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PERFORMANCE OF FATTENING RAMS FED VARYING LEVELS OF FORE-STOMACH DIGESTA

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ABSTRACT

This study was conducted to evaluate the performance of fattening rams fed fore-stomach digesta (FSD) to replace cowpea husk at 0 (control), 10, 20, 30 and 40 % levels (treatments 1, 2, 3, 4 and 5 respectively). Results showed that including FSD up to 30 % level in the diet did not significantly (P>0.05) affect live weight gain. Total dry matter intake (TDMI) for treatment 1 was significantly higher (P<0.50) than those obtained for treatments 3, 4 and 5. Animals on treatment 4 had better nutrient digestibility, followed by those on treatments 1, 3, 5 and 2, in that order. N-retention recorded for treatments 1 and 5 were similar. Treatment 3 (20 % FSD) gave the lowest (P<0.05) feed cost per kg live weight. These results indicate that FSD could be incorporated up to a level of 30 % in the diets of fattening rams without significantly affecting performance. However, for best economic returns, the inclusion rate should not go beyond 20 %.

Keywords: Fore-stomach digesta; Nutrient digestibility; Nitrogen balance

INTRODUCTION

The scavenging nature of small ruminants in Nigeria cannot be relied upon to provide adequate nutrition for optimum livestock production (Adebowale and Taiwo, 1996). It is therefore important to ensure adequate feeding in order to enhance productivity. In north-western Nigeria, the problem of feed shortage is severe especially during the long dry season (about 8 months in a year), during which animals subsist on very poor quality grass and crop residues, thus leading to very low levels of performance. At this time, pastures are dry and highly lignified, so that they alone cannot satisfy even the maintenance requirements of livestock (LeHouerou, 1980). The effects of all these on livestock production are obvious. It is therefore necessary to look for alternative sources of feed ingredients in order to optimize animal performance.

Fore-stomach digesta (FSD) is an abattoir waste product that can be obtained free of charge from most abattoirs in the country. Due to lack of adequate disposal facilities, it is often found decaying in most abattoirs, producing repulsive odour and providing conditions for the proliferation of various parasites. Its utilization as a feed ingredient will therefore provide an effective means of waste disposal and reducing environmental pollution, in addition to lowering feed cost. This experiment was therefore designed to investigate the effect of including fore-stomach digesta in the diets of fattening rams.

Table 1: Gross composition of the concentrate mixture

Ingredients	Treatments (inclusion levels of force-stomach digesta, %)				
	1(0)	2(10)	3(20)	4(30)	5(40)
Fore-stomach digesta	0	10	20	30	40
Cowpea hay	40	30	20	10	0
Maize	23	23	23	23	23
Wheat offals	30	30	30	30	30
Cotton seed cake	5	5	5	5	5
Bone meal	1	1	1	1	1
Salt	1	1	1	1	1
Total	100	100	100	100	100

MATERIALS AND METHODS

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 *Eragrositis gangetica* (grass) and *Borreria scabra* (legume), obtained from the Usmanu Danfodiyo University Farm at Dabagi. The grass/ legume mixture was manually harvested in September. The harvested forage was cured for 2 - 3 days. 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 rations.

Prices of all ingredients were obtained to allow for analysis of feed cost.

Feeding Trial

Twenty yearling rams with an average weight of 32 kg (consisting of 15 Uda and 5 crosses of Uda x Yankassa) were used in a randomized block design (Steel and Torrie, 1980) to evaluate the effect of feeding various levels of fore-stomach digesta (FSD) on the performance of fattening rams. The animals were allocated to five treatment diets, with four rams in each treatment. The treatments were balanced according to breed and weight. Thus, each treatment consisted of three Uda and one cross bred. The animals were housed individually in pens measuring 1 x 2 m in size. Before the commencement of the feeding trial, the animals were sprayed against external parasites and de-wormed against gastrointestinal helminths.

The concentrate was formulated in such a way that FSD replaced cowpea husk at 0 (control), 10, 20, 30 and 40 % levels (table 1). The hay consisted of a mixture of equal ratio of *Eragrostis gangetica (*grass) and *Borreria scabra* (legume).

