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NUTRITIONAL VALUE OF SUNFLOWER MEAL AS A PROTEIN SUPPLEMENT FOR GROWING RUMINANTS

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Summary

The nutritional value of sunflower meal (SFM) as a protein supplement for growing cattle and sheep was determined by feeding different levels of the meal and evaluating treatment responses through in vivo digestibility, nitrogen retention, average daily gain, feed conversion and wool growth. Three experiments, two steer metabolism studies and one lamb feeding study, were conducted. In the first steer study, SFM was substituted in a typical feedlot finishing diet at 0, 5.5, 11 and 22 percent. The diets continaing 0, 5.5 and 11% SFM were made isonitrogenous and isofiberous with cottonseed meal (CSM) and cottonseed huls, respectively. The 22% diet was formulated to determine the efficacy of feeding high levels of sunflower meal. The 22% treatment resulted in increased (P .05) digestibility of both dry matter and organic matter over all other treatments. No differences (P .05) were noted in nitrogen retention. Eight new steers fed a Coastal Bermuda grass hay based diet were used in the second study to determine the digestibility of sunflower meal. Treatments consisted of 0, 5, 10 and 20% sunflower meal. No differences (P .05) were found in total diet digestibility or nitrogen retention. Digestibility of SFM, calculated by difference, tended to decrease as the percent in the diet increased. One hundred and twenty feedlot lambs were used in the third study to compare SFM and CSM in 12% and 8% crude protein growing-finishing diets, and to determine the efficacy of supplying both SFM and CSM in a diet. Lambs fed the combination of SFM and CSM gained more (P .05) at the same level of crude protein than lambs receiving only SFM or cottonseed meal. Lambs on the 8% crude protein diets gained more on SFM than cottonseed meal.

Introduction

The importance of SFM is increasing in terms of high quality feed by-products for ruminant animals. However, limited data are available on the digestibility and utilization by growing cattle and sheep, and on the importance of the relatively good supply of sulfur-bearing amino acids in the sunflower protein. Data reported indicates that SFM is an efficient source of protein and energy for ruminants and is equal to CSM as a protein supplement.

The nutritional value of SFM has been studied rather extensively in poultry (4,5,7,12,17,18,19) and swine (13,16) with less data available on growing ruminants. Thus, experiments were designed to evaluate SFM as a protein supplement as compared to CSM, and to determine the digestibility of sunflower meal.

Some of the initial work reported with beef cattle showed that SFM, though slightly unpalatable, was equivalent to CSM as a protein supplement (10). In

a later study Kercher et al (16) found no differences between SFM and soybean meal in performance trials using average daily gain and feed efficiency as indicators. Amos et al (1) reported nitrogen retention to be higher in wethers fed SFM than similar lambs fed soybean meal. In contrast, the digestibility and nitrogen retention was higher for lambs fed soybean meal (6). The objectives of the research to be reported was to evaluate SFM as a protein supplement for growing-finishing cattle and sheep.

Experimental Procedures

Three experiments (two steer metabolism studies and one lamb feeding study) involving 16 steers and 120 lambs were conducted to determine the digestibility of SFM and the nutritional value as compared to cottonseed meal. The criteria for evaluating treatment effects were digestibility and nitrogen retention in steers, and wool growth, average daily gain and feed conversion in lambs.

Experiment 1.

Eight Holstein steers weighing 296 kg were used in two replicated 4x4 Latin squares. Sunflower meal was substituted in a growing-finishing diet at 0, 5.5, 11 and 22 percent. Ingredient and chemical composition of the experimental diets are listed in tables 1 and 2, respectively. The diets containing 0, 5.5 and 11% SFM were made isonitrogenous and isofiberous with CSM and cottonseed hulls, respectively.

TABLE 1. Composition of sunflower meal.

Item	% as is
Dry matter	93.3
Crude protein	30.0
Crude fiber	27.0
Ether extract	1.1
Ash	6.6
Calcium	.4
Phosphorus	.8
Gross energy (cal/g)	4.1

TABLE 2. Composition of experimental diets. Experiment 1.

