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Full-Length Research Paper

Chemical and Mineral Composition of Sheep and Goats Fore-Stomach-Digesta (FSD) Ensiled with Urea and Rice Milling Waste (RMW)

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ABSTRACT: FSD from sheep and goats was collected at a slaughterhouse in Sokoto. For the collection, at least 5-10 animals from each species were brought to the abattoir for slaughter. Each animal received at least 0.5kg of fresh FSD after slaughter and evisceration. Representative samples were collected after the samples had been thoroughly mixed. In this experiment, a factorial design in CRD was used, with three replications of fore-stomach digesta (FSD) from sheep and goats. For three weeks, the samples were thoroughly mixed and ensiled. The proximate composition of sheep (FSD) ensiled with urea and graded levels of Rice Milling Waste (RMW) shows that DM was significantly different between treatment means, with treatment D (90.08%) having significantly higher ($P<0.05$) value compared to the rest of the treatments but similar to C (89.63%). The CP content was significantly higher ($P<0.05$) in treatment D (19.73%) but significantly the same with treatment A (19.47%) which is also significantly similar ($P<0.05$) to treatment C (19.33%). Treatment B (18.76%) which has the lowest value was significantly different ($P<0.05$) to all other treatments. the DM and ASH contents for Goats (FSD) ensiled with urea and graded levels of (RMW) were significantly higher ($P<0.05$) in treatments D 90.18% and 13.27% respectively. Generally, in this study Dry Matter (DM) values of FSD from sheep and goats were higher in the treatments where FSD, Urea and RMW were not ensiled (treatment D) compared to those that were ensiled (treatments A, B and C). The FSD of sheep produced higher CP values as compared to those obtained from camel FSD and cattle FSD when ensiled with urea and RMW. This study concludes that Dry matter, Crude protein and Crude fibre contents of (FSD) by adding Urea and (RMW) could be improved.

Keywords: Ruminants; Fore-Stomach digesta; factorial design; mineral composition

INTRODUCTION

According to Gatenby (2002), energy from food is used for maintenance and production such as growth, lactation, and pregnancy. Many factors influence an animal's energy requirements, including age, species, animal activity, level of production, and temperature. Also, it is not the total amount of energy in a food that is important, but the amount of energy that the animal can use (Church, 1978; Gatenby, 2002). Sheep have the ability to use roughages as energy sources because microorganisms in the rumen convert roughages into usable energy sources by providing volatile fatty acids that the sheep can use, allowing sheep to be useful in an energy-deficient world (Church, 1978). One of the waste products that can be used as an alternative cheap source of feed ingredients is fore-stomach digesta (FSD) (Maigandi et al., 2008; kwaido et al., 2016).

It is a byproduct of slaughterhouses made from the forestomachs of slaughtered camels, cattle, sheep, and goats (Maigandi and Tukur, 2002a; kwaido et al., 2016). It is discovered decaying in abattoirs, releasing repulsive odors into the environment and fostering the growth of various microorganisms (Maigandi and Tukur, 2002b; kwaido et al., 2017). The material contains a significant amount of nutrients that can help animals perform better (Boda, 1990). Because of the millions of bacteria and protozoa present in the aforementioned food animals, research has shown that Fore-Stomach Digesta (FSD) is rich in carbohydrate, proteins, vitamins, and minerals (Kumar, 1990). Farmers have practiced systems of storing and improving animal feeds in surplus for use during times of scarcity for many years.