Each treatment was fed one of the experimental diets (- i.e. concentrate) in addition to the hay. The concentrate, water and mineral salt-lick were offered *ad libitum,* while hay was restricted to 1 % body weight of the animals. Thus, the quantity of hay offered was adjusted each week after weighting the animals. The feeding was done twice daily (morning and afternoon). The animals were allowed two weeks of adjustment before commencement of data collection. The feeding trial lasted for 90 days.

Feed intake was recorded daily during the 90 days of the experimental period, while water intake was measured during the first 28 days. Live weight gain was monitored weekly. Prior to weighting, water and feeds were withdrawn for at least six hours.

Digestibility Study

At the end of the feeding trial, a digestibility study was carried out using two animals per treatment. The animals were placed in metabolism crates, and were fed the same ration used in the feeding trial. The animals were fed for a preliminary period of 14 days followed by a 7 days collection period.

During the collection period, daily feed consumption was monitored. The total faeces voided by each animal per day was also collected and weighed. About 5% of the faecal output was then taken to the laboratory where it was weighted and oven dried. This procedure was repeated during the seven days collection period. At the end of the collection period, the dried samples were bulked and thoroughly mixed before analysis.

Urine was collected with the aid of bowls placed under the metabolism crates. 10 mls of 10% sulphuric acid (H_2S04) 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 using a measuring cylinder. Aliquot samples were then taken and transferred to the laboratory where they were frozen until analysis. The remaining urine was poured away. The bowls were washed, and replaced under the crates. This procedure was repeated for each treatment for the seven days.

Analytical Procedures

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

Statistical Analysis

Data were anlaysed statistically by using the General Linear Model (GLM) available in SAS (SAS, 1988).

RESULTS

Experimental Diets

The chemical composition of the experimental diets is presented in Table 2. Mean DM of the different concentrate mixtures was 96 %. Average CP content of the concentrate mixtures was about 11 %, although it was slightly higher for treatments 1 and 2 (11.4 %), compared to treatments 3, 4 and 5 (10.7 %). EE tended to increase from 4.3 % for treatments 1 and 2 to over 5 % for the other treatments. CF also increased from 32 % for treatment 1 to 35 % for treatment 5. NFE however tended to decrease from 46 % for treatments 1 and 2 to 41 % for treatment 5. Ash content tended to be higher for treatments 3, 4 and 5 compared to treatments 1 and 2 (Table 2).

The hay contained 90 % DM, 4.5 % CP, 1.5 % EE, 38.6 % CF, 44.95 % NFE and 10.5 % ash.

Live Weight Changes, Feed and Water Intake

Average daily gain decreased from 244 g/day for treatment 1 to 99.7 g/day for treatment 5 (Table 3). The differences were however not significant (P<0.05) up to the 30 % inclusion level of FSD (treatment 4).

Table 2: Chemical composition of experimental diets

Parameter	Treatments (inclusion levels of force-stomach digesta, (%)					Hay
	1(0)	2(10)	3(20)	4(30)	5(40)	
Dry matter	96.00	96.00	96.00	96.00	96.00	96.00
Crude protein	11.40	11.35	10.75	10.65	10.85	4.50
Ether extract	4.30	4.33	5.50	5.50	5.40	1.50
Crude Fibre	32.00	32.15	33.80	33.50	35.00	38.60
NFE	46.40	46.17	41.95	43.81	40.75	44.90
Ash	5.90	6.00	8.10	6.50	8.00	10.50

DM intake from concentrate decreased significantly (P<0.05) from 1.5 kg/day for treatment 1 to 1.0 kg/day for treatment 5. There was no significant variations in DM intake of hay (P<0.05), though the highest value was recorded for animals in treatment 3 (0.5 kg/day) and the least was recorded for those in treatment 5 (0.3 kg/day) (Table 3). Total DM intake (TDMI) therefore decreased from 1.8 kg/day (treatment 1) to 1.3 kg/day (treatment 5). The value obtained for treatment 1 was significantly higher (P<0.05) than those obtained for treatments 3, 4 and 5. Similarly, TDMI for animals on treatment 2 was significantly higher (P<0.05) than that of animals on treatments 5. TDMI as percentage of body weight of the animals were 3.49, 3.49, 3.50, 3.19, 3.33 and 3.29% for treatments 1, 2, 3, 4 and 5 respectively. The differences were significant only between treatments 2 and 3.

