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Effect of Feeding Differently Processed Sweet Sorghum (*Sorghum bicolor L. Moench*) Bagasse Based complete Diet on Nutrient Utilization and Microbial N Supply in Growing Ram Lambs

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ABSTRACT

This study was carried out to identify appropriate processing method for efficient utilization of sweet sorghum bagasse (SSB), an agro-industrial by product of ethanol industry after blending with concentrate. SSB based complete diet with roughage to concentrate ratio of 50:50 was processed into mash (SSBM), expander extruded pellet (SSBP), chop form (SSBC) and evaluated in comparison to sorghum stover based complete diet in mash form (SSM). Twenty four Nellore X Deccani ram lambs (9 month age; 21.1±0.57 kg body weight) were randomly divided into four groups of six animals each and the experimental complete diets were allotted at random to each group and evaluated for their intake, nutrient utilization and microbial N supply. Among all the groups, the average dry matter (DM) intake (g/kg $w^{0.75}$), digested DM, organic matter and crude protein were higher ($P<0.01$) in lambs fed SSBP diet. The cellulose digestibility was higher ($P<0.05$) in lambs fed SSBP diet than those fed SSM and SSBC diets. Intake of digestible crude protein (DCP, g/d) and metabolizable energy (MJ/d) were higher ($P<0.01$) in lambs fed SSBP diet. The SSBP diet had higher ($P<0.01$) DCP and N ($P<0.05$) balance compared to other three diets. Increased ($P<0.01$) purine derivatives and microbial N supply was observed in processed diets. Expander extrusion of SSB based complete diet resulted in improved ($P<0.01$) efficiency of microbial protein synthesis. It is concluded that, when SSB was processed into complete diets, in terms of nutrient utilization and microbial N supply, the expander extruded pellet diet was better utilized than chopped or mash form by the growing ram lambs.

***Key words**: Sweet sorghum bagasse- complete diet- nutrient utilization- microbial N supply -lambs*

1. Introduction

Sweet sorghum *(Sorghum biocolor* L. Moench) is similar to grain sorghum but features more rapid growth, higher biomass production, wider adaptation, and has great potential for ethanol production. Sweet sorghum is more water-use efficient and can be successfully grown in arid and semi-arid tropics. It is grown in areas with an annual rainfall range of 400-750 mm worldwide on about 44 million hectares in almost one hundred different countries (ICRISAT, 2008). The major producers are the United States, India, Nigeria, China, Mexico, Sudan and Argentina (FAO, 2007). The dual-purpose nature of sweet sorghum offers new market opportunities for smallholder farmers (Blummel et al., 2009). The stillage from sweet sorghum after the extraction of juice has a higher biological value than the bagasse from sugarcane when used as roughage source for cattle, as it is rich in micronutrients and minerals (Reddy et al., 2005a). A crop yielding 40 ton fresh stalk/ha with 60% extractability would yield about 6-7.5 ton/ha dried stalk residue (Gailai et al., 2008). The residue left after extracting the juice from stalks can compensate the fodder loss.

The stalk residue after extraction of juice is generally considered to be low in protein, energy and have low digestibility mostly due to highly lignified cell walls (Almodares et al., 2011). It can represent a large potential source of energy for ruminants provided their nutrients are fully exploited with suitable processing technology. Thus scientific and judicious combination of these processed residues with concentrates to produce a well-balanced complete diet for meeting the nutritional requirements for various physiological functions has a great significance. Processed fibrous crop residue could be successfully used as the sole source of roughage in complete diet for optimum growth and milk production (Reddy et al., 2003). The complete diet system has potential for utilizing existing feed resources more effectively for economical animal production. Likewise, attempts have been made to use sugarcane bagasse in many situations as an emergency feed in Brazil, Cuba and Philippines. Sugarcane bagasse based complete diet improved the efficiency of protein and energy utilization and animal performance in cattle calves (Reddy et al., 2002; Pandya et al., 2009). The complete diet can be further processed by the expander and extruded method. Expander and extrusion of complete rations proved successful, which stimulates bacterial action in the rumen, increase the bulk density, palatability and nutritive value, reduces wastage, increased efficiency in utilization of feeds by 5-10% and 3-5% improvement in rate of weight gain and reduced cost of feed per unit produce (Samanta et al., 2003; Praveen Kumar et al., 2004; Reddy et al., 2005b).

Therefore, the present investigation was carried out to evaluate the effect of incorporating sweet sorghum bagasse (SSB) in complete diet processed into either mash, expander extruder or chopped form on nutrient utilization and microbial N supply in growing ram lambs.

