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Cottonseed meal or feather meal as protein supplements in the diets of growing sheep

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Abstract

Chemical analyses and *in vivo* digestion trial were conducted to compare conttonseed meal (CSM) with feather meal (FM) as supplements in the diets of growing sheep. The supplements were analysed for the proximate components and gross energy. The digestion trial (using 20 crossbred whether lambs) compared a basal ration (a) which contained 65% ground maize, 28% chopped ryegrass straw, 6% molasses and 1% limestone flour (8.9% CP) with rations in which (b) CSM was added to the basal to supplement 50% of total nitrogen (CSM-50, 14.8% CP), (c) commercial FM was added to the basal to supplement 40% of total N (FM-40, 14.60% CP) and (d) commercial FM was added to the basal to supplement 50% of total nitrogen (FM-50, 15.8% CP).

FM contained higher CP, ether extract (EE) and gross energy (GE) than CSM. However, CSM had higher acid detergent fibber (ADF), total ash and nitrogen free extract (NFE) than FM. Both protein supplements (FM and CSM) were digested to a similar degree (P>.05). However, protein digestibility was significantly higher (P<.05) for the supplemented rations than for the basal ration. N retention was higher (P<.05) for the FM-40 diet than for the CSM-50 and FM-50 diets with no difference (P>.05) among the two latter diets. Digestibility of EE was in the order: CSM-50> FM-40 = FM-50> basal (P<.05). Digestibility of ash was higher (P<.001) for the CSM-50 diet than for any of the other diets. Digestibility of NFE was higher for the supplemented diets than for the basal diet (P<.05). The study showed that FM compared well with CSM as protein supplements for growing sheep (per unit of N basis).

Introduction

By-products (especially those high in N) are becoming very important in livestock rations. Church (1978) pointed out that protein is important in feeding animals because it is the nutrient found in highest concentration (other than water) in organs and muscle tissues. Aderibigbe and Church (1983) observed that although feathers and hairs are almost pure protein (85-100% CP), these are mostly keratine which are not readily digestible in the natural state, but are utilizable by ruminant animals if processed through steam cooking under pressure.

As the Nigerian poultry industry expands, there will be an increase in the number of rendering plants with subsequent increased production of feathers which are by-products of these plants. Feeding feather meal to ruminants and other livestock will help to reduce environmental pollution, produce edible livestock products from non-edible waste and reduce competition between livestock and humans for food.

The objective of this study was to compare conttonseed meal (which is a widely used protein supplement in ruminants' rations) with feather meal as protein supplements for growing sheep.

Materials and Methods

Chemical analyses and *in vivo* digestion trial were conducted to compare cottonseed meal (CSM) with feather meal (FM) as protein supplements for growing sheep.

Chemical Analyses:

Each supplement was analyzed for dry matter (DM), crude protein (CP), ether extract (EE) and ash by the methods described in AOAC (1975). Acid detergent fiber (ADF) was determined by the method of Van Soest (1963) using the modified micro-procedure of Waldern (1971). Nitrogen free extract (NFE) was obtained by difference except that ADF was used instead of crude fiber. Gross energy was determined using a Parr adiabatic Oxygen bomb calorimeter.

In Vivo Digestion:

The trial involved 20 crossbred wether lambs alloted to four treatments (equalized as to weight) with five lambs per treatment. The trial compared a high concentrate (8.9%CP) (8.9% CP) basal ration (a) which contained 65% ground maize, 28% chopped rygrass straw, 6% sugar cane molasses and 1% limestone flour with rations in which (b) CSM was added to the basal to supplement 50% of total N, resulting in a 14.8% CP diet; (c) commercial FM was added to the basal to supplement 40% total N (14.6% CP) and (d) commercial FM was added to the basal to supplement 50% of total N (15.8% CP). The chemical components of the basal ration and each protein supplement are shown in table 1. The daily feeding schedule during the digestion trial is shown in table 2. Daily feed was divided into two equal parts and fed at 0800 hr. and 1600 hr. The basal as well as each supplement were weighed separately and thoroughly mixed (for supplemented diets) before being fed.

Each trial consisted of a 14-day pre-adjustment period during which animals were kept in four covered pens bedded with wood shavings. After pre-adjustment, animals were housed in metabolism cages designed to allow separation of urine and faeces for a 7-day adjustment period and a 10-day collection period. Animals were gradually adapted to experimental diets (from a diet of grass hay) during the pre-adjustment period and brought to full feed of experimental diets *(ad libitum)* in the first 10 days. Records were kept on feed offered and feed refused when animals were on *ad libitum* experimental diets. Feed offered was reduced during the adjustment and collection periods to 80% of *ad libitum* consumption. During the collection period, total faecal and urinary excretions were collected daily for each animal. Faecal samples were weighed and urinary samples were measured. Ten percent aliquots of faecal and urinary collections were stored at 5C for later analyses. Five ml of phosphoric acid were added to each urine collection bucket in order to minimize N loss. Water and trace mineral blocks were available to all animals ad libitum during the entire period.