The goal is to create a product that will not be degraded by microorganisms in the environment but will be broken down by rumen microbes (Chesworth, 1992 and kwaido et al., 2017). Ensiling the feed material, which aims at controlling microbial fermentation that could improve the feeding value of a feed ingredient (kwaido et al., 2017), is one method of conserving and improving feeds for animals, particularly unconventional feeds. Another method is to use less expensive nitrogen sources in diets, as proteins are a costly component that is essential for growth. Urea is a less expensive source that can be added to ruminant diets to meet at least some of their nitrogen requirements (kwaido et al., 2016). The use of Urea and ensiling processes could improve the palatability and feeding value of fore-stomach-digesta (FSD). However, there is a scarcity of data on the use of this unconventional feed resource in boosting production in this ecological zone. Thus, the purpose of this study is to see how feeding ensiled Fore Stomach Digesta (FSD) with urea with or without Rice Milling Waste (RMW) affects the performance of Uda sheep (kwaido et al., 2016).

The studies' main goals are to determine the chemical composition of Sheep and Goats Fore-Stomach-digesta (FSD) ensiled with Urea and rice milling waste (RMW) and the mineral composition of Sheep and Goats Fore-Stomach-digesta (FSD) ensiled with Urea and rice milling waste (RMW) (RMW).

MATERIALS AND METHODS

Sample collection and Preparation

FSD from sheep and goats was collected at a slaughterhouse in Sokoto. For the collection, at least 5-10 animals from each species were brought to the abattoir for slaughter. Each animal received at least 0.5kg of fresh FSD after slaughter and evisceration. Representative samples were collected after the samples had been thoroughly mixed. The collected representative samples were immediately transferred to an airtight container and transported to the experimental site. Urea and rice milling waste (RMW) were purchased in Sokoto from the central market and the Kalambaina rice processing center, respectively.

Experimental design and ensiling procedure

In this experiment, a factorial design in CRD (Steel and Torrie, 1980) was used, with three replications of fore-stomach digesta (FSD) from sheep and goats. The inclusion of RMW at graded levels in the FSD, as indicated in (Table 1). For three weeks, the samples were thoroughly mixed and ensiled. As laboratory silos, twenty-four (24) 946ml bottles were used (Ogunlolu et al., 2010). Roy and Rangnekar (2006)'s procedure was followed, in which 1kg urea was dissolved in 15 litres of water and sprinkled on 25kg FSD. The samples were ensiled in triplicate for 21 days. After filling the bottles with weighed materials and compressing them, masking tape was used to further seal them.

Chemical analysis

The 24 ensiled samples were opened and gathered for analysis three weeks later. For analysis of the samples' proximate composition, AOAC (1990) techniques were used, and Van Soest et al. (1991) and Georing and Van Soest (1970) protocols were used to determine the fiber fractions (ADF, NDF, ADL, cellulose, and hemicellulose). According to AOAC guidelines, the samples' mineral content was examined (1990). Atomic Absorption Spectrophotometer (AAS) was used to determine the samples' calcium (Ca) and magnesium (Mg) contents, while Flame photometer was used to determine the amounts of potassium (K) and sodium (Na).

Statistical analysis

Data collected from the proximate, fibre fractions and mineral analyses were analysed using analysis of variance (ANOVA) and treatment means were compared using the Least Significant Difference test (LSD) (Steel and Torrie, 1980). Energy was calculated from the formula: 37 X %CP + 81 X %EE + 35.5 X % NFE (Pauzenga, 1985).

RESULTS

Table 2 shows the proximate composition of sheep Fore-Stomach Digesta (FSD) ensiled with urea and graded levels of Rice Milling Waste (RMW). The DM was significantly different between treatment means, with treatment D (90.08%) having significantly higher ($P<0.05$) value compared to the rest of the treatments but similar to C (89.63%). Also B (89.11%) and C (89.63%)

Table 1: Gross composition of the Ensiled FSD with Urea and RMW

	Inclusion Levels of Rice Milling Wastes			
FSD	**0**	**25**	**50**	**75**
Sheep	100 + urea	75 + urea	50 + urea	25 + urea
Goat	100 + urea	75 + urea	50 + urea	25 + urea
Urea	+Urea*	+Urea*	+Urea*	+Urea*

