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The Status of Safflower

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Abstract

The US safflower industry has matured in the relatively short period of 15 years to a position of stature in terms of stable oil prices, modern processing, and world-wide distribution. This dry land crop is grown in rotation with barley, wheat, rice and other grains. The higher oil content seed developed by the agronomists' reduction of hull content content has made safflower more valuable to domestic and foreign markets. US production has increased to more than 300,000 tons. Processing of the seed is done by conventional methods, preferably continuous screw pressing and solvent extraction.

The future of safflower will depend primarily upon the demand for linoleic-acid based products—either in foods such as the new margarines and other polyunsaturated products, or industrial uses of nonyellowing drying oils, and chemical modifications of linoleic acid. Secondarily, it will depend upon more sophisticated utilization of the protein by-products.

History

SAFFLOWER, ALTHOUGH ONE of the world's oldest crops, has become a significant world-traded oilseed in the past 15 years.

The safflower plant and name have their origin in the Near East. The earliest interest in the safflower plant was focused on its colorful florets. The orange dye of the florets was used in fabric coloring as well as food coloring in place of saffron. Today the plant is grown with deep red, orange, yellow, and even almost white florets. It would appear impractical to harvest the florets mechanically in the United States today. However, hand harvesting in some foreign countries is still done.

Carl Claassen rediscovered the value of safflower in Nebraska during the 1940's. In 1950 the crop was introduced into California where its production has grown steadily (1). Research has improved safflower seed to the extent that now an acre of safflower (average yield for California and Arizona) will produce more oil and protein than an acre of soybeans (average for Illinois).

Agronomy

The safflower plant (*Carthamus tinctorius*) is a member of the *Compositae* family. For centuries, it was grown in the Near East, India, Africa and Europe. Very substantial acreages are still grown in India, but the safflower crop there bears little resemblance to the modern safflower developed in the United States. The safflower "revolution" was

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TABLE I

Safflower Seed Production
(Million of Pounds)

	California	Other states	Total
1949	....	16	16
1950	14	20	34
1951	15	5	20
1952	47	5	52
1953	52	4	56
1954	29	0	29
1955	72	5	77
1956	142	3	145
1957	114	13	127
1958	118	26	144
1959	212	36	248
1960	255	70	325
1961	290	70	360
1962	550	200	750
1963	600	180	780
1964	522	38	560
1965			570

started by Dr. Claassen who was looking for plants suitable for Nebraska's dry lands. At that time yields were low and the all-important oil content was in the 27–28% range. By intensive breeding research, Dr. Claassen was able to reduce the hull content, thereby increasing the oil and protein content dramatically. Tomorrow's commercial varieties will be 47–49% oil content which is probably near the upper limits of practical production.

Basically, safflower is a dry land crop which grows best in arid climates on land with a high water table (2). In areas of high atmospheric humidity, such as those in the soybean belt, safflower is quite susceptible to plant diseases and therefore is not grown east of the 100th meridian. However, highest yields are obtained by careful irrigation. Too much water results in root rot. An increasing portion of the crop is grown on dry land with some form of irrigation. Foreign countries with suitable climate and soil conditions such as Australia, Spain, Mexico and some Latin American areas are beginning to grow the modern safflower plant.

In California, safflower is frequently grown in rotation with rice, barley, wheat and other spring-planted small grains. In the Western Great Plains, it is grown in rotation with many of the grain crops. It is usually planted February through March for harvest in August. In the Great Plains areas these dates are about a month later, but in Arizona the time is a few weeks earlier.

The plant is characterized by a vigorous root system which will penetrate the soil 6–12 ft. The above-ground portion is about 3 ft tall and quite bushy. The heads of the plant contain 20–100 seeds each. The seed, about the size of barley, has a hard fibrous hull surrounding the meat or kernel.