CP intake (CPI) decreased significantly (P<0.05) with increasing levels of FSD in the diets. Thus, CPI for animals on treatment 1 (182 g/day) and 2 (166 g/day) were significantly highly (P<0.05) than for those on treatments 4 (135 g/day) and 5 (123 g/day). Expressed as percentage of TDMI, CPI for animals on treatment 1 and 2 were significantly higher (P<0.05) than those of animals on the other treatments. Protein efficiency ratio decreased from 1.35 for animals on treatment 1 to 0.78 for those on treatment 5. The differences were however not significant (P>0.05) up to treatment 4 (i.e. 30 % inclusion level of FSD).

Crude fibre intake averaged 605.05, 556.83, 539.93, 505.65 and 475.38 g/day for animals on treatments 1, 2, 3, 4 and 5 respectively, indicating a decrease in CF intake with increasing levels of FSD in the diets. The value obtained for animals on treatment 1 was significantly higher (P<0.05) than those obtained for animals on treatments 4 and 5.

Table 3: Live weight gain, feed and water intake of rams fed varying levels of fore-stomach digesta

Parameter	Treatments (inclusion levels of force-stomach digesta, %)					
	1(0)	2(10)	3(20)	4(30)	5(40)	SE
Initial body weight (kg)	31.75	31.75	31.63	32.00	32.00	0.6
Average final weight (kg)	52.25	47.63	48.75	44.00	40.38	9.3
Final weight gain (g/day)	1.71[a]	1.37[a]	1.42[a]	1.09[ab]	0.70[b]	0.2
Average daily gain (g/day)	244.00[a]	195.00[a]	202.43[a]	156.29[ab]	99.71[b]	43.4
Concentrate dry gain matter intake (g/day)	1460.74[a]	1330.37[b]	1211.81[c]	1129.63[d]	998.21[e]	95.1
Hay dry matter intake (g/day)	357.12	335.97	457.56	329.40	325.35	42.9
Total dry matter intake (TDMI) (g/day)	1817.0[a]	1664.7[ab]	1549.70[bc]	1459.0[bc]	1324.70[c]	163.9
TDMI as % of body weight	3.49[ab]	3.50[a]	3.19[b]	3.33[ab]	3.29[ab]	0.2
Crude protein intake (CPI) (g/day)	182.40[a]	165.97[ab]	145.1[bc]	134.90[c]	123.03[c]	16.4
CPI as % TDMI (g/day)	10.04[a]	9.97[a]	9.36[b]	9.25[b]	9.28[b]	0.1
Protein efficiency ratio	1.35[a]	1.18[a]	1.40[a]	1.16[a]	0.78[b]	0.2
Crude Fibre intake (CF) (g/day)	605.05[a]	556.83[ab]	539.93[ab]	505.65[b]	475.38[b]	55.8
CFI as % of TDMI	33.30[a]	33.45[a]	34.84[b]	34.66[c]	35.89[a]	0.1
Feed: Gain Ratio	7.59	8.62	7.67	9.34	11.09	0.9
Water consumption (mls/day)	6237.5[a]	6450[ab]	6710.0[b]	6747.50[b]	6757.50[b]	45.1

Means in a row followed by same letter(s) are not significantly different (P>0.05).

Feed:gain ratio varied from 7.59 for animals on treatment 1 to 11.09 for those on treatment 5. The differences were however not significant (P>0.05).

Water intake increased from 6.2 litres/day for animals on treatment 1 to 6.8 litres/day for those on treatment 5, indicating an increase in water intake with increasing levels of FSD. The values recorded for treatments 3, 4 and 5 were significantly higher (P<0.05) than that recorded for treatment 1.