**1kg of Urea plus 25kg of the diet*

Table 2: Proximate Composition of Sheep Fore-Stomach Digesta (FSD) ensiled with urea and graded levels of Rice Milling Waste (RMW)

Variables	Inclusion Levels of RMW (%)				SEM
	A (0)	**B (25)**	**C (50)**	**D (50*)**	
Dry Matter (%)	88.38[c]	89.11[b]	89.63[ab]	90.08[a]	0.11
Organic Matter (%)	77.24[b]	77.42[b]	77.89[ab]	78.49[a]	0.18
Crude Protein (%)	19.47[ab]	18.76[c]	19.33[b]	19.73[a]	0.12
Crude Fibre (%)	27.63	28.18	28.13	29.28	0.10
Ether Extract (%)	6.50[a]	5.11[c]	6.04[b]	6.90[a]	0.12
Nitrogen Free Extract (%)	35.26[a]	36.23[a]	34.77[a]	32.50[b]	0.30
Ash (%)	11.14[b]	11.69[a]	11.73[a]	11.59[a]	0.09
**ME (kcal/kg)	2498.62	2394.19	2438.78	2442.66	

Means on the same row with different superscripts are significantly different (P<0.05) **Unensiled samples*

Table 3: Proximate Composition of Goats Fore-Stomach Digesta (FSD) ensiled with urea and graded levels of Rice Milling Waste (RMW).

Variables	Inclusion Levels of RMW (%)				SEM
	A (0)	**B (25)**	**C (50)**	**D (50*)**	
Dry Matter (%)	89.82[ab]	90.02[ab]	89.57[b]	90.18[a]	0.16
Organic Matter (%)	76.73	76.94	76.75	76.91	0.21
Crude Protein (%)	17.47[c]	17.15[c]	17.97[b]	18.68[a]	0.07
Crude Fibre (%)	26.08[b]	28.53[a]	29.53[a]	30.03[a]	0.15
Ether Extract (%)	5.67[b]	4.54[c]	5.50[b]	6.67[a]	0.13
Nitrogen Free Extract (%)	37.70[a]	36.71[a]	34.18[b]	31.35[c]	0.25
Ash (%)	13.08[ab]	13.07[ab]	12.82[b]	13.27[a]	0.08
**ME (kcal/kg)	2444.01	2305.49	2323.78	2344.35	

Means on the same row with different superscripts are significantly different (P<0.05)
**Unensiled samples*

treatments did not differ significantly (P<0.05) between each other. Treatment A (88.38%) recorded significantly the least value. OM was significantly higher (P<0.05) in treatment D (78.49%) and similar to treatment C (77.89%) which significantly did not differ (P<0.05) with treatments A (77.24%) and B (77.42%) whose values are the lowest. The CP content was significantly higher (P<0.05) in treatment D (19.73%) but significantly the same with treatment A (19.47%) which is also significantly similar (P<0.05) to treatment C (19.33%). Treatment B (18.76%) which has the lowest value was significantly different (P<0.05) to all other treatments. The CF content between treatments was statistically not significant. The EE was significantly higher (P<0.05) and similar in treatments D (6.90%) and A (6.50%) but significantly different with treatment C (6.04%) and also with treatment B (5.11%) which was the lowest. The NFE content recorded significantly lowest (P<0.05) value in treatment D (32.50%), but was significantly the same in treatments A (35.26%), B (36.23%) and C (34.77%). The Ash content was significantly the same in all the treatments except in treatment A (11.14%) whose value was the lowest.

Table 3 indicates the Proximate Composition of Goats Fore-Stomach Digesta (FSD) ensiled with urea and graded levels of Rice Milling Waste (RMW). Table shows that the DM and ASH contents for Goats Fore-Stomach Digesta (FSD) ensiled with urea and graded levels of Rice Milling Waste (RMW) were significantly higher (P<0.05) in treatments D 90.18% and 13.27% respectively but similar to that of treatments A and B, while treatment C recorded significantly the lowest (P<0.05) value and also similar to treatments A and B. CP content was significantly different and higher (P<0.05)

Table 4: Fibre Fractions of and Mineral Composition Sheep Fore-Stomach Digesta (FSD) ensiled with urea and graded levels of Rice Milling Waste (RMW).

