SESAME

An Oilseed Crop with Potential in California

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SESAME is probably the oldest cultivated oil crop with a wide distribution in the tropical and subtropical regions. It is mentioned in the old Hebrew and Egyptian scripts and the ancient Sanskrit literature. Some of the earliest references to sesame culture were made by the ancient Greek writers Theophrastus (4th century B.C.) and Solon (7th century B.C.). Sesame was introduced into the United States from Africa during the 17th century.

California growers became interested in sesame early in this century, but it has not yet become a commercial crop. Harvesting has been the major factor limiting the introduction of the crop. Until recently all available strains of sesame shattered their seeds when the plants reached maturity—making it impossible to harvest the crop mechanically. In 1943 a non-shattering mutant type was discovered in Venezuela, and extensive efforts have been made to transfer this trait to commercial varieties of sesame. A number of non-shattering (indehiscent) varieties have been developed, but these have not been generally accepted because of low yields, poor germination, poor seedling vigor, inferior seed quality and small pods. One additional problem is that indehiscence often has a variable expression—some pods remain closed while others split open in various degrees, even on the same plant. Furthermore, although indehiscence is genetically determined, it exhibits a strong genotype-environment interaction so that various degrees of capsule splitting appear to be promoted by different levels of atmospheric temperature and soil moisture. Several indehiscent types had to be discarded because they produced exceedingly thick-walled pods which were very difficult to thresh.

A flat stem mutant of sesame (left) and the normal stem (right).

Edible oil

Sesame oil is not widely known in the United States. In Central and South America, Asia, and the Mediterranean countries, however, it is considered a superior edible oil because of its high quality and stability. The meal is an excellent source of protein for both human and animal consumption. Of particular interest is the fact that the meal protein contains all the major amino acids found in meat and in comparable proportions, as shown in the table.

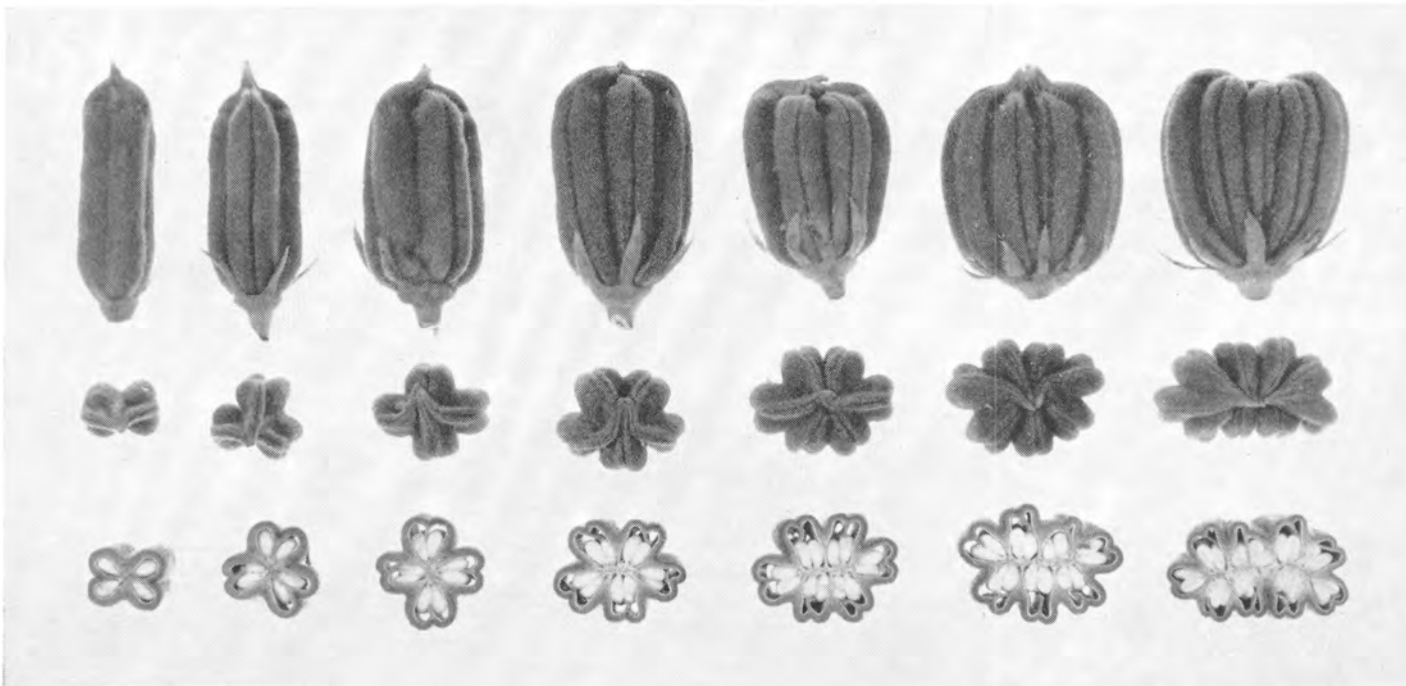
About half of the whole seed imported and grown in the United States is used, after decortication, as a topping for bread and rolls. Small quantities go into industrial uses for the preparation of antioxidants, synergists for insecticides, cosmetics, and for a number of medicinal preparations. Small quantities of sesame oil are available in the market, primarily in health food stores. There is every reason to believe, however, that sesame would be easily accepted by the oilseed processing industry if it could be produced at a competitive price. Refined sesame oil has a very pleasant flavor and taste and is rich in polyunsaturated fatty acids as shown in the graph.

