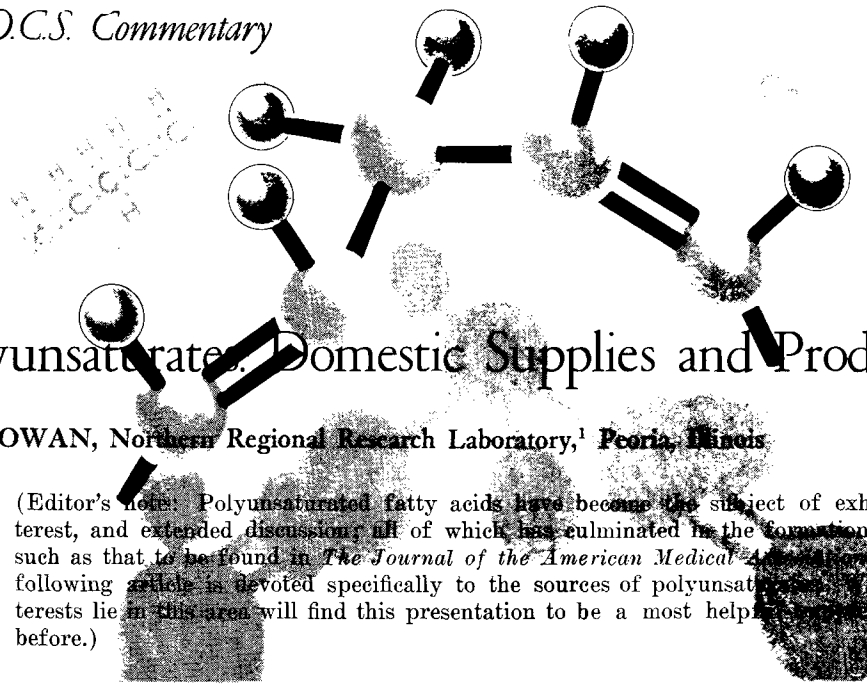

Polyunsaturates: Domestic Supplies and Products

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(Editor's note: Polyunsaturated fatty acids have become the subject of exhaustive research, great interest, and extended discussion, all of which has culminated in the formation of many definite opinions, such as that to be found in *The Journal of the American Medical Association, 181,* 411–429 (1962). The following article is devoted specifically to the sources of polyunsaturates. We trust that those whose interests lie in this area will find this presentation to be a most helpful supplement to all that has gone before.)

Abstract

Sources of edible oils high in polyunsaturated fatty acids are reviewed, as are the availability and composition of these oils and the products derived from them.

CONSUMER DEMAND for food products containing polyunsaturated fatty acids has grown steadily in recent years. Use of visible fats for salad and cooking oils, salad dressings, mayonnaise and related products has increased more rapidly than the population (13). This *per capita* increase in usage is shown in Figure 1.

In the field of marketing (17), and in biochemical studies (5) ever-increasing attention is being afforded oils containing polyunsaturated fatty acids. Increased research activity—both commercial and non-commercial—is evident concerning such products as blended margarines (21), emulsified beverages (11), pharmaceuticals (24), and frozen desserts (22). Organizations including the Food and Nutrition Board of the National Academy of Sciences (20), the Ad Hoc Committee on Dietary Fat and Atherosclerosis of the American Heart Association (12), and the Council on Food and Nutrition of the American Medical Association (3), have published statements regarding diet and unsaturated oils.

Final decisions on the relationship between dietary fat and heart disease or atherosclerosis must await the outcome of further studies. However, under present circumstances, it seems appropriate to review the sources, supply, and composition of oils and related products high in polyunsaturated fatty acids (hereinafter called polyunsaturates).