2. Materials and methods

2.1. Cropping conditions of sweet sorghum

Sweet sorghum hybrid CSH22SS was sown during second week of June after onset of monsoon in deep red loamy soil with a soil depth of 1m. Seed rate was 7-8kg/ha. 90 kg nitrogen per hectare along with 40 kg/ h P_2O_5 was applied. The deficiency of S, Zn and B in the soil was corrected by applying 200 kg Gypsum, 50 kg Zinc sulfate and 2.5 kg of Borax. The crop was harvested after 118 days and the stalk yield was 23 t/ha.

2.2 Site of study

The experiment was carried out at the College of Veterinary Science, S. V. Veterinary University, Rajendranagar, Hyderabad (17^0 12′ N, 78^0 18′ E, 545 m above sea level) in India. The ambient temperature and relative humidity values during the period of study were in the range of 28- 42^0 C and 28-32%, respectively.

2.3 Experimental diets

The SSB was incorporated in complete diets with roughage to concentrate ratio of 50:50 and were processed into mash (SSBM) and expander extruder pellets (SSBP) and chaffed SSB (SSBC) form. A sorghum stover based complete diet (SSM) with roughage to concentrate ratio of 50:50, processed into mash form as a control diet since sorghum stover is the commonly available crop residue for feeding of ruminants in Deccan plateau of India. The ingredient composition of complete diets is presented in Table 1.

2.3.1 *Chopping*

The SSB was chopped to 1.5-2.0 cm size using the chaff-cutter and mixed with concentrate maintaining roughage to concentrate ratio of 50:50.

2.3.2 *Mash preparation*

The SSB and concentrate ingredients required for grinding were ground in a hammer mill using 8 mm sieve after proportioning experimental diets in 100 kg batches as per formula with roughage to concentrate ratio of 50:50. The ground material was conveyed from hammer mill through screw conveyer to bucket elevator, which in turn elevated the material and conveyed into the horizontal mixer. Mineral mixture and vitamin supplement were prepared into a premix by diluting with de oiled rice bran and added into horizontal mixer directly in required quantity. Molasses was heated to 70^{o}C in the preheating chamber and added into the mixer directly while mixing. The diet was mixed for 10 minutes and collected into gunny bags. Similarly mash of sorghum stover based diet was prepared with roughage to concentrate ratio of 50:50 as control diet.

2.3.3 *Expander extruder processing*

Expander- extruder is a system which combines the features of expanding (application of moisture, pressure and temperature to gelatinize the starch portion) and extruding (pressing the feed through constrictions under pressure). The SSB mash with 12-13% moisture at room temperature was reconstituted with required quantity of water to get 17-18% moisture into the mixer itself and then sent to the hopper above the expander-extruder from which it passed through screw in barrel and attains 90-95^{0}C by the time it comes out of the die openings with a diameter of 16 mm. The pellets coming out of the expander-extruder were cooled and collected into bags.

2.4 *Experimental animals and feeding*

Twenty four growing Nellore x Deccani ram lambs with average body weight (BW) 21.1±0.57 kg and aged 9 months were randomly distributed into four groups of six animals each in a Completely Randomized Design (CRD). All animals were kept in well ventilated pens (4m x 3m). Hygienic conditions were maintained in the pens by regular cleaning. All the lambs were dewormed and vaccinated against Peste des Petits Ruminants (PPR) before the initiation of the experiment. Respective diets were offered to the animals twice daily at 9.00 and 15.00 h. Animals were offered weighed quantities of respective complete diets *ad libitum* during the experiment. Clean drinking water was made available for the lambs throughout the experimental period.

2.5 *Metabolism study*

A metabolism study was conducted using Nellore x Deccani ram lambs to assess the nutrient utilization and energy, nitrogen (N), calcium (Ca) and phosphorus (P) balance of processed experimental complete diets. Animals were kept in hygienic, well ventilated individual metabolism cages where feces and urine were separately collected. Animals had free access to water throughout the experiment. Prior to collection period, experimental lambs were acclimatized to metabolic cages for 5d following preliminary period of 10 d.

During the collection period of 7 d, daily feed offered, leftover as well as feces and urine voided were recorded. 24 h collection of feces was made using fecal bags harnessed to the ram lambs. The daily urine out put of each lamb was measured by collecting urine in glass bottles kept at the bottom of the metabolic cages, which were added with 50 ml of 5% sulphuric acid daily to avoid nitrogen loss. Representative samples of each feed offered, residues and feces were collected for 7 d and composited. After estimation of dry matter (DM), the samples of all the experimental feeds, residues and feces were ground separately in a laboratory Wiley mill through 1 mm screen and preserved in air tight bottles for subsequent analysis. For balance studies, 5% total urine voided daily by individual animal, after thorough mixing, was composited and preserved in glass bottles and kept in refrigerator till analyzed for nitrogen, energy, calcium and phosphorus content.

