EFFECT OF FEEDING REGIME AND TIME OF SAMPLING ON RUMEN METABOLITES OF YANKASA RAMS FED BASAL DIET OF SORGHUM HAY OR SILAGE SUPPLEMENTED WITH CONCENTRATE

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ABSTRACT
The study was conducted at Ahmadu Bello University Zaria which aimed at evaluating the effect of feeding regime and time of sampling on rumen metabolites of growing Yankasa rams fed a basal diet of grain sorghum hay or silage supplemented with concentrate. Twelve (12) growing Yankasa rams averaging 17.0±0.2 kg were randomly assigned to four feeding regimes treatment consisting of T_1 = Sorghum hay + concentrate daily, T_2 = Sorghum silage + concentrate daily, T_3 = Sorghum silage + concentrate after 1-day and T_4 = Sorghum silage + concentrate after 2-days. The result shows that the dry matter and crude protein contents of concentrate, hay and silage were 97.31 and 14.77 %, 94.41 and 11.35 % and 75.36 and 10.42 %, respectively. The dry matter (95.57 – 84.14%), crude protein (12.72 – 12.16%), NDF (47.88 – 38.27%) and ADF (25.00 – 24.19%) ranges were obtained for the treatment diets. Feeding regime had significant ($P<0.05$) effect on rumen indices considered with pH (5.48 – 6.20), temperature (31.41 – 34.59 ^oC), TVFAs (23.33 – 26.89 mmol) and NH_3-N (8.81 – 10.52 mg/100) ranges, respectively. There was significant ($P<0.05$) effect of sampling time on rumen indices with higher pH (5.93) and NH_3-N (10.74mg/100) obtained at 0 hours before feeding. Higher ($P<0.05$) TVFAs (31.00mmol) and temperature (35.53^oC) were recorded at 8 and 4 hours post feeding, respectively. It can be concluded that sorghum silage or hay could be fed alongside concentrate every other day or 2-days after for high pH, temperature, TVFA and NH_3-N

Keywords: Concentrate**,** Feeding regime, Hay, Rumen, Silage, Sorghum and Time

INTRODUCTION
In ruminant production, feeding regime is used to describe a regulated system/pattern of what meals are been offered, how frequently they are offered, what sequence is followed, and during which particular period they are offered. In Nigeria, small ruminants' management system may be extensive, intensive or semi-intensive. According to Oludimu (1992) and Lakpini (2002), under the extensive management system, goats and sheep graze on large expanse of land or scavenge all day to feed themselves. At best, they are offered feed supplements such as kitchen refuse, cassava/yam/ banana peelings, bean husks and maize chaff. The animals raised under this system are very destructive to crops, and are prone to diseases, risk of theft and parasites infestation which result in low productivity (Weaver, 2005). However, irrespective of the management system, it is important to increase the proportion of forage in the diet to reduce or minimize cost (Bouwman *et al*., 2005) bearing in mind the production objective. Feeding regime, like the number of meals and the sequence of feeding roughage and concentrates during feeding is important to prevent sub-acute ruminal acidosis (Nordlund *et al*., 1995). The levels of rumen metabolites (VFAs, NH_3-N) and pH are closely related with feeding regime (Steger *et al*., 1970).
Beauchemin (1992) recommended to dairy producers that forages should be fed before starch-rich concentrates, particularly in the morning, in order to increase rumen buffering capacity. And alternately, less rapidly fermentable starch sources, such as corn, should be substituted to reduce the rate of production of volatile fatty acids and lactic acids. Both of these practices have been reported (Robinson, 1989; Beauchemin, 1992) to result in higher intake of forage and increased overall animal productivity. Furthermore, Carro *et al*. (1994) studied the effect of time of supplementary feeding on

performance of sheep. The authors offered cereal-based concentrate supplement 1 hour after feeding hay in the morning and 30 minutes before feeding hay in the afternoon, at the rate of 700 g/sheep/d, and observed a higher total OM intake when concentrates were given after rather than before a period of ingestion of hay. This suggests that feeding supplement after rather than before a major grazing may be an effective means of minimizing reduction in forage intake as a consequence of feeding concentrate. Hence, the study aimed to determine the effect of feeding regime and time of sampling on rumen metabolites of growing Yankasa rams fed a basal diet of grain sorghum hay or silage supplemented with concentrate.