Variables (%)	Inclusion Levels of RMW (%)				SEM
	0	25	50	50*	
Neutral Detergent Fibre (NDF)	67.51	66.71	66.92	68.03	0.30
Acid Detergent Fibre (ADF)	42.93^{bc}	42.42^{c}	43.00^{b}	43.97^{a}	0.20
Acid Detergent Lignin (ADL)	12.00^{b}	12.50^{b}	11.18^{c}	13.40^{a}	0.19
Cellulose	30.93^{b}	29.92^{c}	31.82^{a}	30.57^{bc}	0.19
Hemi-cellulose	24.57	24.29	23.92	24.07	0.37
Calcium (Ca)	5.3^{a}	4.8^{b}	4.2^{c}	4.5^{bc}	0.01
Phosphorous (P)	3.8^{a}	3.5^{a}	2.5^{b}	2.8^{b}	0.01
Potassium (K)	24.8^{a}	24.8^{a}	21.6^{b}	23.6^{a}	0.05
Magnesium (Mg)	3.8^{a}	3.9^{a}	2.9^{c}	3.4^{b}	0.01
Cobalt (Co)	0.3^{a}	0.2^{b}	0.2^{b}	0.2^{b}	0.001

Means on the same row with different superscripts are significantly different (P<0.05)
*Unensiled samples

in treatment D (18.68%) compared to all the other treatments followed by treatment C (17.97%) which is also significantly higher (P<0.05) and different to treatments A (17.47%) and B (17.14%) whose values are similar. In the CF content the values were significantly (P<0.05) the same in treatments B (28.53%), C (29.53%) and D (30.03%). The lowest value was obtained in treatment A (26.08%) whose value is significantly different (P<0.05) from the rest of the treatments. EE recorded significantly higher (P<0.05) value in treatment D (6.67%) followed by A (5.67%) and C (5.50%) whose values were similar and then the lowest was in treatment B (4.54%) was significantly different (P<0.05) from the other treatments. NFE content significantly (P<0.05) the same in treatments A (37.70%) and B (36.71%) but differ with that of treatments C (34.18%) and D (31.35%).

Table 4 indicates Fibre Fractions and Mineral Composition of Sheep Fore-Stomach Digesta (FSD) ensiled with urea and graded levels of Rice Milling Waste (RMW). Table 4 indicated that the NDF value was not significantly different between treatment means. The ADF content recorded significantly (P<0.05) highest value in treatment D (43.97%) and also differed with the other treatments. The ADL content was also significantly (P<0.05) higher in treatment D (13.40%) followed by treatments A (12.00%) and B (12.50%) whose values were similar. Treatment C (11.18%) was the lowest. Cellulose content recorded significantly (P<0.05) lowest value in treatment B (29.92%) and the highest was in treatment C (31.82%). There was no significant difference in the Hemi-cellulose content. The mineral composition was also shown in the same table with the calcium content having significantly (P<0.05) highest value in treatment A (5.3%). Treatment D (4.5%) value was similar to both treatments B (4.8%) and C (4.2%). The Phosphorous content was significantly (P<0.05) higher and similar in treatments A (3.8%) and B (3.5%) and also significantly the same in treatments C (2.5%) and D (2.8%) whose values were lower. The Potassium content was significantly (P<0.05) higher and the same in all the treatments except in treatment C (2.16%) whose value was the lowest. In the Magnesium content treatments, A (3.8%) and B (3.9%) recorded significantly (P<0.05) higher and similar values compared to the other treatments. Cobalt content was significantly (P<0.05) higher in treatment A (0.3%) and also differed with rest of the treatments whose values were similar.