2.6 *Microbial N flow*

The daily intestinal flow of microbial nitrogen (g/d) from total urinary purine derivatives (PD) (mmol/d) was calculated (IAEA-TECDOC-945, 1997) using the PD work software of IAEA (2001). The equation used to relate absorption of microbial purines (X, mmol/l) and excretion of purine derivatives in urine (mmol/l) was $Y = 0.84 + (0.150W^{0.75} e^{-0.25X})$. The calculation of X from Y was performed by Newton- Raphton iteration process.

2.7 *Chemical analysis*

Feed, feces and urine samples were analyzed for nitrogen using ‘Terbotherm’ and ‘Vapodest’ (Gerhardt "Königswinter," Germany) based on the micro-Kjeldhal method (AOAC, 1997; procedure no. 4.2.02). DM, total ash (TA) and ether extract (EE) were determined according to procedures (nos. 4.1.03, 4.1.10 and 4.5.01, respectively) described by AOAC (1997). Cell wall constituents in feeds, feces and residues were performed as per the method described by Van Soest and Robinson (1985). The neutral detergent fibre (NDF) was estimated using sodium sulfite and the NDF and acid detergent fibre (ADF) fractions include residual ash. Calcium (Ca) was estimated as per the method described by Talapatra et al. (1940). Phosphorus (P) was determined colorimetrically as per the method of Ward and Johnston (1962). The metabolizable energy (ME) of the diets was estimated from gross energy (GE). The GE of feed, feed residues, feces and urine was measured as per the procedure described in the manual of Gallenkamp Automatic Ballistic Bomb Calorimeter. Methane was estimated as 4.5 per cent of GE intake in growing sheep (Ulyatt et al., 2005; IPCC, 2006).

2.8 *Statistical analysis*

Statistical analysis of the data was carried out according to the procedures suggested by Snedecor and Cochran (1994). Least-square Analysis of variance was used to test the significance of various treatments and the difference between treatments means was tested for significance by Duncan's new multiple range and F Test (Duncan, 1955).

3 Results

3.1 *Chemical composition*

The chemical composition and energy value of all the experimental complete diets was similar (Table 2). CP, NDF and ADF content of the diets ranged from 11.2-11.7, 52.0-52.6 and 29.5-31.1%, respectively.

3.2 *Voluntary feed intake*

Dry matter intake (DMI) in lambs fed experimental diets was ranged from 83.6 to 92.6 g/kg $w^{0.75}$ and significantly ($P<0.01$) different among the experimental lambs (Table 3). Lambs fed SSBP diet had higher DMI than SSBC, SSBM and SSM diets by 27, 14 and 21%, respectively.

3.3 *Nutrient digestibility and nutritive value*

The DM, organic matter (OM) and crude protein (CP) digestibility was higher ($P<0.01$) in lambs fed SSBP diet (Table 3). The OM and CP digestibility of SSBM was higher ($P<0.01$) than SSBC diet whereas, their digestibility was similar to that of sorghum stover based diet. The cellulose digestibility of SSBP diet was higher ($P<0.05$) than the SSBC and SSM diets. The digestible crude protein (DCP) value of SSBP diet was higher ($P<0.01$) than the other three diets. Digestible energy (DE) and ME values were higher ($P<0.01$) for SSBP diet than SSBC and SSM diets (Table 3). Further it was observed that SSBC has lower (P<0.01) DCP value than SSBM and SSM diets. The average daily intake of DCP in lambs fed SSBP was higher (P<0.01) than those fed the other three diets. The DCP and energy intake of lambs fed SSBP diet was higher than the requirements of lambs weighing 25 kg with average daily gain of 100 g as stipulated by ICAR (1998).

3.4 *Energy digestibility*

The gross energy intake (GEI) and digestible energy intake (DEI) was higher (P<0.01) in lambs fed SSBP diets (Table 4). Higher (P<0.01) ME intake was also observed in lambs fed SSBP diet than the other diets.

3.5 *Nitrogen balance*

The nitrogen balance (g/d) was higher (P<0.05) in lambs fed SSBP diet and it was comparable among the lambs fed the other three diets (Table 5).