MATERIALS AND METHODS

The experiment was conducted at the Sheep Unit of Teaching and Research Farm, Department of Animal Science, Ahmadu Bello University Zaria, Kaduna State. Samsorg-17 grain sorghum planted on the 15th June, 2019 was conserved as silage. The sorghum plants were harvested at soft dough stage with the aid of forage chopper and harvester. The sorghum was chopped after which they were compressed in PICs (Purdue Improved Crop Storage) bags and properly tied so as to allow anaerobic fermentation process. The bags were stored until required for feeding. After adjustment, twelve (12) growing Yankasa rams aged between 12 and 15 months with an average body weight of 17$\pm$0.02 were balanced for their weights and allotted to four (4) dietary treatments with four (4) rams per treatment in a Completely Randomized Design. Grain sorghum hay and silage supplemented with concentrate were used at 60:40 hay/concentrate ratio. The composition of the concentrate supplemented consists of the following: maize offal, wheat offal, cotton seed cake, bone meal and salt (Table 1). The rams were pen-fed individually at 4 % of their body weight for a period of 90 days. Feeding regime was used as the treatment consisting of T_1 = Sorghum hay + concentrate supplemented daily, T_2 = Sorghum silage + concentrate supplemented daily, T_3 = Sorghum silage + concentrate supplemented after every other day and T_4 = Sorghum silage + concentrate supplemented after two days. Feed was offered once in the morning at 8:00 am. Daily records of feed offered and left-over were recorded to determine the voluntary feed intake. Water was provided *ad-libitum* to the rams. Rumen fluid samples were collected using stomach tube at 0 hour before morning feeding and subsequently at 4 and 8 hours post feeding, respectively. The stomach tube was carefully inserted into the rumen of the rams through the oesophagus, after restraining the animals. The pump was pressured to collect the rumen liquor into a stainless container. A clinical thermometer and digital pH meter were used immediately to determine the temperature and pH of the rumen fluid, respectively. The samples were strained through a double layer cheese cloth to remove extraneous materials. Ten (10) ml of the rumen fluid was measured into well-labeled plastic bottles containing equal volume (10 ml) of 0.1 normal Sulphuric acid (H_2SO_4) solutions to trap the ammonia nitrogen (NH_3-N). The rumen fluid samples were immediately stored in a freezer at a temperature of -4^oC pending laboratory analysis. Proximate components of dry matter and Nitrogen (N) for crude protein determination (N x 6.25); and neutral detergent fibre (NDF) and acid detergent fibre (ADF) were determined according to AOAC, (2005) and van-Soest *et al.* (1991) respectively in the Biochemical Laboratory, Department of Animal Science, A. B. U., Zaria. Rumen fluid samples were analyzed for pH, temperature, total volatile fatty acids (TFVA) and ammonia nitrogen (NH_3-N) in the Central Laboratory of NAPRI, Shika, Nigeria. Data collected were analyzed using the General Linear Model Procedure of SAS (2005). Significant means were compared using the Duncan's Multiple Range Test (Duncan, 1955).

Table 1: Ingredient composition of concentrate supplement fed to growing Yankasa rams

Ingredients	Percentage (%)
Maize offal	40.00
Wheat offal	31.50
Cotton seed cake	25.00
Bone meal	2.50
Salt	1.00
Total	100.00
Calculated analysis (%)	
Crude Protein	13.63
Metabolizable energy (kcal/kg)	2679.00
Cost/kg diet (₦)	93.40

RESULTS AND DISCUSSION

Chemical Composition of the Experimental Diets Fed to Growing Yankasa Rams

Chemical composition of the experimental diets fed to growing Yankasa rams (Table 2) revealed that the dry matter (DM) contents of the concentrate, hay and hay + concentrate daily were above 91.0 %. This might be due to dryness of the concentrate and fibrous nature of the hay. The value of DM observed in this study for the silage was higher than 57.00 and 68 % reported by Adewumi (2019) for indigenous sweet sorghum and Samsorg-17 silages. The crude protein contents reported in this study were above 10 – 12 % CP requirement for sheep and goats (Wada *et al*., 2016). The neutral detergent fibre (NDF) was below the 60.00% suggested by Muia (2000) as critical limit for efficient utilization of roughages. The acid detergent fibre (ADF) reported was below 30.00% thus indicating that the diets were of very good quality in line with the report of Blezinger (1999).

Table 2: Chemical composition of the experimental diets fed to growing Yankasa rams

Parameters (%)	Concentrate	Hay	Silage	Hay + Conc daily	Silage + Conc daily	Silage + Conc Skip-a-day	Silage + Conc Skip-2-days
Dry matter	97.31	94.41	75.36	95.57	84.14	84.14	84.14
Crude protein	14.77	11.35	10.42	12.72	12.16	12.16	12.16
NDF	14.66	70.03	54.01	47.88	38.27	38.27	38.27
ADF	2.64	39.90	40.32	25.00	24.19	24.19	24.19

NDF = Neutral detergent fibre, ADF = Acid detergent fibre

Effect of Feeding Regime and Sampling Time on Rumen Metabolites of Growing Yankasa Rams Fed a Basal Diet of Grain Sorghum Hay or Silage Supplemented with Concentrate

