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A Review of the Nutritional Value Of Sunflower Meal

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EDITOR'S NOTE: Dr. Keith J. Smith, author of this article, is assistant director of research and education, National Cottonseed Products Assn., Inc., Memphis. Smith holds B.S. and Ph.D. degrees from Iowa State University in animal science and ruminant nutrition, respectively. The review was prompted by the recent increase in interest in sunflowers as an oilseed crop. An estimated 216,000 acres were planted to sunflowers in Minnesota and North Dakota in 1967. Cotton Belt plantings in 1967 indicated an economic advantage in certain areas, and in 1968 520 farmers are reported to have planted 33,250 acres. Oil mill plant owners with open plant time are also interested. Plantings extend from North Carolina to California. Sunflowers are now being planted at 36 experimental station sites. Smith noted that feed manufacturer interest is growing, and that considerable tonnage of sunflower meal will be available to feed manufacturers next fall.

1. COMPOSITION — A. General —The composition of sunflower meal will vary according to the composition of the seed and the method of processing. In interpreting research reported in the literature, one must keep in mind that great changes in sunflower meal production have been made during the past few years. These changes have come about through introduction of new varieties of sunflowers and changes in the method of seed processing. The most marked improvement in the feed product has been the lowering of the crude fiber content in the meal through advances in oil extraction and meal processing.

Table 1 presents Canadian data on the proximate analyses of sunflower meal compared to cottonseed and soybean meal. Realizing the deficiencies in proximate analyses, it would appear that sunflower meal has several characteristics which resemble cottonseed meal more than soybean meal.

B. Amino Acids — Considerable data are available on the amino acid composition of sunflower meals. Table 2 shows some of the data on amino acid composition that are reported in the literature. These results are in fair agreement; and, since they are on a nitrogen basis, they should be directly applicable to the current supply of low-hull, higher-energy, sunflower meals.

The amino acid balance of sunflower meal has been thoroughly investigated, and lysine has been found to be the first limiting amino acid. Numerous experiments have shown that additional lysine will improve performance (McGinnis et al., 1948; Ewing, 1951; Klain et al., 1956; Howe et al., 1965; Thomas et al., 1965; Smith, 1966; and Evans and Bandemer, 1967). Andric et al. (1964) reported that lysine supplementation increased chick gains; however, the increased performance was not sufficient to increase net return. This conclusion reflected the high cost of lysine supplementation in 1964.

Smith (1966) showed that supplementing a sunflower meal-based, semi-purified diet with L-lysine caused shifts in the plasma amino acid patterns which tended to increase the levels of essential amino acids and decrease the non-essential.

The possibility of a second limiting amino acid in sunflower meal was suggested in the research reported by Klain et al. (1956). A chick study was reported in which soybean meal was completely replaced with sunflower meal. Supplementing the sunflower meal ration with graded levels of lysine improved performance; however, the increments of improvement reached a plateau prior to achieving the performance of the soybean meal basal ration. This would indicate a possible second limiting amino acid.

Howe et al. (1965) reported results in which sunflower meal was supplemented with both L-lysine and DL-threonine and the rat PER response was greater than could be attributed to lysine supplementation alone.

Evans and Bandemer (1967) have suggested that the sulfur amino acids are deficient according to analysis of sunflower meal. Since growth experiments in which sunflower meal was supplemented with DL-methionine (McGinnis et al., 1948; Thomas et al., 1965; Howe et al., 1965; Smith, 1966) have failed to support their conclusions, it may be that the sulfur amino acids are only limiting when lysine is adequate.

Other possible limiting amino acids have been investigated in semi-purified diets, with sunflower meal as the sole source of protein, without beneficial responses. The amino acids included L-histidine (Smith, 1966), leucine and tryptophan (Thomas et al., 1965).

Early work by Mitchell et al. (1945) studied sunflower protein and reported that the biological value was in the same class as the better cereal grains.

C. Energy Content — The crude fiber content of sunflower meal varies according to the proportion of hulls removed prior to processing and/or the extent of tail-end meal screening. Titus (1955) presented extensive analytical data on two sunflower meals with hull content of 34% and 14% for meals with and without hulls, respectively. Since sunflower meals are now produced with a much lower percentage of hulls left in the meal, care must be taken in interpreting energy data.

Lautner and Zenisek (1964) reported energy studies conducted with chicks for "whole" sunflower meal. Gross energy values of 4820 and 4864 Kcal./kg. and metabolizable energy values of 1907 and 2603 Kcal./kg. were reported for whole sunflower meal and soybean meal, respectively. These results indicate that gross energies are similar between the two protein sources. The metabolizable energy, or the energy available to the animal, is less in sunflower meal due to the amount and utilization of the hull.