AMINO ACIDS IN SESAME MEAL AS COMPARED WITH MEAT

Amino acids	Sesame meal (%)	Meat (%)
Lysine	2.8	10.0
Tryptophan	1.8	1.4
Methionine	3.2	3.2
Phenylalanine	8.0	5.0
Leucine	7.5	8.0
Isoleucine	4.8	6.0
Valine	5.1	5.5
Threonine	4.0	5.0

High stability

One of the outstanding features of sesame oil is its stability resulting from powerful antioxidants released upon oil extraction. When pure fats, especially those with a high proportion of unsaturated fatty acids (oleic, linoleic and linolenic acids), are exposed to air, light and heat, they deteriorate and become rancid. Rancidity results from oxidative changes in the double bonds of the fatty acids of



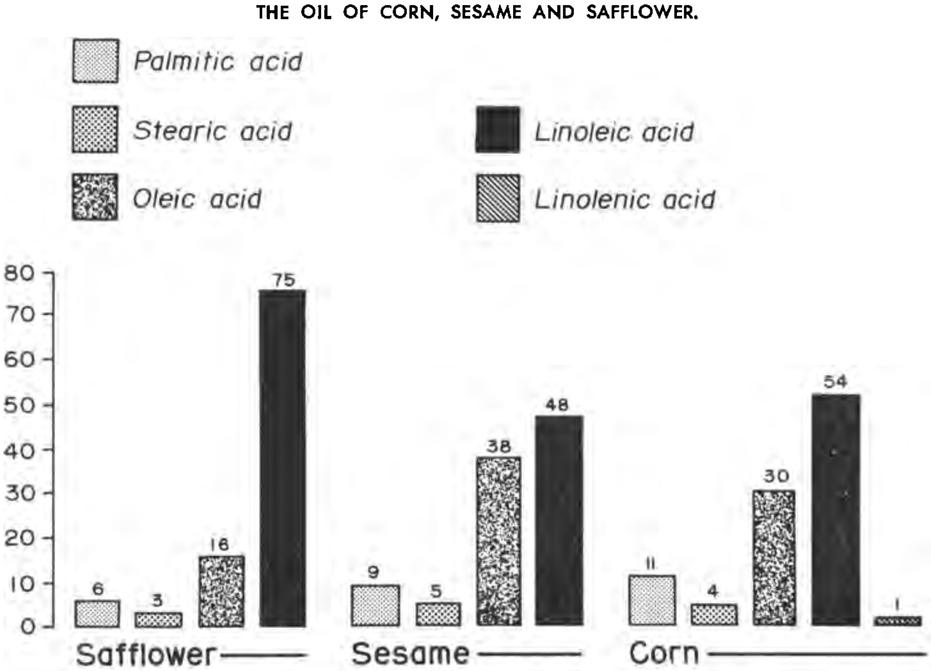
The familiar sesame capsule has two carpels (first capsule on the left). It is not uncommon, however, to find capsules with as many as five carpels.

the oil and, therefore, it proceeds more rapidly in vegetable oils with a high degree of unsaturation. The rate of oxidation, however, is often slower than expected because of the presence of antioxidants which delay oxidation of fats at the expense of their own oxidation. The amount of antioxidants present in oilseeds (tocopherols, phenols, etc.) varies in different oilcrops and even among varieties of one oilcrop. It may change after harvest depending on the conditions of storage and drying of the seed. Sesame oil exhibits the greatest resistance to oxidation because of its high content of a strong antioxidant known as sesamol, a glucoside produced by hydrolysis of sesamolin which occurs in the unsaponifiable fraction of the oil.

