FORE-STOMACH DIGESTA IN THE DIETS OF GROWING SHEEP. 1. PERFORMANCE AND ECONOMICS OF PRODUCTION

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Abstract

This study was conducted to evaluate the performance of growing sheep fed varying levels of fore-stomach digesta replacing cowpea husk at 0, (control) 10, 20, 30 and 40% levels designated as treatments 1, 2, 3, 4 and 5 respectively. There was an insignificant decrease in the average daily gain (ADG) ($p>0.05$) from 94 g (treatment 1) to 68 g (treatment 5). Total dry matter intake (TDMI) showed a significant decline ($P<0.05$) from treatment 1 (830 g/day) to treatment 5 (706 g/day). When expressed as percentage of body weight, TDMI was highest for treatment 2 (3.5%) and lowest for treatment 5 (2.3%) but the differences were not significant ($P<0.05$). Feed efficiency was similar for all treatments. CP and CF intakes were not significant between treatments. N retention was higher for animals on treatments 2 (96 g/day) and 4 (10? g/day) compared to the other treatments. Significantly, N retention was significantly higher ($P<0.05$) for animals on treatment 1 (81 g/day) and 3 (86 g/day) compared to those on treatment 5 (71 g/day). Total cost of feed per kg liveweight gain was highest for animals on treatment 2 (N156) and lowest for animals on treatment 5 (N82) but the differences were not significant ($P>0.05$).

Keywords: Fore-stomach-digesta, growing sheep, performance, economics

Introduction

The alarming rise in the prices of conventional feeds is necessitating the exploration of neglected materials such as slaughter wastes, agro-industrial wastes and other subsidiary feeds, especially animal based products, in the livestock feed industry (Alhassan, 1985). One of such wastes or by-products is fore-stomach digesta (FSD). It is an abattoir waste product that can be obtained free of charge from most abattoirs in the country. Due to lack of adequate waste disposal facilities, it is often found decaying in most abattoirs, thus producing repulsive odours and providing conditions for the proliferation of various micro-organisms. FSD is normally obtained from slaughtered ruminants and camels. A large number of these animals are slaughtered daily in most Nigerian cities, and the FSD is removed after evisceration. Farmers sometimes use it as a source of organic manure. It has however been realized that animals, especially ruminants, eat it up after it has been spread on farms, particularly during the late dry season when feeds are in short supply (personal communication with local farmers, 1995). As a result, farmers are getting discouraged with the burden of transporting FSD to their farms, which will later be consumed by animals. The use of FSD as a feed ingredient could therefore be more economically feasible than its use as manure. This study was therefore aimed at evaluating the performance of growing sheep fed varying levels of FSD.

Materials and Methods

Experimental animals and their management

Twenty male lambs (consisting of 10 Uda, 5 Yankassa and 5 crosses of Yankassa and Uda) were purchased from different village markets in Sokoto State. On arrival at the farm, the animals were tagged and weighed. They were then dewormed and sprayed against external parasites. The animals were then treated with oxytetracycline HCl (a broad spectrum antibiotic administered by injection) and vaccinated against PPR with Tissue Culture Rinderpest Vaccine (TCRV).

Feed ingredients

Fresh fore-stomach digesta (FSD) was collected from animals slaughtered at the Sokoto abattoir and open-air dried on tarpaulin sheets. The thinly spread digesta was turned from time to time to ensure uniform drying. The sun-dried digesta was packed in sacks and stored. Bone meal was prepared from discarded bones collected at the Sokoto abattoir. The bones were burnt, crushed and sieved to get a fine textured powder.

The hay used in the experiment consisted of a mixture of equal ratio of the grass *Eragrostis gangetica* ('Burburwa') and legume *Borreria scabra* ('Danfarkami'), obtained from the Usmanu Danfodiyo University Dabagi Farm. The grass and legume mixture was manually harvested in September, 1998. The harvested forage was cured for 2-3 days (depending on weather conditions). After drying, the hay was chopped into pieces of about 5-10cm in length, packed and stored.

The other feed ingredients, i.e. maize, wheat offal, cotton seed cake, cowpea husk and salt were purchased from Sokoto central market. Maize was crushed before incorporation into the ration.