More research data are needed on the energy content of sunflower meal. It can be assumed, however, that forthcoming values for metabolizable energy will be directly related to the levels of crude fiber and residual oil in the meal.

D. Other — Sunflower meal compares favorably with other oilseed protein feedstuffs as a source of calcium and phosphorus (Clandinin, 1958). Listed in Table 3 are some values reported in the literature for the mineral composition of sunflower meal.

Grau and Almquist (1945), Day and Levin (1954), Titus (1955), and Klain et al. (1956) reported that sunflower meal is a rich source of the B-complex vitamins. Considerable data are reviewed and values are listed by Clandinin (1958).

2. EFFECT OF PROCESSING ON NUTRITIONAL VALUE—Several studies have been made on the effects of processing variables on the nutritive value of sunflower meal. In general, like other oilseed proteins, the nutritive value of sunflower meal is greatly affected by conditions employed in processing.

Clandinin and Robblee (1950) initially suggested that the relatively poor quality of the protein in sunflower meal is due to excessive processing temperatures. These workers then conducted a series of experiments to support their hypothesis, and Morrison et al. (1953a) showed that the nutritional value of the meal increased as the processing temperatures were lowered. Opening the choke on the expeller resulted in the production of sunflower meal of superior nutritive value as compared to that of meals processed under similar temperature conditions with the choke in the regular position. The effects of temperature on chick performance were verified later by the same authors (Morrison et al., 1953b).

Renner et al. (1953) reported that less lysine, arginine and tryptophan were obtained from sunflower meal processed at 240°F. (cooker) and 260°F. (conditioner) than from low- or medium-temperature sunflower meal processed at 200-220°F. or 220-240°F., respectively.

Alexander and Hill (1952) found that the dry heating of sunflower meal at 250°F. caused marked destruction of lysine in the meal. The heat treatments did not affect methionine. Bandemer and Evans (1963) reported that heating sunflower seed to 250°F. for 45 minutes caused small losses in most of the amino acids, with the largest decrease in basic amino acids —namely, lysine, histidine and arginine. Autoclaving a high quality sunflower meal at 15 lb. steam pressure resulted in loss of lysine (Alexander and Hill, 1952; Renner et al., 1953) arginine and tryptophan (Renner et al., 1953) and significantly decreased performance in chicks (Morrison et al., 1953a) and rats (Evans and Bandemer, 1967). Evans and Bandemer (1967) autoclaved sunflower seed at 250°F. for 0, 15 and 30 minutes and found significant decreases in the nutritive value of the protein with an increased length of autoclaving.

The effects of temperature on processing have been studied in a series of Russian experiments and reported by Tkacev et al. (1964 and 1965). These workers fed sunflower meal, processed at different temperatures, to swine in a series of growth and digestibility studies. The three sunflower meals selected were processed at temperatures of 257-266°F. (severe), 239-257°F. (normal) and 221-239°F. (mild). The mild heat treatment had the highest average daily gains, lowest feed per unit gain, and highest digestibility of organic matter, crude protein, ether extract and nitrogen-free extract. These authors concluded that low temperature processed meal was superior in nutritive value.

The effect of sunflower seed processing on the energy value of the meal has been previously discussed and, therefore, will not be repeated. However, a report by Teleki and Delic (1963) is worth mention. They reported that screening sunflower meal can improve the protein content while decreasing the fiber. Their data showed that a 49% protein meal with 7% husks can be screened into 53, 48 and 40% protein fractions with 12, 15 and 20% crude fiber, respectively. No data were given on relative yields of each fraction.

TABLE 1. Average Composition of Selected Oilseed Meals[1]

	—Sunflower Meal—		—Cottonseed Meal—		Soybean Meal
	Expeller	Solvent Extracted	Expeller	Solvent Extracted	Solvent Extracted
	Percent				
Moisture	7.0	7.0	7.0	9.0	11.0
Ash	6.8	7.7	6.1	6.5	5.8
Crude fiber	13.0	11.0	11.0	11.0	6.0
Ether extract	7.6	2.9	5.8	1.6	0.9
Protein (Nx6.25)	41.0	46.8	41.4	41.6	45.8

[1]Source: National Academy of Sciences—National Research Council, publication 1232, 1964.

