Substitutability of Fractionated Beef Tallow for Other Fats and Oils in the Food and Confectionery Industries: An Economic Evaluation[1]

HAROLD H. TAYLOR, ERS, USDA, **F.E. LUDDY, J.W. HAMPSON**, and **H.L. ROTHBART**,
Eastern Regional Research Center, ARS, USDA, Philadelphia, Pennsylvania 19118

ABSTRACT

The United States is the most important beef tallow producer in the world, supplying ca. 5.5 billion pounds annually. Approximately half of this beef tallow is exported at relatively low prices when compared to other fats and oils. Only ca. 10% of the total is used in domestic edible products. On the other hand, cocoa butter, coconut oil, palm oil, and palmkernel oil are imported oils whose demand for use in food and confectionery products has been increasing over the past few years. The first of these is the most expensive fat in the world. Beef tallow contains specific triglycerides which are also contained in these imported fats and oils. Through modern technology, beef tallow has been fractionated into products which are compatible with or superior to the imported fats and oils. It is visualized that products from fractionated beef tallow can be used as substitutes and extenders to cocoa butter, palm oil, and other fats and oils in the food and confectionery industries. The economic evaluation in this paper, analyzed through time series data and multiple regression techniques, established the past relationships between per capita consumption of confectionery food fat, beef tallow, cocoa butter, adjusted per capita disposable income, and adjusted costs of confectionery, beef tallow, and cocoa butter from 1956 to 1973. The substitutability of fats and oils was evaluated and the potential uses of fractionated beef tallow investigated.

INTRODUCTION

Approximately 5.5 billion pounds of beef tallow are produced each year in the United States (1,2). Prices range from 1/12 to 1/6 the price of cocoa butter (3,4). Approximately 5.0 billion pounds have been classified as inedible tallow and 0.5 billion pounds as edible. Over 50% of the total tallow is currently being exported. Major uses of domestic inedible tallow include ca. 1.0 billion pounds in animal feeds, 0.8 billion pounds in fatty acids, 0.5 billion pounds in soaps, and 0.3 billion pounds in lubricants and similar oils.

To reduce reliance on expensive imported fats, a method was developed to separate the desired compounds from beef tallow. One of the resulting products may be used as a cocoa butter replacement since its properties are almost identical to those of the expensive import. A liquid oil, valuable as a food oil for salad or cooking use, is also obtained as a co-product of the beef tallow separation process. Partial hydrogenation of the oil has resulted in a new family of semisolid fats which require no further fractionation. These semisolid fats have great promise in confectionery and shortening applications. Confectionery, as used in this study, includes products such as solid chocolate, solid chocolate mixed with other foods, panned chocolate and/or confectioners' exteriors, panned chocolate and/or confectioners' interiors, chocolate coating, hard candy, caramel, marshmallows, nougats, creams, fudge, jellies, licorice, bar goods, specialties, packaged goods, bulk goods, and penny goods.

This oil, which is currently being evaluated, is light in color and has extraordinary oxidative stability after it has been deodorized and the legal level of antioxidant has been added. These developments are under commercial evaluation and may make available confections, baked goods, and other food products at lower prices to the consumer while *diminishing our reliance* upon expensive imports. In addition, the research may open up new, higher-priced markets for beef tallow now exported at low prices. Foreign markets for U.S. tallow are now threatened by palm oil, which has kept beef tallow prices down, although most other fats have increased in cost.

The economic evaluation in this paper will pertain to the per capita consumption of visible food fats and include an evaluation of the potential substitutability of fractionated

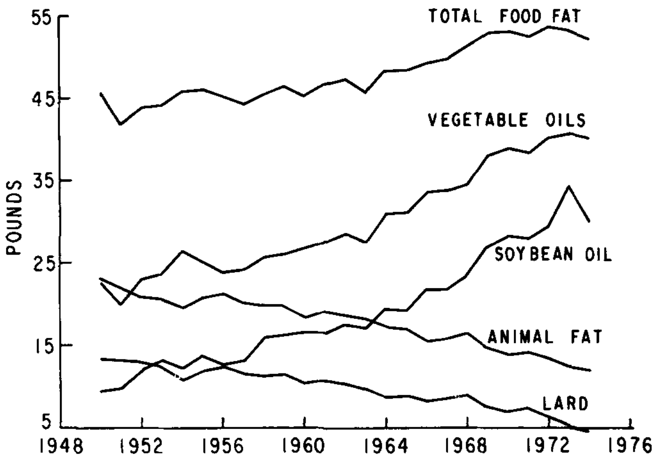

FIG. 1. U.S. visible per capita disappearance of total food fats, vegetable oils, soybean oil, animal fats, and lard in food products.