Nutrient Digestibility

Animals on treatment 4 (30 % FSD) had the highest DM digestibility and those on treatment 2 (10 % FSD) had the least (Table 4). DM digestibility for animals on treatment 4 (84 %) was significantly higher (P<0.05) than those for animals on treatments 2 (68 %), 3 (77 %) and 5 (69 %). Similarly, DM digestibilities for animals on treatments 1 (79 %) and 3 (77 %) were significantly higher (P<0.05) than for those on treatments 2 and 5 (Table 4). CP digestibility followed a similar pattern with the highest value recorded for animals on treatment 4 (79 %), and the least for those on treatment 2 (64 %). The value recorded for animals on treatment 4 was significantly higher (P<0.05) than that recorded for those on treatment 2.

Table 4: Nutrient digestibilities of rams fed varying levels of fore-stomach digesta

Parameter	Treatments (inclusion levels of force-stomach digesta, %)					
	1(0)	2(10)	3(20)	4(30)	5(40)	SE
DM digestibility (%)	79.24^{ab}	67.75^{c}	76.55^{b}	84.26^{a}	68.71^{c}	5.2
CP digestibility (%)	72.27^{ab}	63.54^{b}	71.47^{ab}	78.57^{a}	68.60^{ab}	5.0
EE digestibility (%)	63.82^{bc}	58.10^{c}	72.44^{a}	67.99^{ab}	64.53^{bc}	4.4
CF digestibility (%)	78.38^{a}	68.37^{b}	79.72^{a}	79.51^{a}	72.06^{ab}	5.0
NFE digestibility (%)	85.64^{ab}	71.81^{bc}	75.84^{bc}	93.47^{a}	68.00^{c}	5.9
Total digestibile (%) nutrients/100g of feeds	153.33	131.46	145.82	162.90	131.82	

Means in a row followed by same letter(s) are not significantly different (P>0.05).

Animals on treatment 3 had the highest EE digestibility (72 %), and those on treatment 2 had the lowest (58 %). The value recorded for animals on treatment 3 was significantly higher (P<0.05) than those obtained for animals on treatments 1 (64 %), 2 (58 %) and 5 (65 %). CF digestibilities for animals on treatment 1 (78 %), 3 (79.7 %) and 4 (79.4 %) were significantly higher (P<0.05) than that obtained for animals on treatment 2 (68.4 %). The value obtained for animals on treatment 5 (72 %) did not differ significantly from those obtained for the other treatments. NFE digestibility for animals on treatment 1 (86 %) and 4 (93 %) were significantly higher (P<0.05) than that obtained for animals on treatment 5 (68 %). The latter did not differ significantly (P<0.05) with the values obtained for animals on treatments 2 (72 %) and 3 (76 %).

Nitrogen (N) Balance

Table 5 shows the results on nitrogen utilization. N intake decreased significantly (P<0.05) from treatment 1 to treatment 5. N intake by rams fed diets containing 20, 30 and 40 % FSD were significantly lower (P<0.05) than those of animals fed the control diet. However, the values obtained for animals fed the 10 % (181.22 g/day), 20 % (166.94 g/day) and 30 % FSD (165.17 g/day) did not differ significantly from each other. Similarly, N intake did not differ significantly from the animals fed the control diet (190 g/day) and those fed the 10 % FSD diet (181 g/day).

Table 5: Nutrient utilization of rams fed varying levels of fore-stomach digesta

Parameter	Treatments (inclusion levels of force-stomach digesta (%)					
	1(0)	2(10)	3(20)	4(30)	5(40)	SE
N intake (g/day)	190.214[a]	181.22[ab]	166.94[bc]	165.17[bc]	143.47[c]	10.5
Faecal N (g/day)	52.62[b]	65.92[a]	47.53[c]	35.47[d]	45.29[c]	4.8
Urinary N (g/day)	67.87[a]	22.94[b]	13.35[c]	4.39[d]	15.78[c]	9.6
Retained N (g/day)	69.72[b]	92.36[ab]	106.06[ab]	125.32[a]	82.37[b]	10.1

Means in a row followed by same letter(s) are not significantly different (P>0.05).