The experimental feeds and faeces were analyzed for DM, CP, ADF, EE, ash, NFE and gross energy by methods described earlier. Urinary N was determined by AOAC (1975) methods. Digestion coefficients for components of each diet and supplement (by difference) was determined by the methods described by Schneider and Flatt (1975).

Statistical Analysis:

Data for the *in vivo* study were analyzed by use of one way analysis of variance as described by Neter and Wasserman (1977). Treatment means were compared by use of the

LSD as described by Steel and Torrie (1980).

Results

Chemical Analyses:

The results of the chemical analysis of the basal diet and each protein supplement are shown on table 1. FM which was the test protein contained higher CP (85.5%) on a dry matter basis than CSM (47.2%) which is a widely used protein supplement in the diets of ruminant animals. FM also had higher ether extract and gross energy than CSM. However, CSM had higher ADF, total ash and NFE contents than FM.

In Vivo Digestion:

The mean *in vivo* digestion coefficients (%) for components of each diet are shown in table 3. The percents digestible dry matter (DDM) and digestible organic matter (DOM) among the treatments were not different (P>.05). The digestion co-efficient for CP was higher (P<.05) for the supplemented diets than for the basal diet. Among the supplemented diets, the percent digestible crude protein (DCP) were not different (P>.05).

The percent digestibility of EE for the experimental diets were in the order: CSM-50> FM-40 = FM-50> basal (P<.05). Digestibility of Ash was higher (P<.001) for the CSM diet than for any of the other diets. The percent digestibility of NFE was higher (P<.05) for the supplemented diets than for the basal diet. Among the supplemented diets percent digestible nitrogen free extract (DNFE) were not different (P>.05). The low level of NFE in CSM (25.3%) coupled with the fact that FM had no NFE (table 1) make this result less meaningful. W.75 N retention expressed as centigrams per kilogram of metabolic weight (cg/kg W.75) was not different (P>.05) among the diets due to large variations among individual animals on each diet. When N retention was expressed as percent of N fed, the values obtained were higher (P<.05) for the basal and FM-40 diets than for the CSM-50 and FM-50 diets.
II new paragraph Table 4 shows the digestion coefficients (%) for DM, OM, CP and GE for each protein supplement in the experimental diets. These values were calculated by difference, a method which assumes that the digestibility of the basal diet did not change when the different protein sources were added to it. The percent digestibilities of DM, OM and CP by difference were in the order: FM-40> FM-50 = CSM-50 (P<.05). GE digestibility by difference was in the order FM-40> FM-50> CSM-50 (P<.05).

Discussion

The high CP content observed for FM agrees with the findings of Aderibigbe and Church (1983), who observed that FM was almost pure protein, containing 85 - 90% CP (DM basis). Thus, FM can serve as high protein concentrate in livestock diets. The higher ether extract and gross energy contents of FM compared to those of CSM could have been due to the fact that during the removal of feathers form birds, some of the skin and adipose tissues (which contain mainly fat) are often pulled off with the feathers. In contrast, the cottonseed oil had been extracted with a solvent resulting in very little oil left in the meal. The result of this study showed that CSM contained higher ADF than FM. Aderibigbe et al. (1982) observed a negative relationship between the ADF content and the nutritive value of forages. The fact that FM contained no NFE and very little fiber suggests that it contains little amount of carbohydrate. Van Soest (1982) pointed out that the proximate system of analysis divides the carbohydrates of feeds into crude fiber and NFE.

The higher levels of digestible CP observed for the supplemented diets than for the basal diet was expected since the basal diet was present in all treatments and the levels of protein in the supplemented diets were higher than that in the basal diet, and were more than adequate for the requirement of the growing lambs. A comparison of the percent digestible CP among the supplemented diets showed no significant differences (P>0.05) indicating that commercial FM compared favourably with CSM as protein supplements for growing lambs. On the contrary, Thomas and Beeson (1977) observed higher faecal N for Hereford steers fed a 12% CP, FM and hair meal (HM) supplemented diets as compared to a soyabean meal supplemented diet. However, the differences in the levels of protein in the different experiments and the different oil seed meals involved do not allow for adequate comparison.