Table 5 indicates Fibre Fractions and Mineral Composition of Goats Fore-Stomach Digesta (FSD) ensiled with urea and graded levels of Rice Milling Waste (RMW). The NDF content recorded significantly (P<0.05) lowest value in treatment B (65.27%) whose value was also similar to treatments A (67.48%) and C (67.00%). The highest value was in treatment D (68.12%). ADF content was also significantly higher (P<0.05) in treatment D (44.36%) and the least was in treatment A (42.07%). Values in treatments B (43.33%) and C (43.02%) were significantly the same. The ADL content recorded significantly (P<0.05) higher in treatment A (15.08%) and the least was obtained in treatment C (12.13%). There was significant difference in the Cellulose content with least in treatment A (29.07%) compared to the other treatment means, but similar to treatment D (29.28%). The Hemi-cellulose content was significantly higher (P<0.05) in treatment A (25.42%) whose value was similar to treatments C (23.98%) and D (23.76%) and the least value was in treatment B (21.94%).

The Calcium and Phosphorous contents were significantly (P<0.05) higher in treatments A (7.1%) and (5.7%) respectively, compared to the other treatments and the least value was obtained in treatments C (5.5%) and (3.6%) respectively. Potassium content was also significantly (P<0.05) higher in treatment A (44.8%)

Table 5: Fibre Fractions and Mineral Composition of Goats Fore-Stomach Digesta (FSD) ensiled with urea and graded levels of Rice Milling Waste (RMW).

Variables (%)	Inclusion Levels of RMW (%)				SEM
	0	25	50	50*	
Neutral Detergent Fibre (NDF)	67.48^{ab}	65.27^{b}	67.00^{ab}	68.12^{a}	0.15
Acid Detergent Fibre (ADF)	42.07^{c}	43.33^{b}	43.02^{b}	44.36^{a}	0.18
Acid Detergent Lignin (ADL)	13.00^{b}	13.29^{b}	12.13^{c}	15.08^{a}	0.11
Cellulose	29.07^{c}	30.04^{b}	30.89^{a}	29.28^{c}	0.27
Hemi-cellulose	25.42^{a}	21.94^{b}	23.98^{ab}	23.76^{ab}	0.12
Calcium (Ca)	7.1^{a}	6.3^{b}	5.5^{c}	6.2^{b}	0.01
Phosphorous (P)	5.7^{a}	4.1^{b}	3.6^{c}	4.0^{b}	0.01
Potassium (K)	44.8^{a}	40.0^{b}	35.0^{d}	37.0^{c}	0.06
Magnesium (Mg)	6.3^{a}	4.2^{b}	3.8^{c}	3.4^{d}	0.01
Cobalt (Co)	0.4^{a}	0.3^{b}	0.2^{c}	0.2^{c}	0.00

Means on the same row with different superscripts are significantly different (P<0.05)
*Unensiled samples

compared to the other treatments. The Magnesium content was also significantly higher (P<0.05) in treatment A (6.3%) and the least value was obtained in treatment D (3.4%). Also Cobalt content was significantly higher (P<0.05) in treatment A (0.4%) followed by treatment B (0.3%) and the least value was in treatments C (0.2%) and D (0.2%).

DISCUSSION

Proximate composition of Sheep and Goats Fore-Stomach Digesta (FSD) ensiled with urea and graded levels of Rice Milling Waste (RMW)

Generally, in this study Dry Matter (DM) values of FSD from sheep and goats were higher in the treatments where FSD, Urea and RMW were not ensiled (treatment D) compared to those that were ensiled (treatments A, B and C). This may be due to the presence of microbial activity as a result of ensiling process given to the FSD prior to the analyses (Kumar, 1989 and Kwaido *et.al.,* 2016). The DM values obtained in this study were higher than those values of (13-20%) obtained by Maigandi and Tukur (2002a) and 14% obtained by Kumar (1989) when FSD was analysed alone. This may be due to the fact that ensiling improves values of feeds for ruminants (Mcdonald *et al.,* 1995; Kwaido *et.al.,* 2017).