Prices of production of all ingredients were noted to allow for analysis of cost of production.

Growth study

A randomised block design (Steel and Torrie, 1980) was used to evaluate the performance of rams fed varying levels of fore-stomach digesta (FSD). Five experimental diets in which FSD replaced cowpea husk at 0 (control), 10, 20, 30 and 40 % levels were formulated. The composition of the diets is shown on Table 1. The twenty growing rams were divided into five groups of four animals each. The grouping was done in such a way that the average liveweight of animals in each group was 25 kg. The animals were housed in individual pens measuring 2x1m, which had been previously disinfected. Each group was fed one of the experimental diets (i.e. treatments) *ad-libitum*. In addition, animals in each treatment group were offered the grass-legume hay at a level of 1% body weight. Feeding was done twice daily (morning and afternoon). Experimental diets and hay were offered at the same time but in different containers. Water was provided at all times. The experiment lasted for 90 days.

During the 90 days experimental period, daily records of feed intake were taken, while live weight gain was monitored weekly. Prior to weighing, water and feeds were withdrawn for at least six hours.

Digestibility trial

At the end of the feeding trial, a digestibility study was conducted using two animals from each treatment. The animals were fed the same experimental diets used in the feeding trial. The digestibility trial lasted for 3 weeks -i.e. 2 weeks for adaptation and one week for faecal and urine samples collection. During the collection period, daily feed intake was recorded. Total faecal output from each animal was also recorded daily. After thorough mixing of the faeces 5% was sampled and transferred to plastic containers. The samples were then sun dried and stored until analysis.

Urine was collected with the aid of bowls placed under the metabolism crates. 10mls of 10% sulphuric acid (H_2SO_4) were placed in each bowl in order to trap ammonia in the urine. Every morning, the total amount of urine that had collected in each bowl was measured. 5% of the daily output was retained and stored in a freezer. At the end of the trial, the daily samples for each animal were bulked and analysed.

Analytical Procedures

Thoroughly mixed representative samples of the five experimental diets, hay, urine and faeces were analysed for proximate composition by A.O.A.C. (1990) methods.

Statistical analysis

Data generated were analysed statistically by using the general linear model (GLM) available in SAS (SAS, 1988).

Results

Chemical composition of the experimental diets

The dry matter (DM) contents of the experimental diets varied between 95 and 97% (Table 2). Crude protein (CP) contents decreased from 19% (treatment 1) to 16% (treatment 5), while ether extract (EE) tended to increase from 3.4% (treatment 1) to 4.8% (treatment 5). Variation in crude fibre (CF) contents did not follow any regular pattern. The highest value was obtained for treatment 5 (37%) and the least was recorded for treatment 1 (34%). Nitrogen free extract (NFE) was highest for treatment 1 (38%) followed by treatments 2, 3 and 4 (36, 36 and 37% respectively); and the least value was recorded for treatment 5 (35%). Ash was higher for treatments 3 and 5 (8%), followed by treatments 2 and 4 (7% and 6% respectively), and the least value was obtained for treatment 1 (5%). The hay contained 93% DM, 5% CP, 1.3% EE, 39% CF and 46% NFE (Table 2).

Feed intake and liveweight gain

Average daily gain tended to decrease from 94g for treatment 1 to 68g for treatment 5 (Table 3). Concentrate DM intake decreased significantly ($P<0.05$) with increasing levels of FSD in the diets. Thus, concentrate intake was significantly higher ($P<0.05$) for treatments 1, 2 and 3, compared to treatments 4 and 5 (Table

Table 1: Gross composition of experimental diets

Ingredients	Treatments (inclusion levels of fore-stomach digesta%)				
	1(0)	2(10)	3(20)	4(30)	5(40)
Fore-stomach digesta	0.00	10	20	30	40
Cowpea husk	40	30	20	10	0.00
Maize	10	10	10	10	10
Wheat offals	27	27	27	27	27
Cotton seed cake	20	20	20	20	20
Bone meal	2	2	2	2	2
Salt	1	1	1	1	1
Total	100	100	100	100	100