Supply of Polyunsaturates. Large amounts of polyunsaturates in the form of soybean, cottonseed, corn, and safflower oils are available to the American food industry today. Table I indicates the reported or estimated totals available in the United States during the 1961 and 1962 processing years (13). This volume is more than sufficient to supply present domestic demands. Each of the oils indicated in Table I is derived from commodities the growth of which is mainly regionalized. Cotton is grown in the South and Southwest, safflower in the West, and soybeans in the North. Corn is grown primarily in the North Central States. Two of these oils are processing byproducts—one from corn grown for starch, and the other from cotton grown for fiber. In 1961, 1.9 billion lb of cottonseed oil and approximately 320 million lb of corn oil were produced. Unlike corn and cottonseed oils, the production of which depends upon that of the primary products, the production of safflower and soybean oils can be expanded substantially.

The growth rate of soybean production has been phenomenal in the United States. Figure 2 depicts increased soybean production in the past 15 years, evidencing spectacular increases between 1953 and 1958, and again in the early 1960's. In 1961, a record production of nearly 700 million bushels was achieved (13). Figure 3 illustrates soybean consumption, the largest amounts having been processed for oil and meal. Some 435 million bushels are being crushed in 1961–1962, producing approximately 11 lb of oil per bushel. Nearly one-fourth of the crop is

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TABLE I

Vegetable Oils—Availability in Billions of Pounds (13)

Year beginning in October	1960	1961
Soybean	4.7	4.8[a]
Cottonseed	1.8	1.9
Corn	0.3	0.3
Safflower	<0.1	<0.1

[a] Based on estimate of soybeans to be crushed; total quantity available is larger.

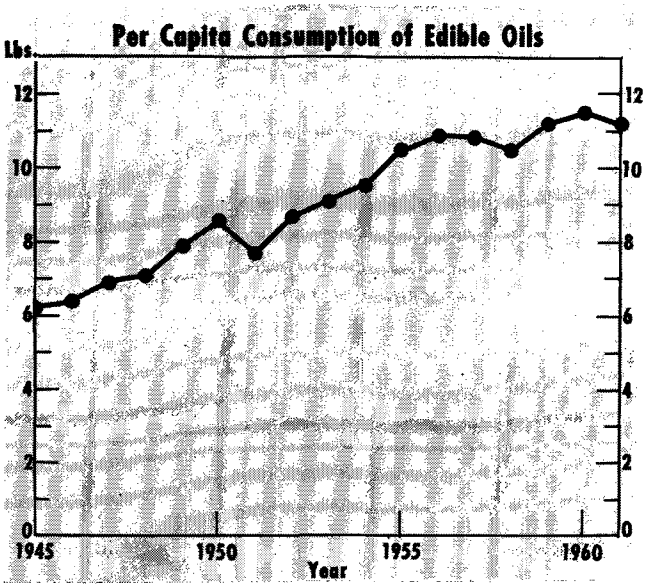

FIG. 1 Per capita consumption of edible oils (category of other uses): salad and cooking oils and oils used in salad dressings.

being exported. Indeed, soybeans are now one of our leading exports.

The steady increase in soybean production since 1947 indicates that soybean oil will substantially contribute to any increased demand for polyunsaturates. The supply of cottonseed oil could remain unhydrogenated, and thereby help meet even greater requirements for products containing polyunsaturates. If available, both corn and safflower oils, now produced in much lesser quantities than soybean or cottonseed oils, would doubtless find expanding markets should the demand for polyunsaturates continue to increase.

Production of saffiower has slowly increased over the past 10–12 years. A capacity for further increase is to be noted, principally west of the 100th meridian (a line just east of Dodge City, Kansas, and Bismark, North Dakota), where the climate is more suitable for its growth than in the region to the east. An estimated 75–90 million lb of oil were available in 1961. It is predicted that this figure will increase in 1962 (4, 23). Safflower flourishes better where dry weather generally prevails subsequent to flowering and during the maturing of the seed. California, Colorado, Idaho, Montana, Utah, Kansas, Nebraska, and North and South Dakota are among the States

