** 27, 79, 95
- Oilseeds,** European imports of, 103
- "Oleard,"** 26
- Oleo oil:** in compound, 119, 145; control of production, by packers, 86; in margarine industry, 11-12, 21, 120-21, 201
- Oleo stock,** production of, for margarine industry, 12
- Oleomargarine,** cost of production of, 148
- Oleomargarine Act,** 49, 58
- Oleostearin:** in compound, 2, 85, 94, 119, 120, 121, 142, 201; control of production, by packers, 86-87; duty on, until 1909, 86; in lard, 12, 21
- "Olive Butter,"** 28, 30
- Olive oil:** in cookery, regional preferences for, 6, 159; in lard substitutes, 28; shortening power of, 280
- "Olivene,"** 28
- Packers:** as compound manufacturers, 72-75, 80, 81-88, 94, 134, 136-39, 141-44, 149, 165; costs of manufacture to, 147; efforts of, to strengthen lard markets, 207-12; lard marketing practices of, 206-07; as manufacturers of

- purely vegetable compound, 140, 142; as refined lard manufacturers, 60, 138; as steam lard manufacturers, 9-10, 12-13
- Paddock bills, 54-55, 57-58
- Palm kernel oil: duty on, 132; early use of, in Europe, 8; imports of, 132; price of, 131; probable future use of, in compound, in United States, 131; United States Food Administration special license regulations on, 308-09; use in Germany, in compound, 157; use in Germany, in margarine, 131
- Palm oil: early use of, 253-54; United States Food Administration special license regulations on, 308-09; use of, in compound, 125, 130; use, in tinplate and soap manufacture, 130
- Patents, *see* Trade marks and patents
- Peanut oil: duties on, 126; effect of tariff on, 165, 179; imports of, 126; United States Food Administration reports and regulations on, 308-09; use of, in compound, 125
- Philippines, as importer of compound, 101; as source of coconut oil, 165-66
- "Plantene," 74, 93
- Portsmouth Cotton Oil Refining Corporation, 149; *see* Appendix D
- Prices:
  - coconut oil, comparison to cottonseed oil, 127
  - compound; around and after 1900, 77; behavior of, 196-99; effect of tariff on, 165; export, to 1914, 99; from 1908-09 to 1932, 109; as percentage of lard, 172; relation to cottonseed oil, 174; relationship to lard, 199-203, 218; seasonal variations in, 183-84; spreads of, from lard, long-time trend, 172; wholesale, and index of business activity, 68, 92, 113
  - cottonseed oil; behavior of, 197-99; compared to coconut oil, 127; determination of, 173-74; fixed, during the war, 110; independence of, over lard, 94-96; relation to lard, 69, 72, 78, 80, 91-92, 95, 121, 171-72, 198-200; seasonal variation of, 184; spreads between lard and, 172, 180; wholesale, and index of business activity, 17, 18, 68, 78, 92, 113
  - lard; behavior of, 197-99; effect of tariff on, 163; effect of United States, on world, 161, 215; export, to 1914, 99; export, from 1908-09 to 1932, 109, 170-71; influence of, on cooking-fat field, 201; post-war, 202; relation to cottonseed oil, 69-72, 78-79, 91-92, 95, 121, 172, 198, 200; relationship to compound, 68-69, 79-80, 171, 179, 200-202, 218; relationship to price of live hogs, 173; seasonal variations in, 183-84; spread between cottonseed oil and, 180; wholesale, and index of business activity, 17, 18-19, 68, 78, 92, 113

- oleostearin; control of, by packers, 87; follows major movements of lard, 198-99; post-war, 201; in recent years, 120, 129-30, 212; wholesale, and index of business activity, 68, 92, 113
- palm-kernel oil, 131
- Procter and Gamble Company, 75, 93, 94, 149, 267, 273; *see* Appendix D
- Producers, compound, 149; *see* Appendix D
- Production:
- compound; from animal and vegetable fats and oils, 194; by class of producers, 149-50; course of, 63-67, 79, 169; decline in, 92-93; during the war, 110; in early 'nineties, 76-77; European, 156-59; by federally inspected and other plants, 62, 90-91, 107, 135-39; forecasting of, 178; post-war, 112, 169-70; of purely vegetable products, 139-41, 174, 194; by regions and states, 143, 150-53; relationship to cottonseed oil, 168-70, 177, 179, 180; relationship to lard, 176, 179, 180; seasonal variations in, 168, 181-83; volume of, 106-08, 142-43; year-to-year variations, factors in, 168-80
  - cottonseed oil; Aspegren estimates of, 63-64; course of, 169; by class of producers, 149; decline in, 177; early, 14, 16-17, 43, 78; effect of AAA reduction of acreage on, 133-34; post-war, 114, 121, 169-70; seasonal variations in, 168, 181
  - hard fats, history of, 233-48
  - illuminating oils, 248-51
  - lard; difficulties of reducing, 216-17; during the war, 114, 170; early figures on, 32-33, 66-67; from 1900-1932, 171; percentage of, to hog products, 174 n.; post-war, 114, 170; relation to size of corn crop, and other factors, 174-75; seasonal variation in, 181-83
  - lard substitutes, 140
  - margarine, post-war, 120, 129
  - shortening; by classes of manufacturers, 135-39, 150; seasonal variations in, 183
  - tallow, factors in, 2
  - "Purola," 27, 30
- Read, Samuel, 97; *see* Appendix D
- Refiners, lard: disappearance of independents, 24-25, 80; early history of, 9-10, 12; use of cottonseed oil by, 22
- Refining, of oils, history of, 251-53
- Refrigeration, effect of improved, on compound industry, 36-37
- Rendering, steam, introduction of, 8-9
- Salad oils, use of corn oil in, 132; use of cottonseed oil in, 18, 19
- Schwarzschild and Sulzberger Company, 73; *see* Appendix D
- Sears, Joseph, 20
- Sesame oil, use of, in compound, 125, 130, 131, 145