3). Similarly, concentrate intake for animals on treatment 4 was significantly higher (P<0.05) than that of animals on treatment 5. With the decrease in concentrate intake, hay intake increased significantly (P<0.05). Thus significantly higher (P<0.05) hay intake was recorded for treatments 4 and 5 compared to the other treatments (Table 3). Hay intake was also significantly higher (P<0.05) for treatment 3 compared to treatments 1 and 2. Total dry matter intake (TDMI) showed a significant decline (P<0.05) from treatment 1 (830g/day) to treatment 5 (706g/day). When expressed as percentage of body weight, TDMI was highest for treatment 2 (2.5%) and lowest for treatment 5 (2.3%) but the differences were not significant (P>0.05) (Table 3).

Table 2. Chemical composition of the experimental diets (%)

Parameter	Treatments (inclusion levels of FSD, %)					
	1(0)	2(10)	3(20)	4(30)	5(40)	Hay
Dry matter	97.20	96.00	95.50	96.00	95.40	93.40
Crude protein	18.90	18.00	16.80	17.10	16.30	5.00
Ether Extract	3.40	4.00	3.90	4.50	4.80	1.30
Crude fibre	34.00	36.00	34.80	35.50	36.90	39.20
N. F. E.	38.30	35.50	36.20	36.90	34.50	45.50
Ash	5..40	6.50	8.30	6.00	7.50	9.00

DM intake from concentrate expressed as percentage of TDMI decreased significantly (P<0.05) from 73% for treatment 1 to 64% treatment 5. DM intake from hay expressed as percentage of TDMI increased from 27% for treatments 1 and 2 to 36% for treatment 5. The value recorded for treatment 5 was significantly higher (P<0.05) than those recorded for the other treatments (Table 3). Similarly, the value recorded for treatment 4 (34%) was significantly higher (P<0.05) than those recorded for treatments 1, 2 and 3. The differences were not significant (P>0.05) between treatments 2 and 3 and between treatments 1 and 2. Feed efficiency was similar for all treatments.

Table 3. Feed intake and liveweight gain of growing sheep fed varying levels of fore-stomach digesta

Parameter	Treatments (inclusion levels of fore-stomach digesta,%)					
	1(0)	2(10)	3(20)	4(30)	5(40)	SE (±)
Average initial weight (kg)	25.00	25.00	25.00	25.00	25.00	
Average final weight (kg)	32.88	31.88	32.00	31.38	30.75	
Final weight gain (kg/week)	7.88	6.88	7.00	6.38	5.75	
Average daily gain (g/day)	93.79 ±42	81.86 ±39	83.36 ±41	75.90 ±13	68.46 ±28	41.6
DM intake from concentrate (DMIC) (g/day)	609.25^{a}	583.10^{ab}	561.16^{a}	518.02^{c}	451.77^{d}	0.2
Dry matter intake from hay (DMIH) (g/day)	220.92^{c}	216.30^{c}	232.47^{b}	263.01^{a}	254.15^{a}	30.2
Total dry matter intake (TDMI) (g/day)	830.17^{a}	799.40^{ab}	793.63^{ab}	781.03^{b}	705.92^{c}	41.6
TDMI as % of body weight	2.48	2.50	2.48	2.48	2.29	0.2
DMIC as % TDMI	73.19^{a}	72.89^{ab}	70.95^{b}	66.35^{c}	63.96^{d}	1.3
DMIH as % TDMI	26.81^{d}	27.24^{cd}	29.05^{c}	33.65^{b}	36.04^{a}	9.9
Feed efficiency	0.11	0.10	0.10	0.10	0.10	

^{a,b,c} Means in the same row with different superscripts, are significantly different (P< 0.05).

Table 4. Crude protein and crude fibre intakes of sheep fed varying levels of fore-stomach digesta

Parameter	Treatments (inclusion levels of fore-stomach digesta,%)					
	1(0)	2(10)	3(20)	4(30)	5(40)	SE (±)
Crude protein intake (CPI) (g/day)	126.20	115.77	105.90	101.73	86.34	34.9
CPI as % of TD MI	15.18^{a}	14.48^{b}	13.37^{c}	13.37^{d}	12.23^{e}	0.2
Protein efficiency ratio	0.73	0.69	0.77	0.75	0.79	0.2
Crude fibre intake CFI (g/day)	293.75	294.71	286.42	287.00	266.33	86.1
CFI as % of TDMI	35.39^{e}	36.87^{b}	36.08^{d}	36.75^{c}	37.73^{c}	0.01

^{a,b,c,d,e}Means in the same row with different superscripts are significantly different (P<0.05).