Ingredient	Treatment			
	A	B	C	D
	% Air Dry			
Grain sorghum (dry rolled)	78.74	78.75	78.75	70.75
Cottonseed hulls	12.00	10.50	9.00	6.00
Cottonseed meal	8.00	4.00	-	-
Sunflower meal	-	5.50	11.00	22.00
Plain salt	.25	.25	.25	.25
Calcium carbonate	1.00	1.00	1.00	1.00
Vitamin A	+	+	+	+

The steers were adjusted to each diet for 22 days prior to each five-day collection period of urine and feces. The animals were housed in metabolism cages within an enclosed building with constant lighting four days prior to and during the collection periods. During the first 18 days of each adjustment period the steers were individually quartered and fed in dirt-floor pens to allow for exercise and maintain the health of the animals.

All diets (treatments) were formulated to meet or exceed National Research Council (NRC) recommendations. Consumption of all diets was limited to 6.8 kg per head daily, fed at two equal feedings. Water was offered free choice. Diets A, B and C were formulated to contain similar crude protein and crude fiber levels based upon chemical analyses conducted on the feed ingredients prior to initiating the experiment. Diet D was formulated to contain twice the SFM as C in order to determine the effects of high levels of SFM feeding. Therefore, crude protein and crude fiber values for diet D were not similar to the other diets.

Experiment 2.

Eight Angus steers weighing 270 kg and fed a Coastal Bermuda grass hay based diet were used in two additional replicated 4x4 Latin squares to determine the digestibility by difference of sunflower meal.

Sunflower meal was included in the diet at levels of 0, 5, 10 and 20 percent. The basal diet consisted of Coastal Bermuda grass hay and urea. The 0, 5, and 10% SFM diets were made isonitrogenous with urea. All steers were equally fed 5 kg per head daily. All other experimental conditions and procedures were similar to those described for experiment 1. The treatments are shown in Table 3.

TABLE 3. Chemical composition of experimental diets. Experiment 1.

Item	Treatment			
	A	B	C	D
	% Air Dry			
Dry matter	89.96	90.39	90.24	90.49
Crude protein	10.80	10.70	10.70	13.20
Crude fiber	8.30	8.60	9.00	10.40
Ash	3.11	3.79	2.76	3.41
Calcium	.45	.45	.47	.50
Phosphorus	.35	.34	.34	.40
Gross energy (cal/g)	4.23	4.14	4.10	4.02

Experiment 3.

One hundred and twenty lambs were involved in a feedlot study to determine: 1) the effects of feeding SFM in a growing-finishing diet in replacement of CSM, 2) the effects of feeding a 50:50 ratio (on crude protein equivalent) of SFM and CSM, and 3) to determine the effects of feeding both SFM and CSM below the NRC crude protein requirements.

Crossbred lambs averaging 26 kg were ear tagged, wormed, vaccinated for enterotoxemia and allowed to adjust to a grain sorghum-based diet for 14 days. At the end of the adjustment period lambs were weighed and stratified by weight, sex and breeding across each of the five treatments. The composition of the five diets is given in Table 4. There were three replications of 8 lambs per replication included on each treatment.

TABLE 4. Composition of experimental diets. Experiment 2.

Ingredient	Treatment			
	A	B	C	D
	% as is			
Ground Coastal Bermuda grass hay	97.29	92.71	88.11	78.71
Sunflower meal	-	5.00	10.00	20.00
Urea	1.50	1.08	.66	-
Plain salt	.50	.50	.50	.50
Dicalcium phosphate	.71	.71	.71	.71
Calcium carbonate	-	-	.02	.08
Vitamin A	+	+	+	+

The treatments consisted of A) 100% of the supplemented protein from SFM, B) 100% for CSM, C) 50% from SFM and 50% from CSM, D) 67% of recommended crude protein requirement from SFM and E) 67% from cottonseed meal. Diets A, B and C were formulated to contain 12% crude protein and D and E to contain 8 percent.