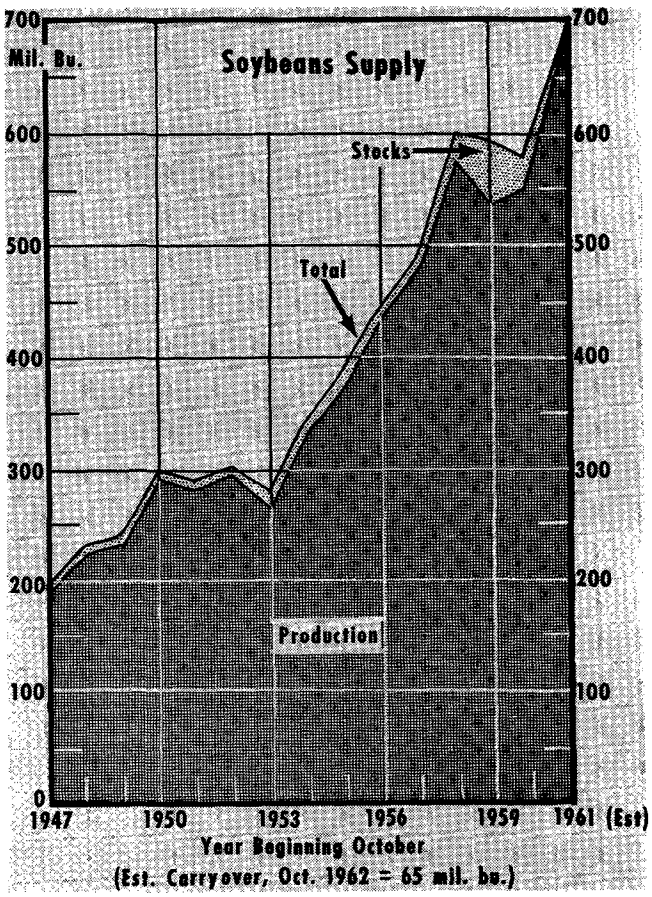

FIG. 2. Soybean supply and production, 1947–1961 (1).

where safflower is now grown, and where its production can be expanded.

Soybeans supply the most important high-protein feed available for livestock and poultry, as indicated by the consumption of over 9 million tons in 1960 and 1961. Increasing production and consumption of poultry and swine (10) is based on availability of soybean meal. Safflower meal is produced in some areas where cattle are raised, and reports indicate the meal can be fed successfully to these and other ruminants (16). Both corn gluten feed and cottonseed meal are used extensively in livestock feeding (2).

Visible Fats: Sources of Polyunsaturates. The major uses of visible fats may be divided into three categories. The first two are table spreads and shortenings. The third category, very general in nature, includes principally dress-

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ings for salad, and salad and cooking oils. Table II lists the amounts of these foods produced in each of the categories during 1960 and 1961 (13), and indicates the oil and fat from which each was derived.

TABLE II

Major Food Uses of Fats, 1960–1961 (13)
(Billion Pounds)

Fats	Shortening		Table Spreads		Other Uses	
	1960	1961	1960	1961	1960	1961
Butter			1.11	1.12		
Soybean	1.17	1.16	1.11	1.06	0.89	1.00
Cottonseed	0.37	0.36	0.14	0.14	0.75	0.82
Lard	0.48	0.53	0.06	0.07	.....	.....
Direct	(1.37)	(1.42)				
Beef fats	0.27	0.35	<0.01	<0.01	.....	.....
Corn oil			0.06	0.09	0.25	0.21
Total all fats (Excluding butter and lard direct)	2.31	2.45	1.37	1.39	1.92	2.10

Consumption figures evidence that soybean oil is the leading source of fat or oil used for this purpose (13). Soybean oil is used in twice the volume of all other edible oils combined. Other visible food fats include butter, lard, and beef fats. However, for high polyunsaturates, it is necessary to look to liquid oils and their products: *mayonnaise, salad dressing, French dressing, salad and cooking oils, liquid shortenings,* and *new-types of shortenings and margarines.*