CP and CF intakes of sheep fed varying levels of FSD are shown in Table 4. Crude protein intake (CPI) decreased from treatment 1 (126g/day) to treatment 5 (86g/day) but the differences were not significant (P>0.05). CPI as % of total dry matter intake (TDMI) decreased significantly (P<0.05) from treatment 1 (15%) to treatment 5 (12%). Protein efficiency ratio varied from 0.69 (treatment 2) to 0.79 (treatment 5) with no significant differences between the treatments (P>0.05) (Table 4). CF intake decreased from treatment 1 (294g/day) to treatment 5 (266g/day), but the differences were not significant (P>0.05). Expressed as percentage of TDMI, CFI increased significantly (P<0.05) from treatment 1 (35%) to treatment 5 (38%).

Nutrients digestibility

DM digestibility was significantly higher (P<0.05) for treatment 3 (72%) compared to the other treatments, whose DM digestibility values ranged from 64 to 66% (Table 5). CP digestibility values were significantly higher (P<0.05) for treatments 2 and 4 (84%) compared to the values recorded for treatments 1,3, and 5 (78, 82 and 80% respectively).

Table 5. Nutrients digestibility of sheep fed varying levels of FSD.

Parameter	Treatments (inclusion levels of fore-stomach digesta,%)					
	1(0)	2(10)	3(20)	4(30)	5(40)	SE (±)
DM	65.20^{b}	65.01^{b}	71.85^{a}	64.41^{b}	66.67^{b}	5.8
CP	78.19^{b}	83.89^{a}	81.56^{b}	84.26^{a}	79.73^{b}	5.9
EE	51.84^{b}	39.18^{c}	56.03^{a}	41.60^{c}	53.94^{b}	4.2
CF	65.24^{c}	69.76^{b}	77.55^{a}	54.79^{d}	71.60^{b}	5.3
NFE	64.10^{b}	59.72^{b}	63.71^{b}	68.05^{a}	60.99^{b}	5.0

^{a,b,c}Means in the same row with different superscripts are significantly different (P<0.05).

EE digestibility was significantly higher (P<0.05) for animals on treatment 3 (56%) compared to those on the other treatments. Similarly, EE digestibility recorded for animals on treatments 1 (52%) and 5 (54%) were significantly higher (P<0.05) than those recorded for animals on treatments 2 (39%) and 4 (42%).

CF digestibility was significantly higher (P<0.05) for animals on treatment 3 (78%) compared to the other treatments. CF digestibility for animals on treatments 5 (72%) and 2 (70%) were also significantly higher (P<0.05) than the values recorded for animals on treatments 1 (65%) and 4 (55%). The value for treatment 1 (65%) was also significantly higher (P<0.05) than that recorded for treatment 4 (55%).

NFE digestibility was significantly higher (P<0.05) for animals on treatment 4 (68%) compared to the other treatments whose NFE digestibility values (60-64%) did not differ significantly (P>0.05) (Table 5).

Table 6. Nitrogen utilization of growing sheep fed varying levels of fore-stomach digesta.

Parameter	Treatments (inclusion levels of fore-stomach digesta,%)					
	1(0)	2(10)	3(20)	4(30)	5(40)	SE (±)
N intake (g/day)	137.27^{a}	145.36^{a}	133.7^{a}	142.64^{a}	117.46^{b}	27.5
Faecal N (g/day)	29.94^{a}	23.42^{b}	24.65^{b}	22.45^{b}	23.81^{b}	1.2
Urinary N (g/day)	26.00^{a}	25.80^{a}	22.95^{b}	20.00^{b}	22.80^{b}	1.0
N retention (g/day)	81.33^{b}	96.14^{a}	86.10^{b}	100.19^{a}	70.85^{c}	5.2
N retention (%)	59.25^{c}	66.14^{b}	64.44^{b}	70.24^{a}	60.32^{c}	5.1

^{a,b,c}Means in the same row with different superscripts are significantly different (P<0.05)

Nitrogen utilization

Nitrogen (N) intake (g/day) was significantly lower (P<0.05) for animals on treatment 5 compared to those of the other treatments, which do not differ significantly (P>0.05) among each other (table 6). Faecal N was significantly higher (P<0.05) for animals on treatment 1, while urinary N was significantly higher (P<0.05) for animals on treatments 1 and 2 compared to the other treatments.