Faecal N was significantly higher (P<0.05) for treatment 2 (65.92 g/day) followed by treatment 1 (52.62 g/day) and the least value was recorded for treatment 4 (35.47 g/day). There were no significant differences (P>0.05) in faecal N between treatments 3 (47.53 g/day) and 5 (45.29 g/day). Urinary N was significantly higher (P<0.05) for animals in treatment 1 compared to the other treatments. Similarly, the value recorded for treatment 2 was significantly higher (P<0.05) than those recorded for treatments 3, 4 and 5. Urinary N did not differ significantly between treatments 3 and 5. The lowest (P<0.05) value of urinary N was recorded for animals on treatment 4.

N-retention tended to increase from 70 g/day for treatment 1 to 125 g/day for treatment 4, and then declined to 82 g/day for treatment 5. The value recorded for treatment 4 was significantly higher (P<0.05) than those recorded for treatments 1 and 5 (Table 5).

Cost of Production

Cost of concentrate decreased from ₦11.7/kg for treatment 1 to ₦9.3/kg for treatments 5, indicating a decreased in cost with increasing levels of FSD (Table 6). Cost of concentrate consumed per day decreased significantly (P<0.05) from ₦ 18/kg for treatment 1 to ₦10/kg for treatment 5. Cost of hay consumed varied from ₦2/day for animals on treatment 1 to ₦1.8/day for those on treatment 5, with no significant differences between the treatments (Table 6). Cost of total feed consumed (i.e. concentrate plus hay) decreased significantly (P<0.05) from ₦20/day for animals on treatment 1 to ₦11.5/day for those on treatment 5. Total feed cost per kg live weight gain was lowest for animals on treatment 3 (₦75) and highest for those on treatment 5 (₦97).

The value obtained for animals on treatment 5 (₦97) was significantly higher (P<0.05) than those obtained for the other treatments. Values for treatments 2 (₦89) and 4 (₦86) were not significantly different between each other (P>0.05), but they were significantly higher (P<0.05) than those obtained for treatments 1 (₦83) and 3 (₦75). Cost of feed/kg live weight gain also differed significantly (P<0.05) between treatments 1 and 3.

Table 6: Cost of production.

Parameter	Treatments (inclusion levels of force-stomach digesta, %)					
	1(0)	2(10)	3(20)	4(30)	5(40)	SE
Cost of concentrate (N/kg)*	11.70	11.10	10.50	9.90	9.30	0.9
Cost of hay (N/kg)	5.00	5.00	5.00	5.00	5.00	22.1
Concentrate intake (g/day)	1521.60[a]	1385.80[b]	1262.30[c]	1176.70[d]	1039.1[e]	15.6
Hay intake (g/day)	396.80[a]	373.30[a]	508.40[a]	366.00[a]	361.50[a]	20.0
Total feed intake (g/day)	1918.50[a]	1759.10[a]	1770.60[a]	1542.70[b]	1401.3[b]	9.2
Cost of concentrate consumed/day (N)	17.79[a]	15.38[b]	13.28[bc]	11.63[cd]	9.67[d]	0.1
Cost of hay consumed/day (N)	1.99[a]	1.87[a]	1.87[a]	1.84[a]	1.82[a]	1.5
Cost of total feed consumed/day (N)	19.78[a]	17.25[b]	15.15[bc]	13.47[cd]	11.49[d]	15.8
Cost of concentrate/kg lives weight gain/day	74.31[c]	79.62[b]	65.62[d]	74.37[c]	81.75[a]	15.8
Total cost of feed/kg lives weight gain/day	82.55[c]	89.24[b]	74.94[d]	86.18[b]	96.51[a]	6.0

Means in a row followed by same letter(s) are not significantly different (P>0.05).

* Feed cost per kg was calculated on the basis of prevailing market prices of ingredients as at June, 2000 (1 ₦ = 0.008 US dollars).

DISCUSSION

Incorporating FSD in the concentrate portion of rations for fattening rams led to significant decreases in concentrate intake with each 10 % addition of FSD. This could be due to the fact that FSD is known to have a characteristic odour which reduces its palatability (Ghosh *et al*., 1997). The chemical composition of the concentrate mixture could also be a contributing factor to this observation, because as the level of FSD increased, CP levels decreased while CF levels increased. High CP and low CF levels have been reported to increase voluntary feed intake (Tolkamp, 1988; Abil *et al*., 1992; Galyean and Goetsch, 1993; Chryaa *et al*., 1997).