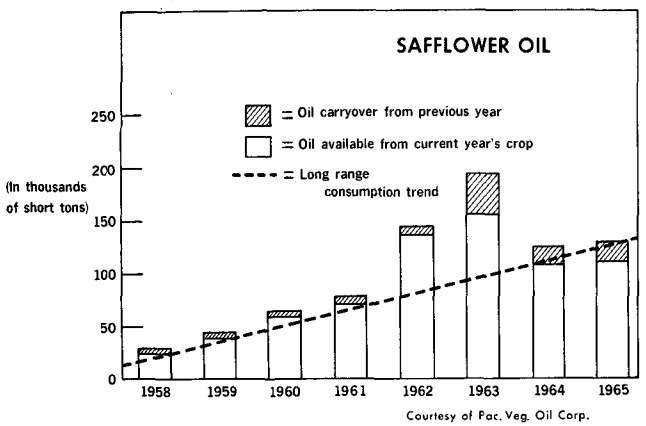

FIG. 1. Safflower oil supply.

After the seed is filled, the plant dries, or "fires." Usually the seed dries to less than 8% moisture before harvesting is practical. The crop is harvested with only slight changes of conventional grain harvesting equipment.

The goal of the agronomists, which has been to develop seed with less hull, is near achievement. This is evidenced by the change from seed of 45–48% hull prior to World War II to the current seed of about 35% hull. Research varieties are approaching 20–22% hull.

The magnificent versatility obtainable from the safflower plant is seen in the different types of oils in the different varieties. In addition to the present commercial oil having almost 80% linoleic acid, there are research types of varying oleic-linoleic amounts, with some almost 75% oleic (3). Commercial quantities of the new oleic types will not be available for several years.

The factors which limit the amount of safflower which can be grown are (1) prices which can be paid for the seed, (2) the amount of cultivatable arid or semiarid land, and (3) our understanding of the crop. Research is gradually removing the first and third factors. The amount of usable land is not yet a limiting factor.

Production

The long-term trend of the production of safflower seed is up. Table I shows that California is the primary source of safflower. However, the other western states can contribute very substantial supplies. As will be seen in the other papers of the symposium, the qualities being found in safflower oil and meal are filling the needs of many types of consumers. There are valid reasons for expecting increased availability of safflower seed. The growers have learned how to obtain better yields. The farm extension services of western universities have become better acquainted with the crop in order to help growers. Agronomic research has offered the grower better seed. Higher oil content seed has enabled companies buying the seed to pay the grower more. As this price increases gradually over the years, safflower will displace other crops which return less to the landowner. Processors will be able to get larger tonnages of seed, thus making the crushing, or processing more efficient.

As evident in Table I, the rate of growth of safflower seed production is striking. Over a 10-year period the rate of increased production is over 25% per year.

The figures for the first 5 years represent a great dollar loss incurred while producers were learning how to grow the crop and build markets. The subsequent figures indicate solid growth. In 1962 and 1963 many new companies entered into safflower seed production in anticipation of the enlarged market for polyunsaturated oils. When this did not materialize, most of the companies ceased safflower seed production. A substantial oversupply was created which reduced the growth rate. Now this surplus has been consumed and seed production will continue its steady increase (see Fig. 1).

The increase in production of safflower seed is evident world-wide as well as in the United States. Exact data are not available, but we expect similar growth curves in other countries thus increasing world-wide availability of safflower.

The price of safflower oil has remained relatively

steady in spite of the changes in production of seed. The competitive products—cotton, corn, linseed, and soy oils—have all tended to stabilize the price. That is, to some extent the competitive oils can be used in place of each other and do so when prices are out of line. As a rule, during the past several years safflower prices have stayed below that of linseed oil, above that of soy oil, and about the same as for cotton oil. The increased availability of safflower seed indicates continued price stability.

Some salient facts which are often overlooked are these: 1) Safflower is *not* a government supported crop. 2) Its growth is the result of private enterprise. 3) Safflower oil is not the by-product of anything.