Feeding regime had significant ($P<0.05$) effect on pH, temperature, total volatile fatty acid (TVFA) and ammonia nitrogen (NH_3-N) (Table 6). Rumen pH, temperature and NH_3-N increased when concentrate supplementation was delayed from silage + concentrate daily to silage + concentrate after 2-days. Ruminal pH is an important factor that measures the acidity and alkalinity of rumen content in ruminants and for optimum rumen microbial fermentation. Gozah *et al*. (2001) reported that when the ruminal pH is low, microbial diversity is reduced as protozoa numbers may sharply decline and the bacterial population altered and largely reduced. The pH values in this study falls within the recommended range of 5.5 – 7.5 (Russell, 1996). Osinowo *et al.* (1994) suggested that for optimum rumen microbial fermentation the rumen pH should range between 6.00 and 7.00. The pattern of rumen NH_3-N production was dependent on the pattern of intakes of hay, concentrate and total dry matter intake. The increase in NH_3-N level with the reduction of both silage and concentrate contradicts the report by Adeleke (2015) who observed that increased intake of protein from concentrate component of the diet was associated with higher concentration of NH_3-N in the rumen. Ammonia is the nitrogen source of main microbes in the rumen (Bandle and Gupta, 1997) and NH3-N concentration is an indicator of degradation and utilization of nitrogen source by rumen microbes (Wang *et al*., 2008).

The effect of sampling time on rumen metabolites was highly varied. Rumen pH and NH_3-N declined from 0 to 8 hours post-feeding while TFVAs increased from 0 to 8 hours post-feeding. The significant decline in rumen pH at 8 hours post-feeding could be as a result of high concentration of TFVAs, as it has been reported that high concentration of VFA has a reducing effect over rumen pH (Abubakar *et al.*, 2010). The value of the TVFAs obtained from this study was within 19.57 - 36.57 mmol/L reported by Jokthan (2007) when pigeon pea forage was supplemented in sheep diet and the 28.80 – 56.80 mmol/L reported by Adamu (2015). Volatile fatty acids (VFAs) are the main energy sources for ruminant feeding solely on roughages. Thus their concentration in the diet gives indication of their energy value. The increase in TFVAs noticed across the time of sampling means that the microbes in the rumen of the rams had enough time to act on the feed thereby producing TVFAs. The increase suggested that the treatment diets improved the anaerobic fermentation of the diet which stimulated the yield of more TVFAs (Bello, 2017). This improved yield of VFA may be due to the increase in digestibility of the diets. The NH_3-N recorded in the present study is higher than 4.84 – 8.56 mg/100 reported by Jokthan *et al.* (2013). Rumen ammonia (NH_3-N) value of 2 – 8 mg/100 is required for high producing ruminant livestock (Drewnoski and Poore, 2012). There was no significant (P>0.05) interaction effect between feeding regime and sampling time on the rumen indices.

Table 3: Effect of feeding regime and sampling time on rumen metabolites of growing Yankasa rams fed a basal diet of grain sorghum hay or silage supplemented with concentrate

Treatments	pH	Temp (^oC)	TVFA (mmol)	NH_3-N(mg/100)
Feeding Regime				
Hay + Conc daily	5.48^c	31.44^b	26.67^a	9.84^a
Silage + Conc daily	5.89^b	31.91^b	23.33^b	8.81^b
Silage + Conc Skip-a-day	5.58^c	33.53^a	26.89^a	10.17^a
Silage + Conc Skip-2-days	6.20^a	34.59^a	25.78^{ab}	10.52^a
SEM	0.10*	0.71*	1.34*	0.47*
Sampling Time (Hours)				
0	5.93^a	31.22^b	22.83^b	10.74^a
4	5.86^a	35.53^a	23.17^b	10.34^a
8	5.58^b	31.85^b	31.00^a	8.43^b
SEM	0.13*	0.94*	1.78*	0.63*
Interaction				
F x S	0.936	0.219	0.908	0.517

^{abc}Means with different superscript within rows differed significantly (P<0.05), SEM = Standard error of mean, F = Feeding regime, S = Sampling time, TVFA = Total volatile fatty acid, NH_3 = Ammonia

CONCLUSIONS

It is concluded that feeding Yankasa rams silage and concentrate supplement after *every other day* or after 2-days resulted in higher rumen pH, temperature, total volatile fatty acids (TFVAs) and ammonia nitrogen (NH_3-N). *Higher TFVAs was obtained at 8 hours post feeding while* ammonia nitrogen (NH_3-N) was higher at 0 hours post-feeding. It is therefore recommended that for higher pH, TVAs and NH3-N sorghum silage should be supplemented with concentrate after 2-days.

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