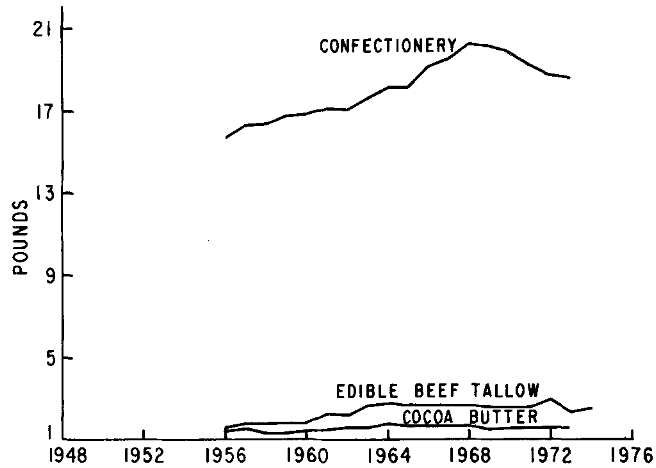

FIG. 2. U.S. per capita domestic disappearance of confectionery, edible beef tallow, and cocoa butter.

[1]Presented in part at the AOCS meeting in Cincinnati, September 1975.

TABLE I

Quantity and Value of the More Significant Imported Food Fats Used in the Food and Confectionery Industries (1973-74 and 1974-75)

	Quantity (million lb)		Average cost per lb		Value (thousand dollars)	
Oils	73-74	74-75	73-74	74-75	73-74	74-75
Palm	325	633	\$0.16	\$0.25	54,069	157,611
Palmkernel	126	149	0.24	0.38	30,520	56,723
Coconut	529	667	0.24	0.41	128,128	275,502
Cocoa beans (55% butter)	510	402	0.56	0.70	288,845	281,847
Cocoa butter	30	34	1.34	1.53	40,230	52,123
Babassu	22	19	0.38	0.42	8,434	7,944
Total					550,226	831,750

beef tallow for other fats and oils in the confectionery and food industries.

JUSTIFICATION OF STUDY

Fat is an important source of energy in the diets of the U.S. consumers. The annual per capita food fat consumption in this country has increased from ca. 115 lb in 1962 to ca. 128 lb in 1972. About 60% of this amount is consumed as invisible fats from food commodities such as meats, eggs, dairy products other than butter, cereals, nuts, and grains. Visible per capita food fat consumption increased from 46 lb in 1962 to 53 lb in 1974 (Fig. 1). Visible food fats are lard, margarine, shortening, cooking and salad oils, and confectionery products (5-7).

Substitution among visible fats and oils in the food and confectionery industries has continually taken place. Figure 1 lists the U.S. domestic disappearance of fats and oils in food products such as vegetable oil, animal fats, and total food fats from 1950 to 1974. Although total visible per capita food fat consumption has increased, vegetable oils have been replacing animal fats. For example, vegetable oil per capita consumption increased from 22.7 to 40.5 lb during this time period while per capita animal fat consumption decreased from 23.2 to 13.5 lb. Per capita consumption of soybean oil (Fig. 1) increased from 9.5 to 29.7 lb during this 20-year period while per capita consumption of lard was reduced from 13.5 to 6.5 lb. However, per capita consumption of beef tallow (Fig. 2) increased from 1.0 to 3.0 lb. Demand for edible beef tallow has been mainly limited to uses in shortenings and spreads (8).

Edible vegetable oils have become dominant mainly because of sharp growth in soybean oil production at competitive prices, increased hydrogenation processing so that shortenings can be made entirely from vegetable oils, changes in consumer preferences from butter to lower-priced vegetable oils and margarines, and consumer trends toward consumption of more unsaturated oils (6).