The significant decrease in concentrate intake with increasing levels of FSD was expected to lead to significant increase in hay intake. However, hay intake did not differ significantly between the treatments, and thus total DM (i.e. both concentrate and hay) intake decreased significantly from 1817 g/day for the control diet to 1325 g/day for the 40 % inclusion level of FSD. This could explain the decrease in average daily gain (ADG) from 244 g for the control diet to 100 g for the 40 % FSD diet. These differences were however not significant up to the 30 % inclusion level of FSD, where the ADG recorded was 156g. It could therefore be concluded that including FSD up to a level of 30 % does not significantly affect the performance of fattening rams. One possible explanation for this is the seemingly better utilization of nutrients induced by FSD. Thus digestibility of nutrients (particularly DM, CP and NFE) was better with the 30 % FSD diet compared to the other treatments (including the control). Thus, total digestible nutrients were higher for the 30 % FSD diet compared to the other treatments. In addition, N retention increased from 70 g/day for the control diet to 125 g/day for the 30 % FSD diet, and then decreased to 82 g/day for the 40 % FSD diet. All these point to better utilization of nutrients up to the 30 % inclusion level of FSD. The better utilization of nutrients induced by FSD might be responsible for the absence of any significant variation in feed efficiency between the five treatments.

The ADG of animals recorded in this experiment is comparable or even better than what has been reported for conventional feed ingredients. For example, Abil *et al*., (1992) reported ADG of 53 -148 g when they replaced cotton seed cake and maize with wheat bran in the diets of Yankassa sheep. Njwe and Kona (1994) reported ADG values of 9 -78 g when they fed elephant grass supplemented with stylo and concentrate to West African dwarf sheep. Adu and Brinckman (1981) reported ADG values of 78 -183 g when they fattened Uda sheep with varying levels of guinea corn and groundnut cake, with *Digitaria smutsii* hay as a source of roughage. It should however be noted that Uda sheep are known to have higher growth rates than Yankassa and West African dwarf sheep. The lower values reported by Abil *et al*., (1992) and Njwe and Kona (1994) compared to our findings is therefore expected, since the majority of the animals used in this study were Uda. The values of Adu and Brinckman (1981) are thus closer to the values obtained in the present study.

The comparative performance of animals in this study with those fed conventional ration components could also be attributed to the chemical composition of the diets. The CP, EE and CF levels of the diets used in this study are comparable to the values reported by Adebowale and Taiwo (1996) when they fed crop residues and agro-industrial by products to West African dwarf sheep. They are also comparable to the values reported by Adeloye (1994) when he fed West African dwarf goats diets containing cowpea husk and maize milling waste.

Increasing the levels of FSD in the diets led to increasing the volume of water intake from 6.2 litres/day for the control diet to 6.8 litres/day for the 40 % FSD diet. This tends to point to the fact that including FSD in the diets of sheep tends to increase water intake. This could be due to the increase in fibre levels with increasing levels of FSD, since increasing the fibre content of rations has been reported to increase the amount of water required to digest the fibre (Okorie, 1983). McDonalds *et al.*, (1988) reported that the water requirement for sheep in the tropics is 5 - 6 litres/day. The values obtained in this study are close to this range.

Economic analysis of the performance of the animals in this study indicate that even though ADG was not significantly affected up to the 30 % inclusion level of FSD, cost of feed per kg live weight gain was lowest for the 20 % FSD diet (₦75) followed by the control diet (₦83). Thus, the 10, 30 and 40 % inclusion levels of the FSD were more expensive in terms of cost compared to the control and 20 % inclusion levels of FSD.

CONCLUSION

Results of this experiment indicate that FSD could be incorporated up to a level of 30 % in the diets of fattening rams without significantly affecting performance. However, for best economic returns, the inclusion rate should not go beyond 20 %. This assertion could nonetheless vary with time and place, due to spatial and temporal variation in the prices of feed ingredients. Finally it is recommended that more trials should be conducted with different categories of livestock and different mixtures of FSD with other ingredients in order to ascertain the true feeding value of FSD.

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