OIL and PROTEIN content of sunflower seed

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Sunflower seed has been grown for mercantile purposes for the past 100 years, initially in eastern European areas. Its cultivation has spread to all parts of the world including the United States, although production in this country has been rather limited. Prior to 1947 most of the seed grown in this country has been used for feed for poultry and hogs.

Quite recently Canada has become a major producer, probably because of the need for a domestic source of edible oils. The current dwarf varieties, developed by Canadian research, are more easily harvested and in addition produce a higher yield of better quality seeds than earlier varieties.

In 1947, a Minneapolis commission house encouraged the production of these dwarf varieties in North Dakota by guaranteeing a market for the seeds at a price pegged to the flax seed value, based on oil content. This industry price support was dropped in March 1948, but in the short time it was in effect, considerable interest was developed in the crop as can be seen from the following data.

Table I—ESTIMATE BY YEARS OF SUNFLOWER SEED PRODUCTION IN NORTH DAKOTA. (DATA FROM OFFICE OF AGRICULTURAL STATISTICIAN, FARGO, N. D., BAE, USDA.)

Year	Acres harvested	Yield	Total Production
		Lbs. per acre	Pounds
1947	3,500	800	2,800,000
1948	22,000	800	17,600,000
1949	10,000	750	7,500,000
1950	4,700	800	3,760,000

The average price received from the 1947 crop was 7 cents per pound or approximately 23 cents per pound of oil based on an oil content of 30 per cent. Without the price guarantee, the 1948 price received for seed varied from 2.5 to 5.2 cents per pound. No figures were available on the selling price of the 1949 and 1950 crops.

North Dakota farmers need an inter-tilled crop in the cash grain area west of the Red River Valley to help control weeds. Sunflowers are a hardy drought resistant crop which may serve this purpose.

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Whether the sunflower will become an important crop depends to a large extent on the development of markets for the seeds.

The meat of the sunflower seed is surrounded with a tough shell or hull. This hull must be removed before processing the seed, both for maximum yields of oil and to make the meal satisfactory for protein supplements.

If hulls are not removed, the meal obtained is excessively high in fiber and cannot be used as a protein supplement to poultry rations. Numerous experiments have shown that the hulls can be used for the production of furfural, a solvent used very extensively in the petroleum and synthetic rubber industry. The hulls have also been pressed into molded fireplace logs. The hulls constitute 36 to 46 per cent of the weight of the seed.

SUNFLOWER SEED OIL

After the hulls are removed the oil can be satisfactorily expressed or extracted in the same type of mills used now for the removal of linseed oil and soybean oil.

The oil has a pale yellow color, a mild taste and a pleasant odor. It is used principally as an edible oil and should be quite desirable as a salad oil because of its stability and flavor retention. We have had samples exposed to laboratory temperatures for a period of three years with no apparent development of rancidity or off flavors. Furthermore, there was no detectable change in the chemical composition of the oil.

The composition of the oil is similar to that of corn oil or cotton seed oil. It differs in that it contains less of the unsaturated fatty acids and a higher linoleic acid content. It contains essentially no linolenic acid. Linoleic acid is characterized by its solubility at room temperature as compared with stearic which is solid. It contains two points of unsaturation. Linolenic acid contains three points of unsaturation. Linolenic acid is one of the chief constituents of linseed oil, and is the big factor in the film forming or drying quality of linseed oil.

Sunflower seed oil would be classed as a semi-drying oil. Film formation can be expected if sufficient drying time is permitted. By modification of the oil it should be possible to prepare alkid resins with favorable properties for indoor coatings where yellowing is a factor.

Numerous investigations of the fatty acid content of the oil have been made. As might be expected the analyses varied considerably with the source of the seed and the variety of seed used. Table II lists analyses of some sunflower seed oils reported in the literature.

From this table it is seen that the analyses of oils from seed (Sunrise variety) grown in North Dakota differ appreciably from values previously reported for this country. The values reported by Jamison and Boughman (3) were based on Mammoth Russian variety. Milner *et. al.* (6) reported averages for four varieties

Table II—COMPARISON OF ANALYSES OF SUNFLOWER SEED OILS FROM VARIOUS PARTS OF THE WORLD (PERCENTAGE OF FATTY ACIDS BY WEIGHT.)

Habitat	Saturated fats	Oleic	Linoleic	Higher Fatty Acids
India (1)	9.73	49.41	40.48	....
Congo (1)	5.3	42.0	52.0	0.7
North China (2)	8.3	37.4	53.6	0.4
Russia (1)	9.6	36.2	54.2	....
Missouri (U.S.A.) (3)	6.4	34.1	58.5	1.0
Kenya (4)	14	17	69	....
S. Rhodesia (4)	14	14	72	....
North Dakota (5)	11.7	14.1	72.8	1.4

(Mennonite, Sunrise, Greystripe, and Manchurian) grown at seven stations as far north as Ames, Iowa, which were in agreement with the values of the Missouri seed of Jamieson. The values obtained for the North Dakota crop are quite similar to the values reported for the South Rhodesia crop.

In order to determine whether the values for linoleic acid found in the Sunrise varieties were characteristic of North Dakota grown seeds in general, a number of additional samples were examined for this one component. A detailed analysis of a large number of oils is not feasible because of the time and cost factors involved. However, by use of spectrophotometric methods it is fairly simple to determine the major component, linoleic acid, and at the same time determine the presence or absence of linolenic acid. We examined a number of samples from field grown crops and of seeds obtained from the Fargo experimental plots. Six samples of seeds from field grown crops or oil obtained from commercial sources pressed from seeds grown in this area contained 72 to 75 per cent linoleic acid. Oil from seeds grown in the experimental plots showed a lower content (55 to 68 per cent). Immaturity of the seed at the time of harvest may have been a factor in these low values.