Diets were fed free choice and the lambs were allowed free access to water. Feed consumption per pen was recorded daily. Lambs were weighed initially and at 28-day intervals to 74 days. Wool plots were shorn on the shoulder area of all lambs on day 1 and at the termination of the experiment. At the end of the study a uniform strip of wool was shorn within the plot to obtain an indication of wool growth on each treatment during the experiment. The wool samples were washed gently, but thoroughly, in a mild detergent to remove foreign material. Upon completion of the last washing, the wool samples were air dried in an oven for determination of weight of wool growth per cm^2 of area.

Results and Discussion

Sunflower meal can be effectively used to replace CSM for growing-finishing cattle and sheep. While CSM has a higher crude protein value than SFM the two apparently have equal digestibilities. There must be compensation for the reduced crude protein in SFM and bdcause the SFM includes some hulls it is necessary to lower the proportionof other fiber sources in the diet when using sunflower meal. Sunflower meal protein which has a higher percentage of sulfur bearing amino acids than CSM may be beneficial for sheep. Methionine has been shown by several researchers to be the first limiting amino acid in sheep (2,9,11,14).

Experiment 1.

In the first experiment SFM was substituted in a growing-finishing beef cattle diet at 0, 5.5, 11 and 22% at the expense of the cottonseed meal. The digestibility and nitrogen retention data are presented in Table 7. No differences ($P < .05$) were detected in diet digestibility or nitrogen retention between treatments 0, 5.5 and 11% sunflower meal. This indicates that SFM is similar to solven extracted CSM when fed on an equal curde protein and crude fiber basis. Pearson et al (10) reported that SFM was equal to CSM as a protein supplement for growing beef cattle. The 22% treatment resulted in increased ($P < .05$) digestibility of dry matter and organic matter over all other treatments. However, no differences ($P < .05$) were found in nitrogen retention. Gross energy digestibility was not different ($P < .05$) among all four treatments.

The increased digestibility resulting from the 22% level of SFM without a subsequent increase in nitrogen retention is somewhat difficult to interpret. Church (3) pointed out that there is not a good correlation between degradation of protein in the rumen and nitrogen utilization. Similar findings of increased nutrient digestibility in conjunction with higher protein levels have been reported (8). Since nitrogen retention did not increase as a result of the increased digestibility indicates that the steers were receiving adequate nitrogen from the other treatments and the extra nitrogen available from the 22% treatment was not utilized and was excreted in the urine.

The digestibility data of SFM calculated by differences are found in Table 8. These were calculated according to procedures described by Schneider et al (15). As Schneider points out, digestibility by difference is, at best, an approximate measure of digestibility due to associative or mutual effects between feeds, and experimental error. These values show a general trend of lower digestibility when the percentage of SFM was increased in the diet.

Experiment 2.

The treatments of this experiment were designed to obtain a better estimate of the digestibility of sunflower meal. The basal diet consisted solely of Coastal Bermuda grass hay, thus removing associative effects of more than one ingredient. The treatments consisted of 0, 5, 10 and 20% of sunflower meal. The digestibility and nitrogen retention data are presented in Table 9. No differences ($P < .05$) in digestibility were found across the four treatments. This indicated that SFM present in the hay diet at levels of 5, 10 and 20% did not affect overall diet digestibility over the urea control. The addition of SFM at all three levels resulted in non-significant ($P < .05$) changes in nitrogen retention. However, retention values for all treatments containing SFM were numerically greater than the urea control.

Experiment 3.

This experiment was desigend to compare SFM and CSM in 12% and 8% crude protein growing-finishing lamb diets, and to determine the efficacy of providing the combination of both on an equal protein basis. Diets A, B and C were formulated to contain 12% crude protein and D and E to contain 8 percent. Supplemental protein for the grain sorghum based diet was supplied in the respective

diets from: A-SFM, B-CSM, C-50% from SFM and 50% from CSM, D-SFM and diet E-cottonseed meal.

