RUMEN FERMENTATION PARAMETERS AND MICROBIAL PROFILES OF WEST AFRICA DWARF SHEEP FED SUGARCANE TOP TREATED WITH DIFFERENT NITROGEN SOURCES

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ABSTRACT
This experiment was carried out to examine the effect of sugarcane top treated with different nitrogen sources on rumen fermentation parameters and microbial profiles of West African dwarf (WAD) sheep. Four different silages were prepared such that sugarcane tops were ensiled alone (control) or with 2% urea (USCT silage), 45% boiler litter (BLSCT silage) and 1% urea plus 22.5% broiler litter (UBLSCT) for 42 days. Each silage treatment contains 2% molasses. Twenty-four female WAD sheep weighing 14.58±1.16kgwere randomly assigned to the four silage treatments in a completely randomised design with six animals per treatment for 84 days. Effect of silages on rumen fermentation parameters and microbial profiles at 4 hours post-feeding were evaluated. Results revealed that the rumen pH was highest in animal fed control silage (6.85) and lowest in those fed BLSCT silage (6.56). Highest ammonia nitrogen, total volatile fatty acid, acetate and propionate concentration were recorded in animals fed BLSCT silage. Total viable bacteria, fungi zoopores, cellulolytic bacteria, and proteolytic bacteria counts were higher ($P < 0.05$) in animals fed BLSCT and UBLSCT followed by animals fed USCT while those fed control silage recorded the lowest counts. It can be concluded that feeding of all treated sugarcane top silages especially BLSCT and UBLSCT resulted in improved rumen ecology in terms of microbial biomass, volatile fatty acids production and ruminal pH compared with the control silage.

Keywords: Sugarcane top, Silage, Sheep, Microbial biomass, Volatile fatty acids,

INTRODUCTION

The most critical constraint hindering livestock productivity in developing countries is irregular and insufficient supply of quality forage (Sarwar *et al*., 2002). In Nigeria, small scale farmers cannot afford the cost of establishing improved pasture, and feeding nutritious supplemental feed such as concentrate to ruminant is expensive. Natural forage crops of good quality are not available all the year round, it is therefore becomes imperative for ruminant nutritionists to investigate more on the use of alternative feedstuffs that are less or not useful to man in order to avoid the problem of feed shortage experienced during the dry season. Ruminant animals have ability to cope with poor quality feeds due to the presence of microorganisms in their rumen which encourage pre-gastric fermentative digestion of feed. Sugarcane top is a crop residues derived after harvesting of the cane and is readily accepted by ruminant either fresh, dried or ensiled (Bhatti and Khan, 1996). Sugarcane top is low in protein, poor in mineral and had low digestibility of nutrients (Patil *et al*., 1999) therefore, there is a need to improve its nutritive value by treating with non-protein nitrogen substances for better utilization by animals since rumen micro-organisms depend on dietary protein for proper growth and optimum activity. Information on the influence of sugarcane top treated with urea and poultry litter on rumen fermentation characteristics and microbial profile of ruminant is limited. The study therefore aimed at determining the effect of sugarcane top treated with urea and poultry litter on the rumen fermentation characteristics and microbial profile of West African dwarf sheep.

MATERIALS AND METHODS

Fresh sugarcane tops were allowed to wilt overnight, chopped into small pieces (about 2-4cm) for ease of loading at ensiling. Four silage treatments were prepared with sugarcane tops ensiled alone (control silage) or with 2% urea (USCT silage), 45% boiler litter (BLSCT silage) and 1% urea plus

22.5% broiler litter (UBLSCT silage). Each silage treatment contained 2% molasses and stored under a shed for a period of 42 days.