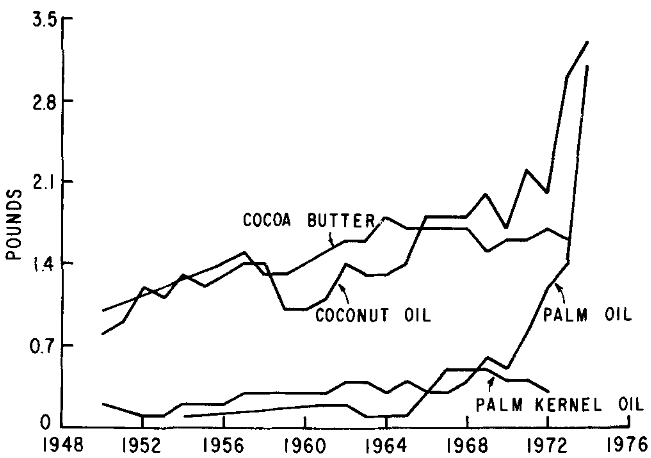

FIG. 3. U.S. visible per capita domestic disappearance of some imported edible fats and oils in food and confectionery products.

This country has also become a major importer of vegetable fats and oils (Table I and Fig. 3) such as palm, palmkernel, cocoa butter, and coconut (9). In recent years these imported oils have found increasing use in the U.S. food industry and confectionery fats, including hard butters, and as a substitute for cocoa butter (10).

The high price of cocoa butter and fluctuations in world supply over the past few years have caused most manufacturers to consider cocoa butter substitutes, reformulation, and price changes in the production of cocoa products and candy bars (10,11).

The imported lauric fats prepared from palmkernel and coconut oil as cocoa butter extenders have a tendency to develop a soapy flavor upon hydrolysis and are not compatible with cocoa butter (12). Domestic substitutes have been prepared from fractions of hydrogenated cottonseed and soybean oils; however, they may be only partially compatible with cocoa butter and sometimes develop rancidity (12-16). A third type of cocoa butter substitute, made by fractional crystallization of palm oil and blending with a fraction of either Shea or Illipe butter marketed in Europe, has glycerides similar to cocoa butter but has restricted use as a cocoa butter extender. The utilization of this product has been restricted due to the short supply of Shea or Illipe butters (17,18).

EVALUATION BETWEEN FOOD FATS AND CONFECTIONERY INDUSTRIES

To more closely examine the relationship between fats and oils in the food and confectionery industries, data on several economic variables were obtained from secondary sources for the years 1956 through 1973 (3,4,6,10,11,19-34). Information on consumption was divided by population per year, and prices and income were adjusted by the consumer price index using 1967 as a base. Information on the following variables was included (Figs. 1,2,4):

X_1 = Year
X_2 = Confectionery per capita consumption in lb
X_3 = Visible food fat per capita consumption in lb
X_4 = Edible tallow per capita consumption in lb
X_5 = Derived cocoa butter per capita consumption in lb
X_6 = Adjusted per capita disposable income[2]
X_7 = Adjusted confectionery cost per lb
X_8 = Adjusted edible beef tallow price per lb
X_9 = Adjusted cocoa butter price

[2]Adjusted per capita disposable income remained relatively constant between 1956 and 1959 at ca. \$2,150. It increased in a linear relationship from 1960 to 1974, increasing from \$2,184 in 1960 to \$3,178 in 1974.

The main objective of this phase of the analysis was to determine the past relationships between confectionery per capita consumption, food fat per capita consumption, beef tallow per capita consumption, cocoa butter per capita consumption, adjusted per capita income, and adjusted prices of confectionery, edible beef tallow, and cocoa butter. This type of information could be helpful in evaluating the potential use of fractionated beef tallow as either a substitute, extender, or additive in the food and confectionery industries.

The literature indicates that many vegetable oils and animal fats are highly correlated with one another; therefore, the separate fats and oils were not treated as independent variables. Instead, food fats (with the exception of beef tallow) were treated as one variable so as to reduce the problem of multicollinearity among the independent variables. Many pair combinations of variables are highly correlated (Table II). For example, beef tallow per capita consumption is independently, positively, and highly correlated wiht confectionery per capita consumption, derived cocoa butter per capita consumption, adjusted per capita disposable income, and also inversely correlated to adjusted confectionery cost per lb. However, food fat per capita consumption is highly and inversely correlated with adjusted confectionery cost per lb. Many of these variables are highly correlated with more than one variable. For these reasons, both multiple and stepwise regression techniques were used to determine the net relationship between variables.