Average daily gain and feed conversion for the five treatments are presented in Table 10. Lambs fed the diet containing the combination of SFM and CSM gained more (P .01) than those fed CSM, at the same crude protein level, but were not different from lambs fed an equal amount of protein from sunflower meal. Voluntary feed consumption was somewhat greater on the diet containing both SFM and CSM, resulting in no differences in feed conversion. Gains and feed conversion were both greater (P .01) on all three diets containing 12% crude protein than on those containing 8%. Gains were improved (P .01) for lambs receiving SFM at the 8% crude protein level over those receiving cottonseed meal. Again, voluntary feed consumption was greater for the SFM treatment, resulting in no differences in feed conversion.

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TABLE 5. Chemical composition of experimental diets. Experiment 2.

Item	Treatment A	B	C	D
	% Air dry			
Dry matter	92.40	92.42	92.00	92.20
Crude protein	10.80	10.82	10.87	12.15
Ash	5.29	5.46	5.09	5.28

TABLE 6. Composition of experimental diets. Experiment 3.

Ingredient	Treatment A	B	C	D	E
	% Air dry				
Crude protein, %	12	12	12	8	8
Ground grain sorghum	40.20	47.80	44.70	59.20	60.70
Cottonseed hulls	30.00	30.00	30.00	30.00	30.00
Sunflower meal	23.80	-	10.95	4.80	-
Cottonseed meal	-	16.20	8.35	-	3.30
Dried molasses	5.00	5.00	5.00	5.00	5.00
Plain salt	.60	.60	.60	.60	.60
Calcium carbonate	.15	.15	.15	.15	.15
Sodium sulfate	.25	.25	.25	.25	.25
Vitamins	+	+	+	+	+

TABLE 7. Apparent digestion coefficients and nitrogen retention. Experiment 1.

Item	Treatment A	B	C	D
Digestion coeff. %[a]				
Dry matter	62.2[c]	63.9[c]	63.9[c]	70.6[d]
Organic matter	64.6[c]	66.7[c]	65.1[c]	73.5[d]
Nitrogen retention[b] (g/day)	29.2[c]	28.1[c]	28.8[c]	36.4[c]
Fecal nitrogen (g/day)	53.5	52.4	52.4	44.6
Urinary nitrogen (g/day)	27.0	33.8	27.9	54.9

[a,b] Data represents the mean of sixteen observations; two replicated 4x4 Latin squares.

[c,d] Means on the same line with different superscripts differ significantly ($P < .05$).

TABLE 8. Average digestion coefficients (by difference) for sunflower meal. Experiment 1.

Item	Percent
Dry matter	72.4
Organic matter	84.0
Crude protein	99.6

TABLE 9. Apparent digestion coefficients and nitrogen retention. Experiment 2.

Item	Treatment			
	A	B	C	D
Digestion coeff. %[a]				
Dry matter	65.2[c]	68.2[c]	67.3[c]	63.8[c]
Organic matter	67.3[c]	69.2[c]	68.1[c]	65.2[c]
Crude protein	72.0[c]	74.1[c]	72.8[c]	71.5[c]
Nitrogen retention (g/day)[b]	6.32[c]	8.17[c]	7.75[c]	8.20[c]

[a,b] Data represents the mean of sixteen observations; two replicated 4x4 Latin squares.

[c,d] Means on the same line with different superscripts differ significantly ($P < .05$).

TABLE 10. Average daily gain and feed conversion. Experiment 3.

Item	Treatment				
	SFM	CSM	SFM+CSM	SFM	SFM
Crude protein of diet %	12	12	12	8	8
Gain/lamb/day (kg)[a]	.242[c,d]	.230[d]	.250[c]	.210[d]	.183[e]
Gain/feed[b]	.128[c]	.128[c]	.127[c]	.104[d]	.103[d]

[a,b] Data represents the mean of three replications of eight lambs per replication during 74 days on feed; average initial weight was 26 kg.

[c,d,e] Means on the same line with different superscripts differ significantly ($P < .01$).