Characteristics of Sunflower Seed and Meal

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ABSTRACT

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Comparison of chemical compositions of confectionary and high oil variety sunflower seeds indicated that their kernels contain similar oil, protein, crude fiber, and ash contents. The only obvious differences between the two types of seed are the bulk density of seed, the proportion and thickness of hulls, and the degree of black coloration on the surface of hulls. Whole confectionary seeds are lower in oil because they have a higher fraction of hull. The thin and dark hulls of high oil seeds create difficulties in processing food grade sunflower protein products. In particular, the dark specks coming from the surface of hulls may make sunflower seed flour nearly black when it is wet. The maximum tolerable level of unhulled seed in the kernel fraction was established by observing flour samples with known proportions of unhulled seed and measuring their color with a Hunterlab Color Difference Meter. The tolerable levels are 3 and 5%, respectively, for high oil and confectionary varieties. This article proposes a method for estimating the amount of hull in kernel-hull mixtures or of crude fiber in meal fractions from seed of known composition, based on the nitrogen content of the dry defatted meal.

Although native to the United States, sunflower seed became commercially important only after introduction of high-oil Russian varieties in 1967. It is a potential protein supplement for human diet, due to its good nutritional content and the absence of any antinutritional factors. However, the primary use of sunflower seed is not for edible protein but for oil, because certain attributes of sunflower seed oil have made it particularly attractive to the food industry. Presently, the residual meal finds a market only in ruminant feeds. Because the world's population is growing, use of oil seeds to feed people instead of animals is becoming more desirable. Studies of sunflower seed for this purpose are therefore appropriate.

The past decade has produced many articles discussing quality, properties, and fatty acid composition of sunflower seed oil (Fedeli et al 1972, Fick and Zimmerman 1973, List et al 1972, Mikolajczak et al 1970, Morrison 1975, Morrison and Robertson 1975, Morrison et al 1973, Putt and Carson 1969, Robertson et al 1978, Zimmerman and Fick 1973); functional properties and pigmentation of meal (Brummett and Burns 1972, Huffman et al 1975, Pomenta and Burns 1971); processes to produce protein concentrate and isolate (Agren and Lieden 1968, Fan et al 1976, Gheyasuddin et al 1970, Hagenmaier 1974, Marinchevski et al 1975, Meith et al 1971, Petit et al 1974, Schwenke et al 1975, Shcherbakov et al 1976, Sodini and Canella 1977, Sosulski and Bakal 1969); composition of hulls and kernels (Cancalon 1971, Earle et al 1968, Kinman and Earle 1964); genetic improvement of oil and amino acid composition (Kinman 1972); and economics and utilization of sunflower seed products (Burns et al 1972; Gandy 1972, 1975; Kinard 1975; Robertson 1972; Smith 1971; Smith 1968; Trotter and Givan 1971).

One purpose of this report is to present data on characteristics of several batches of sunflower seeds that were employed in processing research. These were all grown in the United States during the past three years. Some seeds were called "high oil or oilseed" varieties and others were called "low oil or confectionary seed." Other researchers have not emphasized the similarities and differences in these two types of seed. Although this is not a survey of the composition of seed produced in this country, the results may help clarify the similarities and differences between the two types of seed and to establish objectives for future research.

MATERIALS AND METHODS

Four lots of oilseed varieties were obtained from commercial suppliers: Romsun HS-52 (1975 crop) from Tex-Ag Company, Mission, TX; Romsun HS-52 (1975 crop) from Plains Cooperative Oil Mill, Lubbock, TX; Cargill 204 (1975 crop) from Cargill Seeds, Fargo, ND; Sun Gro 380 (1976 crop) from L&W Sunflower Company Inc., Petersburg, TX. Besides these, six samples of an experimental variety were supplied by USDA Southwestern Great Plains Research Center, Bushland, TX. These samples, designated Hybrid 896, were from seeds planted in the same area of west Texas at different times between March and July 1976.

Seeds from three confectionary varieties were supplied by Dahlgren & Company, Crookston, MN. These, designated D508, D611, and D613, were from the 1975 crop year.