Table III compares the usage of soybean and cottonseed

TABLE III

Salad Oil Usage 1960 (13)
(Million pounds)

Oil	Soybean	Cottonseed	Total
Mayonnaise and salad dressing	453	185	646
Total salad and cooking oil	887	752	1,917

oils in mayonnaise and salad dressings, and in total use of salad and cooking oils (13). Table IV indicates the minimum amounts of oil in the dressings labeled: *mayonnaise, French dressing* or *salad dressing.* Each has established

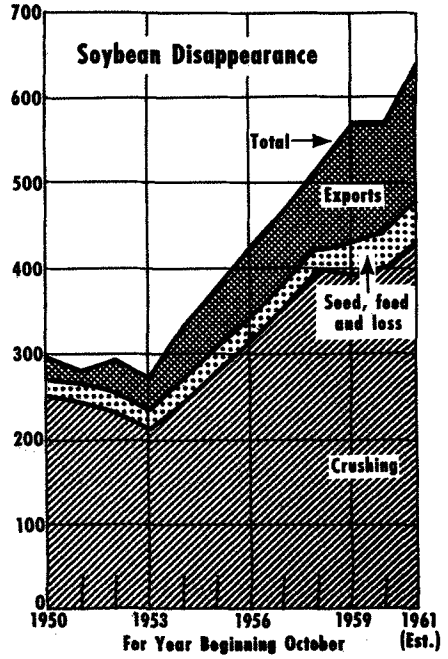

FIG. 3. Soybean disappearance (1950–1961).

TABLE IV

Oil Content of Dressings for Salad (7)

Dressing	Oil Content (Wt. %)
Mayonnaise	65
French	35
Salad	30

standards of identity for interstate commerce (7). Most labels indicate that the dressings are made with a vegetable oil. As shown in Table III, most dressings available through retail outlets contain soybean or cottonseed oils, the former being utilized to a comparatively greater extent.

Newly marketed shortenings, margarines, and salad and cooking oils derived from soybean, cottonseed, corn, and safflower oils are finding consumer acceptance. For example, one new liquid shortening is a suspension of a high-melting fat in an oil. These new products vary in composition, but they are high in polyunsaturates and low in saturates, as shown in Table V. Some of these new products are useful in making pastries, cakes, and other baked goods, normally made only with shortening containing lower percentages of polyunsaturated fatty acids.

A résumé of the polyunsaturated fatty acid content and P/S ratios (polyunsaturated content divided by saturated fatty acid content) of some consumer products—both new and old—will also be found in Table V (3, 18, 19, 21).

TABLE V

Analysis of Table Spreads and Shortenings

Kind	Type	Saturated	Polyunsaturated	P/S ratios
Special margarines [a]	Blends of liquid oils with more saturated fat	14–28	22–34	1.2–1.7
Conventional margarines [a]	All hydrogenated vegetable oils	17–22	7–15	0.5–0.9
Conventional shortening [b]	Hydrogenated vegetable oils	25.9	12.5	0.48
Special soybean oil (salads, frying, and baking) [b]	Hydrogenated winterized oil	15.0	40.2	2.7
Liquid shortening [b]	Partially hydrogenated soybean oil	22.8	32.3	1.4
New shortening [b]	Partially hydrogenated soybean and cottonseed oil	23.9	29.4	1.2

[a] Analyses are given on the basis of grams in 100; margarines contain 80% fat.
[b] Analyses are given for a single commercial sample.