N retention was higher for animals on treatments 2 (96 g/day) and 4 (100 g/day) compared to the other treatments. Similarly, N retention was significantly higher (P<0.05) for animals on treatments 1 (81 g/day) and 3 (86 g/day) compared to those on treatment 5 (71 g/day) (Table 6).

Cost of Production

Cost of concentrate decreased from N14.41/kg for treatment 1 to N7.16/kg for treatment 5 (Table 7), indicating a decrease with increasing levels of FSD in the diets. Cost of concentrate consumed thus decreased significantly (P<0.05) from N9.03/day for treatment 1 to N3.39/day for treatment 5. There were no significant differences between the treatments in the cost of hay consumed (P>0.05), which varied from N1.16/day for treatment 2 to N1.41/day for treatment 4. Cost of total feed consumed (i.e. concentrate plus hay) decreased from N10.21/day for treatment 1 to N4.75 per day for treatment 5. Cost of concentrate per kg live weight gain decreased from N99 per day for treatment 1 to N59 per day for treatment 5, but the differences were not statistically significant (P>0.05). Total cost of feed (i.e. hay plus concentrate) per kg live weight gain was highest for animals on treatment 2 (N156) and lowest for animals on treatment 5 (N82) but the differences were not significant (P>0.05).

Table 7. Cost of Production

Parameter	Treatments (inclusion levels of fore-stomach digesta, %)					
	1(0)	2(10)	3(20)	4(30)	5(40)	SE (±)
Cost of concentrate (N/kg)*	14.41	12.60	10.78	8.97	7.16	
Cost of hay (N/kg)	5.00	5.00	5.00	5.00	5.00	
Concentrate intake (g/day)	626.80[a]	607.40[ab]	587.60[b]	539.66[c]	473.56[d]	16.9
Hay intake (g/day)	236.53[b]	231.59[ab]	248.90[b]	281.54[a]	272.12[a]	11.4
Total feed intake (g/day)	863.32[a]	838.98[ab]	836.50[ab]	821.20[b]	745.67[c]	20.3
Cost of concentrate consumed (N/day)	9.03[a]	7.65[ab]	6.34[abc]	4.84[bc]	3.39[c]	2.3
Cost of hay consumed (N/day)	1.18	1.16	1.25	1.41	1.36	1.36
Cost of total feed consumed (N/day)	10.21[a]	8.81[ab]	7.58[ab]	6.25[ab]	4.75[b]	2.7
Cost of concentrate/kg liveweight gain (N/day)	99.03	136.23	89.74	65.57	58.80	
	±6.86	±97.83	±30.54	±11.00	±24.54	
Total cost of feed/kg liveweight gain (N/day)	112.17	156.45	106.85	84.58	81.88	
	±8.11	±111.55	±35.47	±13.97	±32.96	

[a,b,c,d]Means in the same row with different superscripts are significantly different (P<0.05)

*Feed cost per kg was calculated on the basis of prevailing market prices of ingredients as at March, 1999 (1N = 0.008 US dollars).

Discussion

Results of the current study indicate that though the average daily gain (ADG) of the growing sheep appeared to decrease with increasing levels of FSD in the diets, the differences were not significant. This indicates that the inclusion of FSD up to the level of 40% does not significantly affect the ADG of growing sheep. This confirms the assertion of Kumar (1989).