Twenty-four female West African dwarf sheep weighing 14.58±1.16kg were randomly allotted to four experimental diets (six animals per treatment) in a completely randomised design. The animals were housed in individual pens and had free access to clean water. Each animal was offered their respective silage on *ad-libitum* basis at 7.00 am in the morning and concentrates feed (at 1.5% body weight) as supplement at 4.00 pm in the evening for a period of 84 days. On the last day of the study, about 60mL of rumen fluid was collected from each animal at 4-hour post-feeding via the oesophagus through the use of suction tube for fermentative and microbial analysis. The fluid was immediately measured for pH and temperature using portable pH meter and was filtered through four layers of cheese cloth, and stored at -20^{0}C pending analyses. Ammonia-nitrogen and volatile fatty acid analyses were analysed (AOAC, 2005; Kayol and Borilek, 1995 respectively). Total direct count of bacteria, protozoa and fungal zoospore was done (Baker and Breech, 1986). Total viable bacteria, cellulolytic, proteolytic and amylolytic bacteria counts were also carried out according to Hungate (1969).

All data collected were subjected to Analysis of Variance (ANOVA) while significant differences among means were compared using Duncan's Multiple Range F-test (SAS, 1999). The mathematical model of the experiment: $Y_{ij} = \mu + T_i + \Sigma_{ij}$, where Y_{ij} = observed value of the dependent variables,μ = Population mean, T_i = Effect of the different silages (treatment effect),Σ_{ij}=Random residual error

RESULTS AND DISCUSSION

The rumen fermentation parameters and microbial profiles of West African dwarf sheep fed sugarcane top silage are presented in Table 2. The rumen pH taken was significantly affected ($P < 0.05$) by the diets with sheep fed control silage having the highest value (6.85) while those fed BLSCT silage recorded the least (6.56). The rumen temperature range across the treatment is compared favourably with 39^{o}C which was necessary for the optimum growth of rumen bacteria (Kamra, 2005). The rumen pH recorded for all treatments fell within the range (6.0-7.0) reported by Aduku (1993) as suitable pH for growth and normal activities of rumen bacteria. Rumen bacteria are very sensitive to pH change and none of the three predominant fibrolytic bacteria can grow at pH less than 6.0 (Shi and Weimer, 1992). Fibre digestion is also reduced when ruminal pH reached values below 6.0 (Wanapat *et al*., 2000). Ruminal ammonia nitrogen concentration recorded was significantly ($p<0.05$) different across the treatments with sheep fed USCT, BLSCT and UBLSCT silages having higher concentration compared to control silage. It means that addition of nitrogen sources (urea and broiler litter) had increased ammonia nitrogen concentration with ammonia being the main nitrogen source for the growth and protein synthesis by ruminal bacteria to achieve maximum fermentation (Hoover, 1986). Nguyen *et al.* (2005) had also stated that rumen ammonia concentration reflected the CP levels in the diets and was associated with higher number of bacteria. Ammonia nitrogen concentrations recorded in sheep fed USCT, BLSCT and UBLSCT silages were within the optimal range of ruminal ammonia nitrogen (15 – 30mg %) (Perdok and Leng, 1990) needed for increasing microbial protein synthesis, feed digestibility and voluntary feed intake.

There were significant variations ($P < 0.05$) in the total volatile fatty acid (TVFAs), acetate, propionate and butyrate concentration across the treatments. Total viable bacteria, cellulolytic and proteolytic bacteria counts also differ statistically ($P < 0.05$). It could be observed from this study that the TVFAs, acetate, propionate and butyrate concentrations increased with addition of nitrogen sources. Results obtained is consistent with the rumen pH data which means that the more acid is being produced, the lower the pH. The highest value obtained for acetic acid in sheep fed BLSCT was higher than the value (66.6 mmol/l) reported by Azizi-Shotorkhoft *et al*. (2012). Variation observed

might be due to differences in the proportion of poultry litter included in the ration. The range of cellulolytic and proteolytic bacteria count observed was similar to the range reported by Chanjula *et al*. (2004).