Confectionary seed varieties had been cleaned and sized by the supplier. All the oilseed varieties were cleaned and sized in our laboratory with a Bauer No. 199 cottonseed cleaner to remove foreign matter and to separate seed small enough to pass through a screen with 12/64-in. round holes.

Chemical composition of kernels, hulls, and whole seed were measured according to official methods of the American Oil Chemists Society (AOCS). Methods Ai-2-75, Ai-3-75, Ai-4-75, Ba-5-49, and Ba-6-61 were used to determine the content of moisture, oil, nitrogen, ash, and crude fiber (AOCS 1971). Amino acid compositions of sunflower meals were assayed according to the procedure described by Lawhon et al (1977).

Fatty acid composition of sunflower seed oil was determined by using a gas chromatographic (GC) technique. About 0.8 μl of methyl esters of fatty acids derivatized by the AOCS Tenative Method Ce-1-62 was injected into a GC (Hewlett Packard Model 5710A) that was equipped with an integrator, recorder, and flame ionization detector. The temperatures of the injector, column, and detector were set at 200, 205, and 300°C, respectively. Helium was used as the carrier gas, with a flow rate of 20 ml/min. A 6 ft by 1/8 in. nickel column packed wth 10% Silar 10C coated on GCRZ (80-100 mesh) was used. It was provided by Applied Science Laboratories, Inc.

A series of round-hole screens was used to examine the seed size distribution for 100-g samples of seed. The bulk density of seed was determined by measuring the weight and volume of 100 seeds in each size fraction. Then the proportions of kernels and hulls for these samples were calculated from manually decorticated seeds. The thicknesses of hulls were measured with a micrometer.

Defatted kernel and whole seed flours were produced by first coarsely grinding kernels or whole seeds. Ground materials were then extracted with petroleum ether at room temperature. After the residual fat content in the meal was lowered to around 1%, the meal was air-dried in a fume hood and comminuted to fine particles with an Alpine pin-mill. Flour samples were wetted with three parts of water and their colors were examined by both visual observation and the Hunter Color Difference Meter, Model D25D2.

RESULTS AND DISCUSSION

Characteristics of Sunflower Seed

During the past three years, data were collected on several varieties of seed grown in the northern and southern United States. Data were obtained in the Food Protein Research and Development Center at Texas A & M University in conjunction with decor-

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tication and depigmentation research projects.

As shown in Table I, there were no obvious differences between oilseed and confectionary varieties in chemical composition and gross pigment content. Hulls of confectionary seed seemed to have a slightly higher content of crude fiber than those of oilseed varieties.

Amino acid compositions of kernels from both types of seed were practically the same and agreed well with data reported by Earle et al (1968).

The fatty acid compositions for oilseed and confectionary varieties were similar and equally sensitive to environmental conditions. In general, oil from northern seed was higher in unsaturation, which is caused by higher levels of linoleic acid. Kinman and Earle (1964) and Earle et al (1968) reported that fatty acid compositions differed slightly with different varieties grown in the same environment. Our data agree with this report.

In samples of one variety (Hybrid 896) that had been planted at the same location in west Texas, the amount of linoleic acid changed with planting date (and, by implication, with harvest date). During March to July, the linoleic acid increased with the time of planting from 41 to 62% and oleic acid decreased from 47 to 26%. These data seem to indicate that ambient temperature during the time when seed is maturing governs the degree of unsaturation. Therefore higher unsaturation might be accomplished in southern growing areas through later planting dates. It is also interesting that the sums of palmitic and stearic acids (10.8 ± 1.3%) were relatively constant regardless of planting dates and varieties.

Although the bulk densities of both varieties differed only slightly, as shown in Table II, the confectionary seed had higher hull content and thicker hulls than did oilseed. Seed size distribution of the oilseed variety was generally sharp and narrow, whereas that for the confectionary variety was wider and skewed somewhat toward bigger seed size. This is demonstrated in Fig. 1 with one sample of each sunflower seed variety.