Also there were higher CP values in the FSD from sheep and goats compared to those of Maigandi and Tukur (2002). The higher CP content in the present study might be due to the addition of urea, as urea adds nitrogen to feed material (Salem and Smith, 2008) and therefore increase crude protein content. The FSD of sheep produced higher CP values as compared to those obtained from camel FSD Kwaido *et.al.,* 2016) and cattle FSD Kwaido *et.al.,* 2017) when ensiled with urea and rice milling waste. This is similar to what was reported by Maigandi and Tukur (2002b) and also confirms the report that sheep are more supplemented with diets that are higher in CP content because they are more preferred for fattening in this part of the country (Malami and Tukur, 1998).

In the present study CP and DM values of camel, cattle, goats and the mixture of FSD were lower than those reported Maigandi *et al.* (2008) when FSD was ensiled with poultry waste. This may be due to differences in ensiling materials used and proportion of FSD and other ingredients used (Maigandi *et al.,* 2008; Alhassan, 1985).

The organic matter contents of FSD from camel, cattle, sheep, goats and mixture in the present study were lower than 90.99 for hay, 93.01 for wheat bran and 93.00 for corn stalk (Elkholy *et al.,* 2009). Also the OM values of unensiled sample in the overall study were higher than the ensiled samples. This might be due to the fact that the longer period of ensiling reduces the moisture content of FSD and increases the DM (Maigandi *et al,* 2008). The CF contents of FSD obtained in this study are lower than those obtained by Wiexian (1995) when wheat straw was treated with urea and ammonia, but were similar to those obtained by Boda (1990) and Maigandi *et.al,* (2004), but were higher than those values when FSD was ensiled with poultry waste (Maigandi *et al,* 2008).

Fibre Fractions and Mineral Composition of Sheep and Goats FSD Ensiled with Urea and Graded Levels of RMW

In the present study the NDF contents (39-43) in the sheep and goats were lower than those reported by Brown and Adjei (1995) when effect of urea ammoniation was tested on the feeding value of guineagrass hay (*Panicum maximum)* but were similar to those reported when FSD from camel (Kwaido *et.al.,* 2016) and FSD from Cattle Kwaido *et.al.,* 2017). Also the NDF and ADF content in this study were lower than those reported by Weixian, (1995) when straw was treated with anhydrous ammonia and urea. The lower NDF in the present study may be due to the report that urea treatment reduced NDF concentration by solubilization of hemi-cellulose and/or ADL fractions (Schiere and de Wit, 1995). The calcium content in this study is similar to those reported by Maigandi and Owanikin (2002a). The calcium: phosphorous ratio in the sheep and goats FSD in this study are in line with what was reported by McDonald *et al.,* (1995) that the calcium: phosphorous ratio considered most suitable for farm animals is within the range of 1:1-2:1, although there is evidence which suggests that ruminants can tolerate higher ratios provided the phosphorous requirements are met. In the overall result the chemical composition that is calcium, phosphorous, potassium, magnesium and cobalt contents recorded highest values in the 100% FSD (treatments A). The cobalt content was within the normal range of 0.02-0.04 mg/kg as deficiency symptoms are said to occur where levels of cobalt in the herbage are below 0.1 mg/kg DM and also sheep are said to tolerate up to 3.5mg/kg as sheep are less susceptible to cobalt toxicosis than cattle (McDonald *et al.,* 1995).

Conclusion

This study concludes that Dry matter, Crude protein and Crude fibre contents of Fore-Stomach Digesta (FSD) by adding Urea and Rice Milling Waste (RMW) could be improved.

Recommendations

Ensiled FSD, RMW and Urea combinations could be used in the diets of ruminants. And also other feed ingredients should be used to improve the feeding value of FSD and RMW for better weight gains.

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