Composition of Edible Oils. Composition of oils varies, depending on seed variety (6, 8), climatic conditions (6), and processing methods. Consequently, it is difficult to compile representative data, because of problems in sample collection and analysis. It is possible to obtain composite samples of a single variety, but one or several samples maturing in either relatively hot or cool weather could give

TABLE VI

Composition of Vegetable Oils

Oil	Number of samples	Polyunsaturates	Saturates	Area	Reference
Soybean	25	58.7	16.0	South	(19)
	6	60.3	14.2	North	
	High	68.5	10.2	Denmark [a]	
	Low	54.6	17.1	South	
Cottonseed	71	50.6	29.0	South	(19)
	High	55.2	26.0		
	Low	50.7	31.0 [b]		
Corn	3	57.6	13.4	West	(19)
Safflower	6	77.7	9.4		(19)
	High	78.9	8.5		
	Low	72.8	10.7		
Linseed	1	74.6	9.9	North	(9)
Peanut	1	24.2	21.9	South	(23)
Olive	1	8.4	16.9		(15)

[a] Sample from European processor; origin of beans unknown. Value was not included in the averages.
[b] This sample had the lowest P/S ratio; P/S ratios were not calculated for this table. See text and Table VII.

a non-representative sample of the variety for a given year. The data collected in Table VI represent analyses obtained by gas-liquid chromatography (GLC). This method is now generally accepted by research workers throughout the country, though it was not the method of choice five years ago. Substantial variability in composition of different samples of soybean oil—presumably in the same crop year is sometimes apparent, as is shown in Table VI. Safflower oil, in the 6 analyses available, varied from 72–78% polyunsaturates. Individual analyses of linseed, peanut, and olive oils are included for comparison. Most of these analyses were carried out on a freshly refined edible grade of oil, suitable for salad oil and salad dressings.

There is a need for further improvement and standardization of the GLC method of analysis. Table VII shows

TABLE VII

Comparison of Actual Compositions with Experimental Analyses (GLC)

Mixture Number		Composition			P/S ratios	% Error in P/S
		Saturates	Linoleic	Linolenic		
I	Actual (Weight)	11.2	58.7	11.0	6.2	
	GLC	11.3	59.2	9.6	6.1	1.7 (9)
II	Actual (Weight)	11.1	10.5	58.7	6.2	
	GLC	12.2	10.1	56.1	5.4	13 (9)
III	Actual (Weight)	49.9	25.1	0.0	0.50	
	GLC	52.3	22.9	0.0	0.44	12 (15)
IV	Actual (Weight)	9.8	27.8	31.5	6.1	
	GLC	10.3	28.1	29.1	5.6	8.3 (19)

GLC analyses on four different synthetic mixtures. The actual weight percentage, the P/S values, and the percentages of error for the P/S values are given. Although the experimental values given for Mixture I are very close, note that a higher percent of linoleic is compensated by a lower percent of linolenic. Furthermore, the same workers ran Mixture II with similar columns, and found the P/S value to be 13% low (9). GLC analyses vary because of the sample size, the differences in retention of components by different columns, and the kind of detector. All the analyses in Table VII were run with thermal detectors. Mixtures I–III were run without temp programming (9, 15), and Mixture IV was run with temp programming (19).

Summary

Over 7 billion lb of vegetable oils, containing more than 50% polyunsaturates, are available in the United States annually. Soybean and cottonseed oils represent about 95% of this total. The remainder of our present supply of edible oils containing more than 50% polyunsaturates is principally corn and safflower oils. The domestic food industry, by choosing among these oils and the products derived therefrom, can supply a variety of food products such as mayonnaise, salad dressing, French dressing, new blended margarines, new liquid and plasticized shortening, and salad and cooking oils—all high in polyunsaturates.

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• *Industry Items*

UNION CARBIDE CHEMICALS CO., New York, N.Y., will construct a new unit for the production of glycol-ether solvents at their Seadrift, Texas, plant. Completion is scheduled for early in 1963.

ATMOSPHERIC ENGINEERS, INC., Los Angeles, Calif, acquired all sales, manufacturing, and marketing rights to the Vitagen Gas Generators, together with all related processes, from the Vitagen Corp.

CELANESE CORP., New York, N.Y., has announced the use of a new European technique for manufacturing acetaldehyde and other acetyl chemicals. Acetaldehyde and related acetyl chemicals have a range of volume end uses in such diversified products as paints and coatings, cosmetics, detergents, insecticides and many other applications.