SYMPOSIUM: OILSEED PROCESSORS CHALLENGED BY WORLD PROTEIN NEEDS

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Production and Use of Oilseed Proteins[1]

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ABSTRACT

The worldwide production of the major oilseeds is reviewed, along with indications of their importance as protein sources either directly in human foods or indirectly for animal feeds. In general, direct food use is limited but could be expanded to help meet world protein needs. Problems to be solved relative to increased food use include protein source, processing, distribution and consumption, including cost and acceptance. The successes achieved by soybeans in the food field demonstrate some of the potentials for the oilseeds.

In this review of the relative magnitude of production for different oilseeds and the use that is being made of the oilseed proteins, various factors must be considered that influence the use of these proteins in food applications. In addition, the review provides a background for subsequent papers in this Symposium concerned with the challenge presented to oilseed processors by world protein needs.

Oilseeds as a group lead a double life. They are eaten as such, often with some processing. Also, they are processed for oil. The oilseeds eaten as food specifically supply protein, whether the consumer is aware of it or not. The protein remaining from processing oilseeds for oil has very little direct use in food. Quantitative data are lacking on the disposition of oil cake or meal, particularly on a worldwide basis. However, the main outlets certainly are animal feed and fertilizer with generally small and variable amounts going into foods. The potential for increasing food use is great and the obvious need for low cost food proteins has brought much attention to bear on oilseeds and the contribution they can make in helping to meet those needs.

Oilseeds are only one of several kinds of seed that provide food, including protein. In considering seeds as protein sources, they might for convenience be divided into the three main groups used by the Food and Agriculture Organization of the United Nations (FAO) and others for reporting production; namely, cereal grains, pulses and legumes, and oilseeds. The approximate amounts produced in 1967 are shown in Table I based on data in the FAO Production Yearbook 1968 (1).

Cereal grains are by far the most abundant, their production amounting to 1.1 billion metric tons. The more important cereal grains are wheat, rice, maize and sorghum. Although they are low in protein (usually in the range of 8% to 14%), the per capita consumption of cereals is so high that they provide a significant proportion of the total

TABLE I

Production of Plant Foods

Commodity	Production 1967, million metric tons
Cereals	1100
Pulses and legumes	40
Oilseeds	100

[1]One of 16 papers being published from the Symposium "Oilseed Processors Challenged by World Protein Needs," presented at the ISF-AOCS World Congress, Chicago, September 1970.

[2]No. Market. Nutr. Res. Div., ARS, USDA.

INDEX

TABLE II

World Production of Major Oilseeds Supplying Food Oil

Commodity	Production 1967, million metric tons
Soybeans	41
Cottonseed	20
Peanuts (in shell)	17
Sunflower seed	10
Rapeseed	5
Sesame seed	2

food protein on a worldwide basis. Estimates place this proportion at around 50%. The cereal grains also find widespread use as animal feed. In this case, they increase the protein supply through conversion to animal protein.

Pulses and legumes include beans and peas along with a large number of other seeds. Produced in the amount of 40 million metric tons, they are well recognized as furnishing food protein.

The oilseeds occupy an intermediate position in terms of supply, being produced in the amount of 100 million metric tons. As already mentioned, the oilseeds are looked upon primarily as oil sources and secondarily as protein sources. This order of emphasis might well become reversed in view of the increasing challenge of world demands for food protein.

For the main oilseeds, production figures are presented in Table II. Although soybeans at 41 million metric tons have the largest production, their direct food use worldwide is relatively small. Likewise, oil cake or meal has relatively minor outlets in food, by far the larger proportion going into animal feed.

The importance of soybeans as a source of food protein differs, of course, among countries. In the United States, only about 1.5% of the meal produced goes into food products. However, because of the large volume of soybeans crushed for oil (606 million bushels in 1968-1969), the 1.5% represents about 220,000 tons of meal equivalent to about 10 million bushels of beans (43 lb defatted, 50% protein meal per bushel). In contrast, Japan is much more dependent on soybeans for food. About 12% to 15% of the total food protein in the Japanese diet is supplied by soybeans (2). In 1967, a total of 2,300,000 metric tons of soybeans were consumed in Japan. Of this, 640,000 metric tons (28%) went directly to food products while 1,600,000 metric tons were crushed for oil. Some 30% of the defatted meal was also sold for foods. It can be concluded that about half of the soybeans used in Japan in 1967 provided food protein, the rest going to feed and limited industrial outlets.

After soybeans, the next major oilseed is cottonseed with a 1967 production of about 20 million metric tons. The situation with cottonseed differs in several respects from that for soybeans. Since cottonseed is a byproduct of cotton production, the supply depends directly on the cotton harvest. Essentially all the seed is processed for oil. The remaining meal goes mainly to animal feed and fertilizer with much less food use than in the case of soybean meal. However, increasing food use can be expected as progress continues in overcoming such obstacles as color and the toxic component, gossypol, found in the pigment glands of the ordinary glanded cottonseed.

Peanuts or groundnuts are close behind cottonseed with a production in 1967 of 17 million metric tons. As with soybeans, there is considerable variation in the extent to which peanuts provide food protein. In the United States, around three fourths of the peanuts are used directly as food, mainly in the form of peanut butter. However, the United States produces only about 5% of the total world supply of peanuts. By contrast, India which produces

TABLE III

Geographical Areas of Oilseed Production

Oilseed	Main producers
Soybeans	North America, China, Far East
Cottonseed	USSR, China, North and Latin Americas, Far and Near East
Peanuts (in shell)	Far East, Africa, China, Latin and North Americas
Sunflower seed	USSR, Europe, Latin America
Rapeseed	Europe, Far East, China, North America
Sesame seed	Far and Near East, China, Latin America, Africa

nearly one third of the total supply, probably uses 10% or less directly as food. The various forms in which peanuts may be eaten include: raw, roasted, as peanut butter, as a partly defatted flour in soups and other foods and as curds and "milk".