The ADG of sheep fed the 40% FSD diet in this experiment (68.5 g) is better than the ADG of 53g reported by Abil *et al.* (1992) when they replaced cotton seed cake and maize with wheat bran in the diets of sheep. Adu (1985) also reported an ADG of 65g when he replaced maize with brewers dried grains in the diets of growing sheep. This clearly indicates that the performance of sheep fed FSD is comparable to that obtained with some conventional feed supplements. Even though the differences in ADG with increasing levels of FSD obtained in this study were not significant, the differences were considerable - from 94g for the control diet to 68g for the 40% inclusion level of FSD (Table 3). The non-significant differences could be explained by a number of factors. It could be due to the large individual variations in ADG recorded for animals within the same treatments (Table 3). One possible explanation for this is that the animals were obtained from different sources, with possible differences in manaagement systems. It could also be due to individual idiosyncrasies to treatment with anthelmintics and other drugs. This could have led to individual animal differences as regards their adaptation to the feeding conditions, even though measures were taken to eliminate these differences at the beginning of the trial.

The relatively good performance of the animals fed high levels of FSD could be due to the fact that even though concentrate intake decreased by 158g from the control diet to the 40% FSD diet, hay intake increased by 33g. Thus total DM intake expressed as percentage of body weight did not differ significantly between the treatments. The increase in hay intake with increasing FSD levels must have compensated for the loss of some nutrients resulting from the lower concentrate intake - thus contributing to eliminate any significant differences between the treatments. The lower concentrate intake with increasing levels of FSD is expected, because the latter is known to have a characteristic odour which reduces its palatability to livestock. Incorporation of highly palatable ingredients in FSD containing rations has been reported to improve intake (Anthony, 1971; Kumar, 1989). If such ingredients were incorporated in this trial, the performance of the animals on the high FSD diets could be expected to be better.

Incorporation of FSD in the diets from 0 (control) to 40% levels led to a reduction in CP content from 19% to 16%. ARC (1990) recommended 17-18% CP for growing sheep. Adu (1985) reported 15-18% CP levels when he replaced maize with brewers dried grains in the diets of sheep. Thus, even at the 40% inclusion level of FSD, the CP levels did not vary much from the recommended or tested CP levels. Therefore, even though CP intake decreased by 40g/day from the control diet to the 40% FSD diet, CP intake as percent of total DM intake decreased only by 3 g/day, leading to non- significant differences in protein efficiency ratio (Table 4). Indeed, N retention increased from 59% for the control diet to 70% for the 30% FSD diet. All these could be responsible for the lack of significant differences in feed efficiency, which could also explain the lack of significant differences in ADG between the treatments.

Finally, it could be seen that nutrient digestibilities were not severely affected by including FSD in the diets of the animals. In fact, total DM digestibility was similar between the treatments, except for the 20% FSD diet which had significantly higher DM digestibility compared to the other treatments. Similarly, CP digestibility was significantly improved only with the 10 and 30% FSD diets. These results tend to point to the fact that FSD improves C digestibility up to a certain limit, or at least, it does not impaired DM and CP digestibilities. The reason for this could be related to the nutritional physiology of ruminants. It is known that rumen micro-organisms have the ability to synthesize microbial protein from nitrogenous substances and carbon skeleton originating from the diet (McDonald *et al.*, 1988). The micro-organisms could also synthesize some vitamins - especially the B-complex vitamins. The presence of all these in FSD could modify the degree of utilisation of FSD containing diets.

Inclusion of FSD in the diets of the animals led to significant reduction in the cost of concentrate consumed, while cost of hay consumed did not differ significantly between the treatments. Thus cost of total feed (concentrate plus hay) consumed decreased significantly with increased FSD levels in the diets. When this was expressed per kg liveweight gain of the animals, the decrease in the cost of feed was no more significant, even though the reduction was considerable - from N112 N/kg liveweight for the control diet to N82/kg liveweight for the 40% FSD diet. As observed for ADG, large individual variations within treatments could have been responsible for this. In addition, it should be noted that the animals used in this experiment were of different breeds. Breed and individual differences are among the factors that influence the ability of animals to convert feed to meat (Williamson and Payne, 1978).

Conclusion

Results of this study indicate that FSD could be incorporated into the diets of growing sheep up to 40% level without significantly affecting performance. An advantage of using FSD in the diets of growing sheep is that it results in lowering feed cost.

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