Many vegetable oils show a precipitation or separating out of certain components on long refrigeration. Even highly unsaturated linseed oil shows this property. None of the samples of sunflower seed oil thus far examined has shown any separation.

Sunflower seed oil should find a ready place in the food trade because of the stability of the oil to development of rancidity. It should also find a market in the protective coatings field where an oil of uniform composition is desired by paint and varnish manufacturers.

SUNFLOWER SEED PROTEINS

After the extraction of the oil from the dehulled seeds a protein rich residue or meal remains. This meal has been studied by a number of laboratories both from the standpoint of the use of the meal as a livestock protein supplement and as a source of industrial proteins.

In protein content sunflower seed meal tops the list of vegetable concentrates, having around 52.5 per cent. If the kernels are completely dehulled it is comparatively low in crude fibre and for a concentrate of plant origin it is unusually rich in calcium and phosphorus. It is an excellent source of thiamin or vitamin B_1 and niacin and for a plant concentrate it is comparatively rich in riboflavin. There are some indications that the riboflavin as indicated in chemical analyses is not all available for growth of the animal.

Table III—*SUNFLOWER SEED MEAL: COMPOSITION COMPARED WITH OTHER HIGH PROTEIN FEEDS AND WITH FLOUR.

				Vitamins per Pound		
	Crude Protein %	Calcium %	Phosphorus %	(Vit. B^1) Thiamin mg.	Riboflavin mg.	Niacin mg.
Sunflower Seed Meal	52.8	.57	.58	16.5	2.2	136
Cotton Seed Meal	43.7	.33	.77	2.0	6.7	18.
Linseed Meal	40.4	.18	1.15	5.8	2.8	22
Corn Gluten Meal	43.	.10	.47	......	.4	14
Wheat Flour, Patent	10.8	.02	.09	.07	.03	0.8
Wheat Flour, Whole	13.0	.04	.38	.56	.12	5.6

* Data from University of Illinois, Ag. Exp. Station, Circ. 608. (1947)

The quality of the protein of the sunflower seed meal has been checked by laboratories using as experiment animals the white rat, poultry, and swine. Experiments indicated that the protein in defatted meal was very digestible. Biological value was 64.5 per cent. This places sunflower seed protein in the same class as wheat and definitely superior to raw soybean protein and corn protein. Experimental work at the University of California showed that sunflower seed meal as a supplement to laying mash was equally as effective as heat treated soybean meal from the standpoint of average egg production and mortality in the flock. The Missouri Agricultural Experiment Station found that sunflower seed meal fed with corn replaced tankage in swine production with no loss of effectiveness of the ration. The Illinois Agricultural Experiment Station obtained similar results in paired feeding trials.

The home economics department at the University of Illinois also conducted some interesting experiments on the use of sunflower seed flour for human consumption. They tested sunflower seed flour additions to plain, spice, and chocolate cakes and in griddle cakes, muffins and yeast rolls, in each case replacing a part of the white patent flour with the sunflower seed flour. In their experiments, sunflower seed flour was a finely divided sample of sunflower seed meal prepared from completely dehulled solvent extracted meats or kernels. Many of the products containing 10 per cent of sunflower seed flour were reported as being delicious.

It could not be used successfully in light colored products as the addition of sunflower seed meal developed a gray cast. Dark colored products would completely mask this gray cast. The gray color in these products is known to be due to the oxidation of a rather complex organic component called chlorogenic acid found in the kernel. The use of sunflower seed flour certainly increased the protein and vitamin contents of baked products. The Illinois experimenters report added flavor, increased loaf volume and a richer brown crust color.

Smith and Johnsen (7) recently investigated sunflower seed meal from the standpoint of the industrial utilization of the protein fraction. They found that the protein could be dispersed very readily with dilute alkali and precipitated by the addition of acids. The resulting proteins had an objectionable dark color which could not be removed by extraction with alcohol or similar solvents. The color of the proteins is caused by the oxidation of chlorogenic acid, mentioned above. Work in the agricultural chemical laboratory at North Dakota Agricultural College has shown that this color formation can be prevented by the addition of small quantities of sodium sulphite to the dispersing medium. Furthermore the resulting protein could be redispersed following precipitation and drying without formation of color. Apparently sufficient sodium sulphite is absorbed to the precipitated protein to prevent oxidation of chlorogenic acid in the redispersed protein.

Proteins have been used industrially for the preparation of adhesives or glues. Bone, hide and casein glues have been used very extensively since earliest recorded history. Recently plant proteins, particularly soybean proteins, have been used in the preparation of adhesives. Many thousands of tons are used for this purpose yearly.

From time to time proteins have been suggested as components for preparation of plastics. Casein from milk has been used quite extensively. In the middle thirty's, soybean proteins were suggested for use and have been used rather successfully in the production of some plastics. An interesting example is the use made by the Ford Motor Company for the preparation of decorative trims during that period. Proteins have also been used quite extensively in the preparation of coatings and facings for paper. Approximately 75 per cent of the casein produced in America is used for this purpose. A number of synthetic fibers have been produced from plant proteins. However, none of these has been generally accepted as a substitute for wool or the other synthetic fibers of the nylon or similar types.

Sunflower seed proteins may have properties which would enable them to compete with other proteins in the preparation of these industrial products.

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