TABLE 2. Selected Amino Acid Distribution in Sunflowers

Amino Acid	g/16gN								
Arginine	7.8[1]	7.7[2]	9.4[3]	8.7[4]	10.0[5]	7.1[6]	8.1[7]	7.2[8]	8.2[9]
Histidine	2.2	2.2	2.1	2.1	2.3	2.2	2.3	1.9	1.7
Isoleucine	4.5	4.7	4.0	3.9	4.1	3.9	4.1	3.8	5.2
Leucine	6.0	6.1	6.1	5.9	5.5	6.1	6.5	5.9	6.2
Lysine	3.8	2.5	3.3	2.8	3.6	3.6	3.8	3.1	3.8
Methionine	2.2	2.1	1.6	1.5	1.5	1.7	1.9	1.3	3.4
Phenylalanine	5.1	4.2	4.2	4.3	4.6	4.2	4.3	3.9	5.7
Threonine	3.4	3.5	3.2	3.2	3.4	3.6	3.8	3.2	4.0
Tryptophan	1.4	1.2	1.0	1 0	..	1.9	1.2	1.0	1.3
Tyrosine	..	2.5	..	..	1.6	..	..	..	..
Valine	4.9	5.0	4.8	4.9	4.0	4.8	4.9	4.4	5.2

Sources: [1]Lyman et al, 1956. [2]Klain et al, 1956 (expeller meal). [3]Renner et al, 1953 (low temperature expeller meal). [4]Renner et al, 1953 (high temperature expeller meal). [5]Bandemer and Evans, 1963. [6]Evans and Bandemer, 1967 (Arrowhead variety and hexane extracted). [7]Evans and Bandemer, 1967 (Mennonite variety and hexane extracted). [8]Evans and Bandemer, 1967 (Greystripe variety and hexane extracted). [9]Block and Bolling, 1951 (solvent extracted meal).

TABLE 3. Mineral Composition of Sunflower Meal

Calcium	%	0.43[1]	0.43[2]	0.26[3]	0.30[4]
Magnesium	%	1.00			0.68
Phosphorus	%	1.04	1.00	1.22	1.30
Potassium	%	1.08		1.08	1.22
Sodium	%				2.09
Manganese	ppm.	22.9	5.0	10.4	4.2
Copper	ppm.				3.6
Iron	ppm.				34.2

Sources: [1]NAS/NRC, 1964. [2]Titus, 1955. [3]Morrison, 1957. [4]Rahman and Kopsic, 1961.

3. COMPARATIVE NUTRITIONAL VALUE OF SUNFLOWER MEALS — Many authors have published research results on experiments comparing the nutritional value of sunflower meals to other commonly used protein supplements. The results of these experiments are often confounded and confused by many factors which tend to dilute the results. Such factors are: variations in nutritive value of the protein supplements tested, basal ration ingredient composition, existing environmental conditions, test animal requirements, etc. Therefore, this review will give the general findings reported in the various research reports, and then, in the summary of this review, an attempt will be made to evaluate the usefulness of sunflower meal by species.

A. Poultry — Various researchers have reported experiments utilizing sunflower meal in poultry rations. Pettit et al. (1944) reported the results of experiments in which meat meal in chick starting rations was replaced with sunflower meal. They concluded that sunflower meal may satisfactorily replace its protein equivalent of meat meal in amounts up to 14% of the ration — which represents a total substitution of the meat meal. O'Neil (1948) found that sunflower meal satisfactorily replaced only one third of the total animal protein in a chick starting ration. These different conclusions were explained in part in a research report by Morrison et al. (1953b). They found that meat meal could be completely replaced by sunflower meal when meat meal was the sole source of supplemental protein. However, when 2½% fish meal was included in the basal ration, sunflower meal could only replace one third of the meat meal in the ration. This observation reflects the significant improvement in the amino acid balance of a combination of fish meal and meat meal versus meat meal alone.

Morrison et al. (1953b) reported that regular temperature expeller sunflower meal (240° F., cooker; 260°F., conditioner) can satisfactorily replace two thirds of the soybean meal in the chick starters used. In another paper, this author reported that by reducing the processing temperature (200°F., cooker; 220°F., conditioner) and opening the expeller choke, a sunflower meal equivalent in its nutritional value to solvent extracted soybean meal can be obtained (Morrison et al. 1953a).

Botha et al. (1964) conducted a large chick growth trial in which the replacement values of sunflower, soybean and peanut meal were compared alone and in all possible combinations to a fish meal basal diet. Results indicated that the 17% fish meal basal ration was partially replaced by the other seven treatments. Sun-