Adaptation study

The adaptation of sesame in California is currently being studied by the Department of Agronomy, University of California. A number of yield tests conducted by the University and private industry in the San Joaquin and the Imperial valleys over the last twenty years indicate that the crop is well adapted in California. Yields matching the highest in the nation have often been reported from dehiscent varieties. In general, the materials tested in the past consisted of selections performing well in other areas of the U.S. or abroad under environmental and cultural conditions not always comparable with those in California. Most yield tests were limited to breeding materials developed by the USDA in Texas. A few of the dehiscent varieties in these tests (K-10, Margo, Oro, Calinda) have performed exceptionally well in some years and locations but poorly in others. As an example, the variety K-10 in 1956 produced 2,294 lbs of seed per acre in Shafter (a record high yield for the U.S. at that time) but only 478 lbs per acre in 1955 in Coalinga. The indehiscent varieties available always yielded less than the dehiscent and rarely exceeded 1,000 lbs per acre.

COMPARISON OF THE FATTY ACID COMPOSITION PERCENTAGE OF THE OIL OF CORN, SESAME AND SAFFLOWER.



500 introductions

In an effort to select strains with better adaptation to local conditions, about 500 introductions of sesame have been included in the U.C. breeding program since 1961; and their performance is being studied closely. The immediate objective is to select high yielding dehiscent strains to replace those currently grown on a small scale in California. The long-term objective is to breed high-yielding indehiscent strains adaptable for mechanical harvesting. In both cases, attention is focused on two types of seed: (1) light colored, easy-to-decorticate seed with a pleasant flavor for use as whole seed by the bakery and confection industries; (2) high oil content seed, rich in linoleic acid for the oil processing industry.

Analyses of the available seed stocks indicated that oil contents range from 47 to 56%. Determinations of the chemical composition of the oil of those samples revealed considerable variation in fatty acid content (palmitic acid 6–12%, stearic acid 2–9%, oleic acid 32–49% and linoleic acid 35–52%). The range in the iodine value of the oil extended from 106 to 126. It is believed that if seed analyses of single plant selections were made, the variability in the content and composition of the oil would be much greater. A great amount of variability is also available in these stocks in terms of maturity, growth habit, and capsule morphology. Some of the variable traits observed, like the flattened stems shown in plant photos, may have no more value than genetic oddities often observed in crops. Others, however, like the multicarpelate capsules (seed photo) or the strong placenta attachment which tends to hold the seed in the capsule in spite of dehiscence might prove to be very valuable traits to incorporate in commercial varieties.

Further research is needed to reach the desired plant breeding objectives and to determine the optimum cultural practices for sesame. Nevertheless, the high content of premium quality oil, superior flavor, and nutritive value of the seed makes sesame an extremely promising oilseed crop for California.

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Lateral pressure effects on . . .

HAY WAFER STORAGE STRUCTURES

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HAY WAFERING has been developed to improve the handling characteristics of forage. Wafered hay lends itself to bulk handling and because of its greater density and flowability, permits heavier loading of storage structures.

Pressure wall (8 × 8 ft) used in first test.

But as production of wafers has increased, deep piling of wafers in storage has caused concern regarding the lateral pressure for which storage structures should be designed. Dairymen have constructed self-feeding barns capable of storing 400 to 500 tons of wafers, with little information on structural requirements to withstand the pressures. Where wafers have been stored in barns designed for baled hay, piling along sidewalls has generally been kept to a minimum, resulting in considerable loss of storage capacity.

Hay wafers vary in size, shape, and density. In bulk, the amount of fines varies from one load to the next. All of these physical characteristics affect the flowability and the lateral pressure of wafers. The width, length, and depth of storage may be expected to affect lateral pressure for any particular wafer. Data reported here are from tests under specific limited conditions, but should be helpful in designing safe wafer storage structures.

Tests were conducted on two different flat wall installations. The first test was made with a single 8x8 ft wall, hinged at the bottom, and supported through a framework to a pressure-measuring device. Wafers were piled against the flat side of the wall, and the pressure was measured at various average contact depths of wafers, as shown in the photo. Plywood was fastened on the ends of the panel, extending away from the pile of wafers, to reduce the effect of wafers rolling around behind the pressure wall.

In the second test, four 4x12 ft panels were erected to form two opposing walls 8 ft wide by 12 ft high and 7½ ft apart. They were supported against lateral movement at the base and each pair of opposing 4x12 ft panels was connected by a steel rod through framework extending from the top of each panel as shown in the drawing. The rod was connected to a tension scale to measure the outward pressure between the walls. An 8x12 ft panel was placed against the ends of the 4 × 12 ft panels to form a three-sided structure. Pressures were recorded on the 8 × 12 ft panel with the same device described in the first test to provide data approximating end-wall conditions. A large pile of wafers formed the fourth side. Pressure readings were taken for each 6-inch increment of depth.