TABLE I
Chemical Composition of Sunflower Seed[a]

Sample	Composition (mfb, %) Oil	Nitrogen	Protein N% × 6.25	Ash	Crude Fiber	Crude Fiber (mofb, %)	Gross Pigment Content (g CGA/100g Flour)[b]
High Oil Variety							
Achene	37.9–49.1	3.1–4.3	19.6–27.1	3.7–4.3	15.2–20.4	25.0–32.9	...
Kernel	49.0–55.0	4.3–4.7	26.7–29.6	3.3–3.9	2.1–2.7	4.8–6.2	2.80–3.86
Hull	1.9–2.9	0.6–0.9	3.7–5.4	2.9–3.5	60.4–61.5	62.2–62.9	...
Confectionary Variety							
Achene	31.7–34.3	2.7–3.6	16.8–22.6	...	22.5–27.7	34.8–40.8	...
Kernel	52.6–56.2	4.6–5.5	28.6–34.2	1.6–1.7	2.0–3.8	4.5–8.0	3.09–3.40
Hull	0.9–2.9	0.6–0.7	3.7–4.6	1.7–4.1	62.8–68.4	64.7–69.0	...

[a]Analytical assays were done on four commercial high oil varieties and three commercial confectionary varieties following AOCS official methods. Data are reported in moisture free basis (mfb) and moisture and oil free basis (mofb).

[b]Gross pigment content (oil free basis) was determined by measuring the ultraviolet absorption of methanol-extracted pigments (12-hr Soxhlet extraction) from defatted kernel flour at wavelength 332 nm and was expressed in grams of chlorogenic acid (CGA) extracted per 100 g of kernel flour.