Regression Model

The following stochastic equation best explains the relationship between the variables:

$$Y = X\beta + U$$

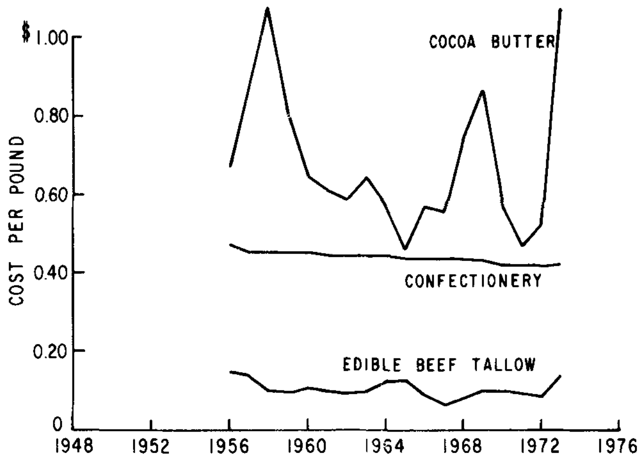

FIG. 4. Adjusted average yearly costs per pound of confectionery, edible beef tallow, and cocoa butter. Costs were adjusted by the consumer price index using 1967 as the base year.

where Y is an nxl vector, the elements of which represent the values of the dependent variables; X is an nxn matrix, the elements of which represent the value of the independent variables; β is an nxl vector whose elements are regression coefficients estimated by the equation; and U is an nxl vector, the elements of which are random disturbance terms estimated by the equation with mean zero and variable G^2 uncorrelated with the independent variables.

Since the regression model was already linear in its parameters, no transformation of the data was necessary and least squares regression technique could be used to estimate the parameters of the model. However, elements in

TABLE II

Zero Order Correlation Matrix of Per Capita Consumption of Confectionery, Food Fat, Beef Tallow, Cocoa Butter, Adjusted Per Capita Disposable Income, and Adjusted Prices for Confectionery, Beef Tallow, and Cocoa Butter

	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9
X_1 = Year	1.0000								
X_2 = Confectionery (lb)	.8753	1.0000							
X_3 = Food fat (lb)	.9567	.8655	1.0000						
X_4 = Tallow (lb)	.8815	.8010	.7651	1.0000					
X_5 = Cocoa butter (lb)	.6285	.6412	.5035	.8430	1.0000				
X_6 = Income	.9810	.8608	.9777	.8339	.5977	1.0000			
X_7 = Confectionery ($)	-.9416	-.8370	-.8825	-.8431	-.6045	-.8909	1.0000		
X_8 = Tallow ($)	-.3460	-.5120	-.2908	-.3075	-.2173	-.2613	.4354	1.0000	
X_9 = Cocoa butter ($)	-.1923	-.2392	-.0953	-.2997	-.5496	-.1272	.2390	.3273	1.0000

TABLE III

Significant Regression Equations Analyzed During the Analysis

Dependent variable	Coefficients									
	α	β_3	β_4	β_5	β_6	β_7	β_8	β_9	R^2	F[a]
Eq. 1 X_2	1.7605	0.29287[c] (0.5057)[b]		2.4727[c] (1.1094)[b]			-16.584[c] (6.3361)[b]		0.8695	31.09
Eq. 2 X_3	25.989				0.00884[c] (0.00047)[b]				0.9559	346.61
Eq. 3 X_4	6.9252			1.6558[c] (0.3452)[b]		-16.218[c] (3.3788)[b]			0.8859	58.21
Eq. 4 X_4	3.3025			1.5801[c] (0.3404)[b]	0.00033[d] (.00024)[b]	-9.5872[d] (5.8805)[b]			0.8992	41.62
Eq. 5 X_5	1.1706		0.2364[c] (0.0377)[b]					-0.2541[c] (0.0925)[b]	0,8075	31.45

[a]All equations significant at the 1% level.

[b]Variables in parentheses represent the value of the standard error of the regression coefficient.

[c]Variables significant at the 5% level.

[d]Variables significant at the 10% level.