Although safflower has achieved its status through private industry's willingness to contract with the farmer up to almost 2 years in advance of sale of the final products, there have been substantial contributions from Government scientists. The federal and state agronomists have been extremely helpful as have the USDA Utilization Research and Development researchers.

Processing

The methods of processing now in use are: continuous pressing, combination continuous-press-solvent extraction, and direct extraction. Conventional equipment can be used. The steps and conditions of each step such as cleaning, grinding or flaking, cooking and conditioning prior to oil removal are also conventional. The press cake, from the combination press extraction method, is readily extracted without a fines or filtration problem.

The extracted cake is normally ground for use as animal feed. One of the problems is obtaining a representative sample which may contain coarse fibers and fine particle size meal. The coarse fibers and fine meal segregate easily in handling, sampling, reduction of sample size, and analyzing with resultant wide swings in analytical data.

The coarse fiber of the hull also presents a problem in determining the oil content of safflower seed. We have found that thorough grinding of the seed in a mortar and pestle is the best method of preparation for laboratory extraction. After a few hours' extraction, the sample should be reground and extracted again. Only with this method is all of the oil removed. Correlation of plant extraction yields with laboratory oil contents run in this manner is quite good.

Another commercial analytical aspect which has been thoroughly studied is the method of determining the amount of dockage or the percentage of clean seed in a sample. The grower or farmer is paid on the basis of clean seed which in California is determined by the State Department of Agriculture. A standard method of determining clean seed has been worked out by the California State Department of Agriculture laboratory, is accepted in international trading as the official method, and is described in the AOCS Official Method Ag 1-65. It has been our experience that aspiration of the seed must be repeated until all empty seeds, that is seeds without meats, are removed. One aspiration is inadequate to give a completely clean sample.

Crude safflower oil is normally low in free fatty acids and gum content. Plant refining losses are in good correlation with the theoretical losses obtained by the AOCS method Ca9f-57.

The physical constants of present commercial safflower oil vary less than other vegetable oils, indicating greater uniformity even though the seed is grown in a wide geographical range and under diverse conditions. Specifications of the common grades traded are found in the National Institute of Oilseed Products, San Francisco rules book (4).

Safflower oil is refined also by conventional equipment, usually centrifuges rather than batch process. Very light colors, down to 2 Gardner, can be obtained by bleaching the refined oil. The carotenoid and chlorophyll type of color bodies are usually at low levels.

It is possible to decorticate safflower seed, remove parts of the hull, then crush the mixture of meats and hulls to obtain a higher protein meal. Some Indian workers report (5) protein contents higher than 50% by decortication and removal of almost all of the hulls. By careful cooking they reported being able to expel the high oil content meats. Our own work confirms the need for careful expelling of the decorticated meats in order to avoid mushing in the continuous press.

Marketing

Safflower seed has found a demand in Japan and Europe as well as the United States. In the foreign countries, safflower is used primarily for its edible oil. The expert traders in these countries shop around for the best buys—world-wide—and have many vegetable oils or oil-bearing materials from which to chose. It is interesting that they often pay relatively more for safflower than the United States processors do for similar competitive oils or oilseeds. I hope it is not because foreign oil chemists have learned more about safflower than the United States' chemists.

Actually, the foreign markets have helped stabilize the US market by acting as a balance. While the US consumption was steadily building, the surges in seed production were absorbed by the foreign buyers who are more flexible in interchanging raw materials.

Future

A major factor in the future of safflower is the demand for "polyunsaturates" in foods. Beyond any question, safflower is the best source of these, with the fewest accompanying saturates. As pointed out in this symposium, it is a stable food oil. As a drying oil, it is considered an ideal alkyd oil, highest in the drying components which do not yellow. And the meal is finding its place in animal feeds as a valuable protein source.

The continued increase in oil and protein content will stabilize price and entable greater tonnages to be grown. Since oilseeds must always be looked at from a world-wide basis, the growth of safflower in many foreign areas will be a stabilizing benefit also.

As the demand for edible oil, drying oil, and protein increases the amount of safflower seed produced should also increase.

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