- Sesame seed, imports of, 131  
 Shea butter, 179  
 Shortening: choice of, 281-83; coconut oil in, 128, 277; correlation of flour quality and effect of, 278; early trade marks and patents on, 73-75; effect of, on leavening process, 279; effect of, on onset of staleness, 279; lard as, 5, 6, 117, 205-06, 280, 281, 282-83; margarine as, 282; measurement of, 280-81; method of action of, 277-78; properties of greatest importance in fats and oils for, 276-77; regional preferences for, 5-8; regulations on, for consumer, during the war, 111; use of, by commercial baker, 191, 266; use of, by domestic consumer, 205, 207; use of margarine in Europe as, 103; uses of fats and oils for, 4-5; vegetable compound as, 281, 283  
 Shortening power: of compound, 280, 281; of corn oil, 280; of cottonseed oil, 280-81, 283; definition of, 275-76; of olive oil, 280; of soy bean oil, 280  
 "Silverleaf," 73  
 "Snow White," 29  
 "Snowdrift," 78  
 South America, as importer of compound, 101, 159  
 Southern Cotton Oil Company, 28, 30, 80, 81, 83, 94, 113, 149, 154; *see* Appendix D  
 Soy bean oil: in compound, 125-26, 130; duties on, 126; effect of tariff on price of, 165, 179; imports of, 126; shortening power of, 280; United States Food Administration special license regulations for, 308-09  
 Squire, John P., 41  
 Staleness, effect of shortenings on onset of, 279  
 Standard Butter Company, 27  
 Statistical tables, 314-50; *see also* Table of Contents  
 Stearin, *see* Coconut stearin, Lard stearin, Oleostearin, Tallow stearin  
 "Suetine," 73  
 Sunflower oil, use of, in compound, 130  
 "Supreme Shortening," 73  
 Swift and Company, 73, 88, 149; *see* Appendix D  
 Tallow oil, 11  
 Tallow stearin, 11, 21  
 Tallows: in compounds, 2, 85, 119-20, 121, 142, 145; as cooking fat, in South America, 159; history of early commercial use of, 234-44; use, in food and industry, 11; use, in lard, 9, 11, 21  
 Tariffs: agitation for, on Philippine oil imports, 166; on compound, 126, 160, 165, 166; on crude and refined coconut oil, 165; effect on ingredients of compound, 165; influence on price level of fats and oils, 163; in Germany, on fats, 159; on lard, 160, 166, 218; on oleostearin, 86; on palm kernel oil, 132; on peanut and soy bean oils, 126, 179; on vegetable oils, 161-62; on whale oil, 179  
 Taxing, of compound, 42, 218-20; effect on world prices, 220; of lard substitutes, 218-19

- Taylor, Alonzo E., 86, 185  
Tompkins, D. A., 19  
Trade marks and patents, 25-30, 72-75, 93, 197, 267; of compounded cooking fats registered in United States patent office, to 1930, 284-305; *see* Appendix B  
Types of compounds, 1, 114-17, 141; early forms, in Europe, 259-63  
  
Union Oil Company, 19  
  
Vacuum process, for compound, 77, 78  
"Vegetole," 73  
  
"Victoria," 29  
  
Wesson, Dr. David, 73, 77, 256, 259, 267  
Wesson Process Company, 78  
West Indies, as importer of compound, 101; as importer of lard, 102  
White grease, 45, 51  
Wilcox, W. J., and Company, 24, 149; *see* Appendix D  
Wiley, Dr. Harvey W., 47  
Wilson bill, 54, 57  
Wright, James, and Company, 38  
  
Zapoleon, L. B., 39, 41, 160-66, 185