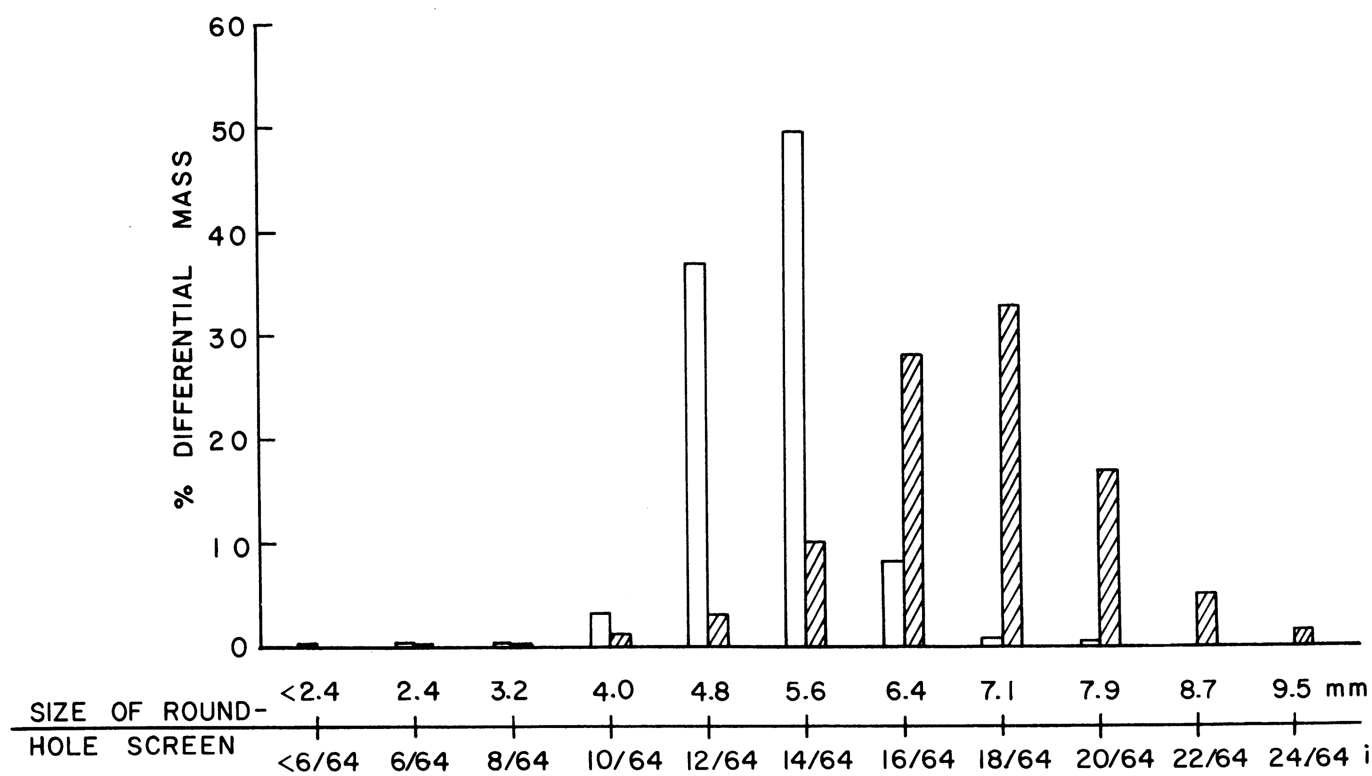

Fig 1. Seed size distribution of oilseed variety (Sun Gro 380, open block) and confectionary variety (Dahlgren D-613, shaded block).

Characteristics of Sunflower Seed Meal

A reliable and quick determination of crude fiber content in meal is desirable in producing low fiber meal. Sometimes even an estimation of the crude fiber content in the meal or the hull content in a processed sample is very useful information. The AOCS crude fiber method is time-consuming, especially because the oil content of a sample must be reduced below 1% before the fiber analysis is conducted. Therefore, we sought more rapid methods of estimating the crude fiber content of mixtures of kernels and hulls and of meal.

Samples with known proportions of kernels and hulls were prepared and analyzed for moisture, oil, nitrogen, and crude fiber content. The results are shown in Fig. 2. Correlation coefficients of all these straight lines are better than 0.99. Therefore, knowledge of the nitrogen or oil content of both pure hulls and kernels on a moisture free basis (MFB) allows use of nitrogen or oil and moisture analyses to estimate the hull content in mixtures of kernels and hulls. Oil and nitrogen content (MFB) of kernels and hulls may vary in sunflower seed lots, depending on the variety and growing environment. Therefore, these measurements should be made on each lot of seed to provide processing guidelines.

Similar relationships were found to apply to defatted meal. The nitrogen determination (moisture and oil free basis) can therefore be used to estimate crude fiber content in meal.

Hull-free sunflower kernels are difficult and costly to produce from high oil variety seed. A low fiber meal was processed from whole seed of the oilseed variety by sieving out hulls. This meal was then examined microscopically and the results are shown in Table III. This meal became completely black upon wetting even though it contained only 5% (in number) black specks.

To establish the critical point for maximum tolerable level of unhulled seed in kernels, defatted hull-free kernel flour and defatted whole seed flour were processed. Blends of these two flours were mixed in varying proportions. The color of these blends was measured with a Hunterlab Color Difference Meter (Model D25D2) in terms of L, a, and b. L is the degree of brightness, with perfect white being 100 and 0 being completely black. Hue is measured in terms of a and b. Only L-values will be reported. Dry blends varied moderately from 88.6 for hull-free flour to 61.0 for whole seed flour. The values of wetted blends ranged from 62.6 to 25.7. When L-values were plotted against percent of unhulled seed (Fig. 3), the maximum tolerable level for unhulled seed, where the dashed tangent line started breaking from the monotonically decreasing curve, was determined to be around 3% for high oil variety. This level was confirmed by visual observations and similar tests on two other high oil varieties. The maximum tolerable level for confectionary varieties was 5%.

CONCLUSION

The compositions of the kernels of oilseed and confectionary varieties of sunflower seed are about the same. Confectionary seeds are lower in oil because they have a higher fraction of hull. The

TABLE II
Bulk density and, Proportion of Hulls and Kernels of Oilseed and Confectionary Variety Sunflower Seed[a]

Sample	Bulk Density (g/ml)	Weight (%) Kernel	Weight (%) Hull	Hull Thickness (mm)
Oilseed	0.31–0.42	70.2–78.9	21.1–29.8	0.16–0.50
Confectionary	0.24–0.40	52.4–64.2	35.8–47.6	0.36–0.81

[a]Data are reported as is basis.

TABLE III
Microscopic Examination of Defatted Sunflower Meal,[a] Oilseed Variety

	Number Distribution (%)	Size Distribution[b] (%) 0~10 μm	20~30 μm	50~150 μm
Flour particles	95.31	87.5	12.5	0.0
Dark specks	4.69	69.6	13.0	17.4

[a]Alpine pin-mill ground and air-jet sieved through 45-μm sieve.
[b]When particle was spherical, the diameter was measured; otherwise the longer dimension was determined.