The coefficient of digestible EE was higher (P<0.05) for the CSM-50 diet than for the other diets. However, the low levels of EE in all diets (2.1% for the basal; 1.3% and 5.1% for the supplemental CSM and FM, respectively) made the result of little significance. The higher coefficient of digestible ash observed for the CSM diet than for the other diets (P<0.05) indicates that CSM was a better source of digestible mineral components than FM for growing lambs. The fact that CSM contained higher level of ash than FM (6.7% and 3.0%, respectively) makes this result more meaningful. Nitrogen retention expressed as percent of nitrogen fed was higher (P<0.05) for the basal and FM-40 diets than for the other diets. This suggests that the optimum level of supplementation of FM in the diets of growing lambs would be 40% of the total nitrogen. The results obtained for the coefficients of digestible DM, OM, CP and GE for each protein supplement in the experimental diets by difference (table 4) also favours the optimum use of FM at 40% of the total nitrogen. The results obtained for the coefficients of digestible DM, OM, CP and GE for each protein supplement in the experimental diets by difference (table 4) also favours the optimum use of FM at 40% of the total nitrogen in the diet. The results showed that FM compared well with CSM as protein supplements for growing lambs on a per unit of nitrogen basis.

TABLE 1: CHEMICAL COMPOSITION OF THE BASAL DIET AND THE PROTEIN SUPPLEMENTS

Item	Feedstuff		
	Basal	Cottonseed meal (CSM)	Feather meal (FM)
Dry matter (DM),%	90.2	90.9	94.4
Analysis, % of DM:			
Crude protein (CP)	8.9	47.2	85.5
Acid detergent fiber (ADF)	14.2	19.5	6.3
Ether extract (EE)	2.2	1.3	5.2
Ash	4.3	6.7	3.0
Nitrogen-free extract (NFE)	70.4	25.3	—
Gross energy (Kcal/g)	4.2	4.7	5.6

TABLE 2. DAILY FEEDING SCHEDULE (G DRY MATTER BASIS) FOR THE EXPERIMENTAL ANIMALS[A]

	Treatment			
Feedstuff	Basal	CSM-50[b]	FM-40[c]	FM-50[d]
Basal	994.2	723	813.4	813.4
Cottonseed meal (CSM)	—	266.1	—	—
Feather meal (FM)	—	—	107.5	161.2
Total	994.2	989.1	920.9	974.6

[a]Daily feed was divided into two equal parts and fed at 0800 and 1600hr.

[b]Conttonseed meal supplied 50% of the total N in the diet.

[c]Feather meal supplied 40% of the total N in the diet.

[d]Feather meal supplied 50% of the total N in the diet.

TABLE 3. DIGESTION COEFFICIENTS (%) FOR INDIVIDUAL COMPONENTS AND N RETENTIONS OF EACH EXPERIMENTAL DIET (MEANS OF FIVE LAMBS)

	Diet				
Component	Basal	CSM-50	FM-40	FM-50	SEM
Dry matter (DDM)*	76.1	76.6	78.5	77.4	.6
Organic matter (DOM)*	78.9	78.0	80.3	79.0	.6
Crude Protein (DCP)*	68.5[a]	80.8[b]	81.1[b]	80.1[b]	.7
Acid detergent fiber (ADF)*	44.3	43.7	48.1	45.3	1.2
Ether extract (DEE)*	85.9[a]	92.9[c]	90.0[b]	89.1[b]	.8
Ash (D Ash)***	48.2[a]	54.9[b]	47.7[a]	47.1[a]	1.3
N-Free extract (DNFE)*	84.9[a]	88.2[b]	89.3[b]	88.3[b]	.5
Gross energy (DGE)	77.5	77.2	79.5	78.4	.7
N retention (cg/kg $BW^{.75}$)*	52.8	61.3	66.3	64.9	4.9
N retention (% of N fed)*	30.3[b]	24.4[a]	28.4[b]	23.1[a]	1.9

[a,b,c]means in the same row with different superscripts are different

*P<.05.

***P<.001.

TABLE 4: DIGESTION COEFFICIENTS (%) FOR CERTAIN COMPONENTS OF EACH PROTEIN SUPPLEMENT BY DIFFERENCE (MEANS OF FIVE LAMBS)

	Supplement			
Component	CSM-50	FM-40	FM-50	SEM
Dry matter (DDM)	74.9[a]	87.4[b]	76.0[a]	1.0
Organic matter (DOM)	74.6[a]	89.0[b]	76.5[a]	.9
Crude protein (DCP)	83.7[a]	86.9[b]	82.4[a]	.7
Gross energy (DGE)	74.7[a]	86.6[c]	79.0[b]	.5

[a,b,c]Means in the same row with different superscripts are different (P<.05).

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