TABLE IV

Principal Fatty Acid Composition of Tallow and Palm Oil

Oils	Composition					
	14:0	16:0	18:0	16:1	18:1	18:2
Untreated						
Tallow	4	27	14	5	42	2
Congo palm oil	2	42	6		36	12
Solvent fractionated						
Beef oil	3	21	9	6	53	2
Congo palm oil	1	35	6		40	16

Y and X were changed to denote deviations from arithmetic means so that an intercept term could be included.

The information in Table III represents the results of the least squares regression techniques. The information includes parameters from five different equations. (One of the crucial assumptions of the linear model $Y = X\beta$ is that of zero covariance for the disturbance terms. The Durbin-Watson statistic was used to determine if any autocorrelation existed among the error terms for this time series data. The results of the tests indicated that the error terms were independent.) Four of the five equations include a different dependent variable. For example, the results of the first relationship listed in Table III can be expressed by the following (equation 1):

$$X_2 = 1.7605 + 0.29287\,X_3 + 2.4727\,X_5 - 16.584\,X_8$$
$$(0.5057) \qquad (1.1094) \qquad (6.3361)$$

where the previously defined variables X_2, X_3, X_5, and X_8 represent the dependent and independent variables, respectively; the intercept value is 1.7605; and the values of the β coefficients for β_3, β_5, and β_8 are 0.29287, 2.4727, and -16.584, respectively. The values in parentheses represent the standard error of each regression coefficient. These relationships can also be seen in Table III.

In the above equation, confectionery per capita consumption was used as the dependent variable. Multiple stepwise regression procedures were used to determine which, if any, of the independent variables would be significant in explaining the average variation in confectionery per capita consumption. The computer was programmed to analyze all variables and systematically eliminate those variables which were not determined significant at the 5% significance level. The independent variables left in the equation can collectively and on the average explain ca. 87% of the variation in confectionery per capita consumption. The F value of 31.099 is significant at the 1% level and indicates that food fat per capita consumption, cocoa butter per capita consumption, and edible tallow price per lb can explain a considerable amount of the variation in confectionery per capita consumption. On the other hand, each of these independent variables separately explains a large portion of this variation. For example, for each 1 lb increase in food fat per capita consumption (X_3), confectionery per capita consumption (X_2) increases by 0.293 lb, and for each 1 lb increase in cocoa butter per capita consumption (X_5), confectionery per capita consumption increases by 2.47 lb. A 1 cent increase in the price of edible tallow (X_8) would reduce confectionery per capita consumption by 0.165 lb (Table III). Current use of edible tallow is mainly in shortenings and spreads. Consumers with fixed incomes generally allocate a certain proportion of disposable income for food. Since confectionery is a luxury item and competes with food, an increase in food cost through shortening may cause a reduction in confectionery consumption.

Equation 2 (Table III) was used with multiple stepwise regression procedures. The only variable which significantly helped to explain the variation in food fat per capita consumption was adjusted per capita disposable income. For each $100 increase in disposable income, on the average, food fat per capita consumption would increase by ca. 0.884 lb (Table III). According to this equation, ca. 95% of the variation in food fat per capita consumption can be explained by adjusted per capita disposable income.

Beef tallow per capita consumption was used as the dependent variable in equations 3 and 4. Stepwise regression procedures were used to obtain equation 3. Equation 4 is similar to equation 3 except adjusted per capita disposable income has been added. In both equations, a significant proportion of the variation in beef tallow per capita consumption can be explained by the independent variables. In equation 3, each 1 lb increase in cocoa butter per capita consumption, on the average, would cause a 1.66 lb increase in beef tallow per capita consumption, while a 1 cent increase in confectionery cost per lb would decrease beef tallow per capita consumption by ca. 0.16 lb. The inclusion of income as a dependent variable to the already discussed variables adds little to the analysis. The degree of explainability, which is not significant, has increased from 89 to 90%, but the level of significance for per capita disposable income and confectionery cost per lb was at the 10 and not the 5% level. The relatively high correlation between per capita disposable income and confectionery cost per lb is one reason for this result.