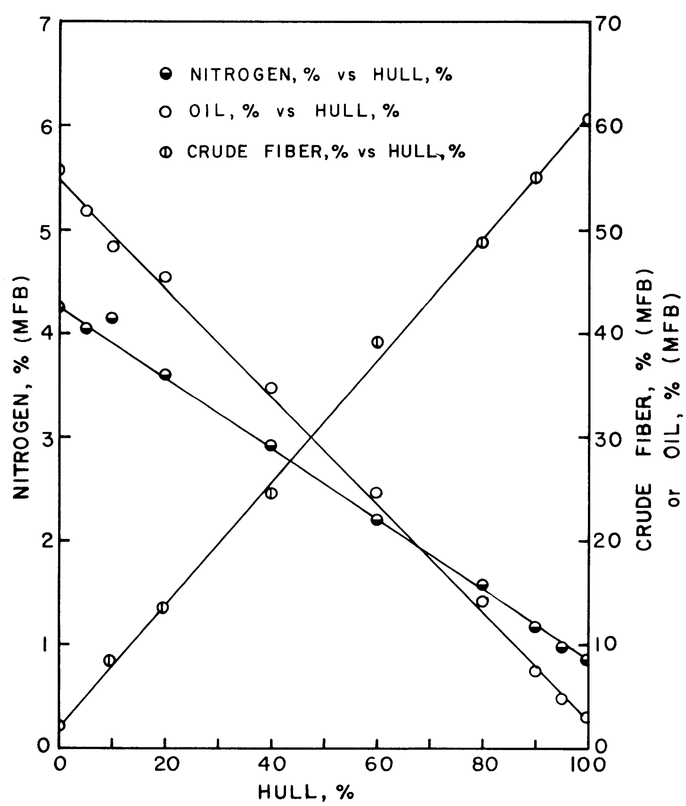

Fig 2. Plot of percent nitrogen, oil, and crude fiber on moisture free basis (MFB) vs percentage of hull in the mixture of hulls and kernels for an oilseed variety (Romsun HS-52).

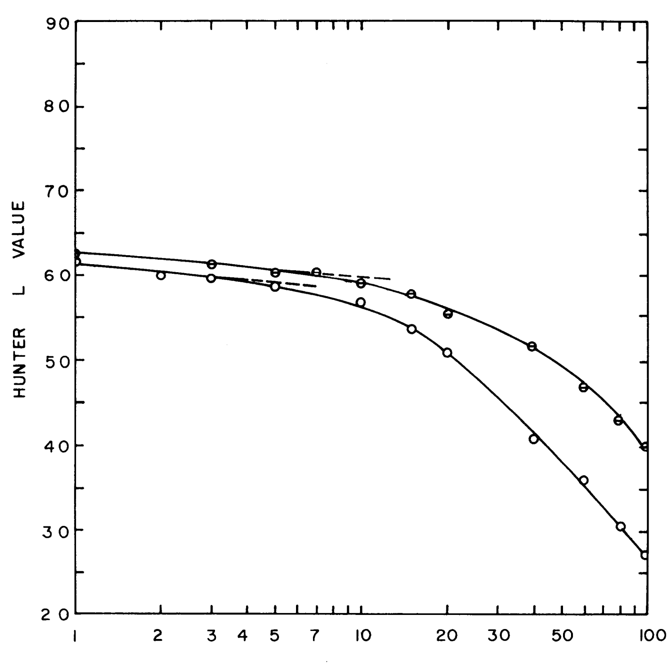

Fig 3. Plot of Hunter-L values of wetted sunflower seed meals (flour/water = 1:3) for oilseed variety, Cargill 204 (O) and confectionary variety, Dahlgren D-508 (Θ) vs percentage of whole seed meal.

most valuable type is the one that produces more oil and protein per hectare. This might be either type and might vary among varieties and locations. A study of this is needed.

Food quality protein products should be made from hull-free kernels. Confectionary varieties are easier to hull and to separate into pure kernels and hulls. For human food, therefore, the confectionary varieties have an advantage that should be exploited.

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