CONCLUSION

It could be concluded from this study that all treated sugarcane top silages especially BLSCT and UBLSCT improved rumen ecology in terms of microbial biomass production, volatile fatty acids concentration and ruminal pH. Sugarcane tops treated with broiler litter and urea is recommended for feeding ruminants especially during the dry season when forages are scarce and of low nutritive value

Table 1: Chemical composition (g/kg DM) of silages and nutrient intake (g/day) by West African dwarf sheep fed sugarcane top silages

Parameters	Treatments				
	Control silage	USCT silage	BLSCT silage	UBLSCT silage	SEM
Chemical composition (%)					
Dry matter	301.20^{c}	287.57^{c}	400.80^{a}	320.00^{b}	13.37
Crude protein	86.00^{c}	120.00^{b}	133.10^{a}	122.60^{b}	5.44
Ether extract	21.20^{b}	20.00^{b}	35.00^{a}	20.00^{b}	1.96
Ash	75.00^{c}	90.00^{b}	130.00^{a}	95.00^{b}	6.16
Neutral detergent fibre	680.00^{a}	630.00^{bc}	610.00^{c}	650.00^{b}	8.36
Acid detergent fibre	380.00^{a}	362.50^{b}	350.00^{b}	355.00^{b}	3.97
Acid detergent lignin	120.00^{a}	110.00^{ab}	100.00^{b}	105.00^{b}	2.73
Hemicellulose	300.00^{a}	267.50^{b}	260.00^{b}	295.00^{a}	5.28
Cellulose	260.00^{a}	252.50^{ab}	250.00^{b}	250.00^{b}	1.68
*Metabolizable energy (MJ/kg DM)	7.13	7.20	7.30	7.29	0.06
Non-fibre carbohydrate	137.80^{a}	140.00^{a}	91.90^{b}	112.90^{ab}	7.47
Nutrient intake (g/day)					
Dry matter	432.03^{c}	431.82^{c}	543.96^{a}	471.76^{b}	13.86
Crude protein	50.46^{d}	58.72^{c}	76.64^{a}	64.17^{b}	2.87
Neutral detergent fibre	221.10^{c}	209.28^{d}	273.27^{a}	229.49^{b}	7.34

*^{a,b,c,} Means on the same row having different superscripts are significantly different (P < 0.05), SEM – Standard error of mean, USCT – urea treated sugarcane top silage, BLSCT – broiler litter treated sugarcane top silage, UBLSCT – urea plus broiler litter treated sugarcane top silage, *calculated according to De Boever ., (1997)*

Table 2: Rumen fermentation parameters and microbial profiles of West African dwarf goats fed sugarcane top silages

Parameters	Treatments				
	Control silage	USCT silage	BLSCT silage	UBLSCT silage	S.E.M
Temperature (ºC)	37.85	38.83	38.90	38.95	0.26
Ph	6.85[a]	6.69[b]	6.56[c]	6.75[b]	0.04
Ammonia-nitrogen (mg/dL)	8.65[c]	17.13[ab]	18.08[a]	16.38[b]	0.36
Total volatile fatty acids (mM)	73.00[c]	108.00[b]	135.00[a]	118.27[b]	7.12
Acetate (mM)	44.33[c]	66.33[b]	80.00[a]	65.73[b]	3.97
Propionate (mM)	16.27[c]	24.33[b]	33.60[a]	26.00[b]	1.90
Butyrate (mM)	9.73[c]	13.00[b]	18.29[a]	17.83[ab]	1.17
Total viable bacteria ($x10^9$CFU/g rumen content)	5.03[c]	6.93[b]	8.01[a]	7.78[a]	0.33
Bacteria ($x10^9$CFU/g rumen content)	3.55[c]	5.40[b]	6.50[a]	6.15[a]	0.14
Protozoa ($x10^6$CFU/g rumen content)	1.35	1.40	1.64	1.95	0.34
Fungi zoopores ($x10^6$CFU/g rumen content)	1.67	1.75	2.05	2.10	0.27
Cellulolytic bacteria ($x10^7$CFU/g rumen content)	5.75c	7.30[b]	8.75[a]	7.75[ab]	0.41
Amylolytic bacteria ($x10^7$CFU/g rumen content)	4.75	4.00	5.75	6.00	0.45
Proteolytic bacteria ($x10^6$CFU/g rumen content)	3.00[c]	4.00[b]	6.50[a]	5.00[b]	0.44

[a,b,c,] Means on the same row having different superscripts are significantly different (P < 0.05), SEM – Standard error of mean, USCT – urea treated sugarcane top silage, BLSCT – broiler litter treated sugarcane top silage, UBLSCT – urea plus broiler litter treated sugarcane top silage

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