Cocoa butter per capita consumption was used as the dependent variable in equation 5. The significant independent variables are beef tallow per capita consumption and cocoa butter price per lb. For each 1 lb increase in beef tallow per capita consumption, cocoa butter per capita consumption will increase, on the average, by ca. 0.236 lb, and for each 10 cents decrease in the price per lb of cocoa butter, cocoa butter per capita consumption will increase by ca. 0.025 lb. The combined effect of the independent variables can account for ca. 81% of the variation in per capita cocoa butter consumption.

The results of the regression analysis indicate that confectionery per capita consumption is dependent upon per capita consumption of food fats and cocoa butter and inversely related to the price of beef tallow. Food fat per capita consumption, on the other hand, is dependent upon adjusted per capita disposable income. Per capita consumption of beef tallow is dependent upon per capita consumption of cocoa butter and confectionery as well as per capita disposable income. Finally, cocoa butter per capita consumption is dependent upon beef tallow consumption and inversely dependent on the price of cocoa butter. Therefore, per capita consumption of either confectionery, food fats, beef tallow, or cocoa butter can be estimated by these respective relationships.

Since several variables in different equations are highly correlated, substitution among some variables in each equation would not significantly reduce the results of the analysis for any equation. For example, income could substitute for food fats in the first equation.

The results of the regression analysis establishes the relationship between per capita consumption of confectionery, food fats, cocoa butter, beef tallow, disposable income, and prices of cocoa butter and beef tallow. The interrelationship of many of these variables with beef tallow could possibly indicate that the new products from fractionated beef tallow could be used more extensively as a substitute or replacement in many products utilizing food fats and cocoa butter.

Cocoa Butter Substitutes

The fractionation of beef tallow yields one product with melting characteristics which resemble cocoa butter. In addition, fractionated beef tallow may have an advantage over cocoa butter since by changing the parameters of the crystallization or by blending of fractions, confectionery fat of various melting ranges can be produced.

Beef Oil–Palm Oil

Palm oil is an imported commodity of growing importance. It has many compositional similarities to beef tallow, as can be seen in Table IV (16,27). The major saturated fatty acid moiety in both materials is palmitate, and the major unsaturate is oleate. Palm oil has more linoleate than tallow and, in addition, is often dark red in color and contains free fatty acids. The color and free acids are usually removed by appropriate processing. Both palm oil and edible tallow are semisolids at room temperature and have found applications in margarine, shortenings, frying fats, and similar food outlets (35).

Palm oil is being fractionated in a number of processing plants throughout the world. The two primary products are a stearine used in some of the aforementioned applications and in confectionery, and an oil. The oil, which typically melts from 4 to 18 C, depending upon fractionation conditions, has received a great deal of attention as a cooking or salad oil. Beef oil produced in the tallow fractionation has some similarities to this palm oil fraction in that the major saturated moiety is palmitate and the major unsaturated moiety is oleate. The beef oil melts at ca. 4 C and is an attractive bright oil of light color. The extremely low concentration of highly unsaturated fatty acid moieties ensures its stability when it is properly processed. It can be used in almost any application where fractionated palm oil could be used.

In addition, beef oil may be used as a starting material for many fat products. It has been hydrogenated under mild conditions to yield a variety of hard butters with designed melting ranges. It may be hydrogenated further to provide shortenings and thus may be used in lieu of a wide variety of products which can be obtained by the hydrogenation of fractionated palm oil.

COST ANALYSIS

Engineers at the Center have completed preliminary cost comparisons of alternatives for producing fractionated tallow. These cost comparisons were based on a preliminary conceptual process (a process with no actual pilot plant data available). These initial cost comparisons indicate that the products which result from beef tallow fractionation can compete economically with cocoa butter and other vegetable oils in the food and confectionery industries.