Sunflower seed for which the production was 10 million metric tons has been attracting increasing attention as an oilseed. Relatively little information is available on its protein use. Some sunflower seed is eaten as such although most is processed for oil.

Rapeseed with a production of 5 million metric tons is processed for oil. The meal is used as animal feed and in other outlets.

Sesame seed has a relatively large food use, both in the form of the seed itself and as a meal or flour. The production of sesame seed in 1967 was about 2 million metric tons.

Other oilseeds, such as coconut and palm kernels, could have been included in Table II. However, the six listed suffice to show in general the amounts of oilseeds available.

Relative to the problem of world protein needs, it is apparent that oilseed proteins do make some contribution to meeting these needs but that this contribution is relatively minor except in the secondary role of animal feeds.

A natural question is whether oilseeds can and will give more help in meeting the world protein needs. They can and probably will be of greater help. However, there are problems that must be solved regardless of what kind of protein is being proposed for increased use. Some of these problems are protein source, processing, distribution and consumption. These problems have strong undertones of economics, including purchasing power, along with cultural and sociological aspects.

The problem of protein source relates particularly to geographic distribution. Local production would be favored over importing the raw material. Oilseeds as a group offer the advantage of quite wide distribution as indicated by the tabulation (Table III) showing the main production areas for the major oilseeds. One could generalize that at least some oilseed production occurs in nearly all parts of the temperate and tropical zones. In addition, there is good reason to believe that the areas of production can be expanded.

Other factors relating to protein source include acceptance by the consumer and quality of the protein. An example of an acceptance problem relates to the flavor of soybeans which is objectionable to some people and in some types of food products. The flavor of soybean meal or flour can be improved by moist heat treatment, commonly referred to as toasting. One type of quality problem is the presence of undesirable constituents, such as the gossypol in the pigment glands of cottonseed. Progress in overcoming this problem is being made along two avenues, the mechanical removal of the glands by processing and genetic breeding of a cottonseed which is glandless (3).

Processing as a problem area relates particularly to whether the processing can be done entirely at home or whether it must be done commercially with added cost to the consumer.

An example of home or local processing is the so-called "Village Process" for making full fat soy flour developed at the Northern Regional Research Laboratory (4). The procedure uses hand-operated equipment and simple conditions. The resulting full fat soy flour retains the caloric and nutritional value of the soybean oil yet has very good storage stability and relatively mild flavor. For larger scale or commercial operation, full fat soy flour can be produced by extrusion cooking (5).

Distribution of the raw material and of the processed food protein may present obstacles if good transportation facilities are not available. In addition, any need for major movement of materials will increase the cost of the food protein to the consumer.

The subject of consumption of the protein actually presents a number of problems the solution of which depends heavily on education of the consumer. One problem is how to use the protein. The simplest method is as a supplement by addition to the recipe; for example, in cookies, bread and chapatties. Alternatively, the protein may be the major ingredient of a more or less new product, such as the beverage, "Vitasoy," which has captured about 25% of the market for soft drinks in Hong Kong. Very sophisticated and complex products also may be made from the protein; for example, simulated meats based on soy flour or isolated soy protein.

Motivation of the consumer to eat the protein product is another aspect of the consumption problem. Generally, the product must have immediate appeal to the consumer. This appeal is achieved most easily by incorporating the protein in a familiar food without changing its characteristics. Otherwise, the consumer must be induced through advertising and education to accept a new product. Hopefully, nutrition can be a strong motivating factor for the consumption of additional protein. Often, however, such is not the case. Price, together with consumer appeal, usually is of greater importance.

Relative to price, the low cost of oilseed proteins is advantageous. At the present market price for defatted soybean flour, the protein therein costs about 14 cents per lb compared with more than $5 per lb for the protein in beef. Such a comparison is not completely fair since people do not simply buy protein (i.e., nitrogen x 6.25). Roasting soybean flour will neither make it look like nor taste like roast beef, although soybean protein can indeed be made to resemble roast beef very closely. However, the production of simulated roast beef requires extensive processing which increases the cost of the final product. Still, the cost of simulated meats based on soybean or other proteins undoubtedly will be lower than the cost of meat, particularly as their production increases.

Lest the problems faced by oilseed proteins in food become overly depressing, the advantage of versatility which the oilseed proteins possess also should be emphasized. Certainly the successful production of simulated meats from soybean flour and isolated protein gives some indication of this versatility. Further evidence is provided by the variety of Oriental foods based on soybeans. Many of these are fermented, such as Chinese cheese (sufu), tempeh and soy sauce, others are not, such as tofu or soy curd.

Even in the simple form of soybean flour, soy protein is showing its versatility as a food ingredient. A good example is CSM (6), a combination of corn meal, soy flour and dry milk solids together with vitamins, minerals and soybean oil. This supplemental food mixture has achieved worldwide distribution through the Food for Peace Program of the U.S. Department of Agriculture. The effectiveness of its use in the feeding of preschool children is introducing oilseed protein nutrition to many people.

This review of oilseed production and use has placed considerable emphasis on soybeans. Such emphasis is natural in view of the progress which has been made in the development of food uses of soybean protein. Research on other oilseed proteins, not only is following the lead given by soybean protein, but also can be expected to yield new and important developments that will contribute to meeting the problem of protein needs around the globe.

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