REFERENCES

1. Kromer, G.W., and S.A. Gazelle, "Fats and Oil Situation," No. 275, ERS, USDA, Washington, DC, November 1974, p.20.
2. Ibid. p. 26.
3. Tontz, R.L., T.A. Warden, and D.H. Rake, "Foreign Agricultural Trade of the United States," ERS, USDA, Washington, DC, August 1975, p. 17.
4. Ibid., p. 55.
5. Kromer, G.W., and S.A. Gazelle, "Fats and Oil Situation," No. 277, ERS, USDA, Washington, DC, April 1975, p. 16.
6. Kromer, G.W., "Food Fat Consumption: More Now and in the Future," Presented at Symposium on Fats and Carbohydrates in Processed Foods sponsored by the American Medical Association, Chicago, IL, October 1973.
7. Mattil, K.F., F.A. Norris, A.J. Stirton, and D. Swern, in "Bailey's Industrial Oil and Fat Products," Edited by Daniel Swern, Interscience Publishers, New York, NY, 1964, pp. 145-152.
8. Kromer, G.W., "Recent Trends in U.S. Productioon and Consumption of Edible Meat Fats," No. 188, ERS, USDA, Washington, DC, February 1965, p. 29 (reprinted from the Fats and Oil Situation FOS-226, January 1965).
9. Kromer, G.W., "Economic Aspects of the Vegetable Oils and Fats Industry in the United States," Presented at International Trade and Development Conference, United Nations Economic Commission for Asia and the Far East, Battelle Seattle Research Center, Seattle, WA, June 1974.
10. Hester, O.C., and R.L. Bogg, "Market Potentials for Modified Edible Fats and Oils," No. 659, ERS, USDA, Washington, DC, May 1964, pp. 12-18.
11. U.S. Department of Commerce, "Confectionery Manufacturers' Sales and Distribution, 1973," Washington, DC, June 1974, p. 2.
12. Ryberg, J.R., Cereal Sci. Today 15:16 (1970).
13. Echeandia, J., Candy Snack Ind. 138:30 (1973).
14. Hardiman, J.P., Ibid. 136:42 (1971).
15. Harris, N.E., and D.E. Westcott, "Substitution of Domestic Fat for Coconut (Lauric) Fat in Coating of Military Chocolate Candies," U.S. Army Natick Laboratories, Natick, MA, February 1974.
16. Luddy, F.E., J.W. Hampson, S.F. Herb, and H.L. Rothbart, JAOCS 50:240 (1973).
17. "Preliminary Report on Possible Future Areas for Research on Lauric Oils and Palm Oil," Committee on Commodity Problems, Food and Agriculture Organization of the United Nations, Rome, Italy, February 1974.
18. Paulicka, F.R., Chem. Ind. (London) 835 (1973).
19. "Cocoa Statistics," Gill and Dufuss Group, London, England, December 1973.
20. "Cocoa Statistics," Vol. 9, Statistical Committee, Food and Agriculture Organization of the United Nations, Rome, Italy, January 1966.
21. Ibid., Vol. 17, April 1974.
22. Cook, L.R., "Chocolate Production and Use," Books for Industry, Inc., New York, NY, 1972, pp. 353-370.
23. Hiematra, S.J., "Food, Consumption, Prices, Expenditures," No. 138, ERS, USDA, Washington, DC, July 1968.
24. Kromer, G.W., and S.A. Gazelle, "Fats and Oil Situation," No. 267, ERS, USDA, Washington, DC, April 1973, p. 15.
25. Kromer, G.W., and S.A. Gazelle, "Fats and Oil Situation," No. 279, ERS, USDA, Washington, DC, August 1975, p. 15.
26. Pick, F., "Pick Currency Year Book," Pick Publishing Co., New York, NY, 1973, p. 584.
27. "Palm Oil, a Major Tropical Product," issued by Congopalm, Societé Coopérative, Avenue des Aviateurs, Kinshasa, Zaire, October 1970.
28. USDA Foreign Agriculture Circular, "Cocoa," FCB 2-74, Foreign Agriculture Service, Washington, DC, November 1974.
29. USDA, "Fats and Oil Statistics, 1909-1965" ERS Statistical Bulletin No. 376, Washington, DC, August 1966.
30. USDA, "Fats and Oil Statistics, 1950-1971," ERS Statistical Bulletin No. 489, Washington, DC, July 1972.
31. USDA, "Agriculture Statistics," Government Printing Office, Washington, DC, 1973, p. 422.
32. Ibid., p. 470.
33. USDA, "Agriculture Statistics," Government Printing Office, Washington, DC, 1974, p. 150.
34. U.S. Department of Commerce, "Statistical Abstracts of the United States, 1974," Bureau of the Census, Government Printing Office, Washington, DC, p. 5.
35. Kalustian, P., "Imported Vegetable Oils and their Application in United States Fats and Oil Industry," Presented at 14th Annual Symposium, NE Section of the AOCS, Newark, NJ, April 1975.

[Received March 18, 1976]