3.6 *Microbial N flow*

Compared to SSBC diet, increased (P<0.01) excretion of allantoin, uric acid, purine derivatives and PD absorbed was due to processing giving the SSBP diet higher value, followed by SSBM and SSM diets (Table 6). Estimated microbial N was higher (P<0.01) with processed diets compared to SSBC, the highest being with SSBP followed by SSBM and SSM diets (Table 6). In fact, the expander extrusion increased the microbial N by 85.0% over SSBC diet with DOMI of 587.1 g/d. Expander extrusion of the complete diet resulted in improved (P<0.01) efficiency of microbial protein synthesis. The microbial CP (g) per MJ of ME fermented in the rumen of the SSBP diet had met the proposed mean values (AFRC, 1993) of 9 and 10 g of microbial CP per MJ of ME fermented in the rumen for sheep at maintenance and growth, respectively (Table 6).

4 Discussion

The higher DMI of SSBP may be attributed to the increased palatability and acceptability of the pelleted diet. The lower feed intake of SSBC diet may be attributed to the poor palatability of chaffed SSB and there was possibility for the animals to make a choice between roughage and concentrate (Ibrahim et al., 1998; Rekhate et al., 2007). Thirumalesh et al. (2003) and Dhuria and Sharma (2010) reported similar findings in sheep on bajra straw based diet. The improved DM and OM digestibilities of pelleted diet might be due to that heat processing causes gelatinization of starch and exposes the highly crystalline or physically inaccessible starches, entrapped in a cellular matrix to enzymatic/microbial digestion (Svihus et al., 2005). It would seem that the use of shear force by an expander would allow increased nutrients to be accessible which were previously bound within cellular material. In addition, during the extrusion process fibre content and composition in high fibre formulations, soluble fibre increases by approximately 3% and carbohydrate content increases by 4-5%.

The Higher CP digestibility in lambs fed processed diets than those fed SSBC diet might attributed to better matching of energy and N and also owing to reduced particle size which can escape the ruminal degradation for better utilization at intestinal level. The lowering of protein degradability was also due to formation of cross linkages between and among peptide chains and with carbohydrates hence, exposed the protein for better utilization at intestinal level due to phenomenon of protected protein (Theurer et al., 1999) thereby accounting for higher CP digestibility at intestinal level (Goelema et al., 1999). Such beneficial effects of expander extrusion processing of complete diet were reported by many workers in sheep (Thirumalesh et al., 2003; Reddy et al., 2005b; Madhavi et al., 2009; Nagalakshmi and Narsimha Reddy, 2012).

Pelleted diets showed higher digestibility of cellulose due to processing, which could alter the cellulose from a crystalline structure to amorphous state and also long pressure leaving segments more vulnerable for bacterial action (Jahn and Kamstra, 1960). Extrusion cooking does not lead to a change in total content of dietary fiber but to a redistribution of insoluble to more soluble fractions. There was matching supply of the energy and nitrogen to rumen microbes on this diet. All these factors might have contributed to the higher cellulose digestibility of SSBP. This finding concurs with observations by Reddy et al. (2005b), who reported increased cellulose digestibility on pelleted diet containing bajra straw in Nellore rams.

The higher DCP, DE and ME content of SSBP diet might be due to higher CP, OM and energy digestibilities (Madhavi et al., 2009). The higher DCP intake of lambs fed SSBP diet might be a reflection of higher DMI than the other three diets. The higher digestibility of nutrients of SSBP diet might have resulted in higher energy digestibility in comparison to other diets. Owing to higher energy digestibility, resulted in higher DE intake in lambs fed SSBP diet. Similar results were reported in Nellore ram lambs fed bajra straw based diets (Thirumalesh et al., 2003; Madhavi et al., 2009).

The higher DMI also resulted in higher intake of N in lambs fed SSBP diet. Similar fecal and urinary losses among all the lambs resulted in higher N retention in lambs fed SSBP diet. The higher retention of N might have attributed to higher digestibility of CP and higher intake of ME on SSBP diet and also due to improved utilization of absorbed nitrogen by matching supply of energy in the form of fermentable carbohydrates arising from expander extruder pelletization. A linear increase in N retention as the ME intake increased with a corresponding decrease in urinary loss was observed (Thirumalesh et al., 2003; Reddy et al., 2005b; Nagalakshmi and Narsimha Reddy, 2012).

The daily output of allantoin and uric acid showed a positive response to the level of DOMI. Allantoin was found to be the principal PD in urine of lambs fed straw based diets. The PD excretion seemed to depend not only on DOMI ($P<0.01$) (Table 6) but also on N intake ($P<0.01$) (Table 5). As indicated in other studies (Flachowsky et al. 2006; Ramos et al. 2009), total urinary PD responded strongly to increased digestible OM intake. Similarly, the daily excretion of PD linearly correlated with the digestible organic matter intake (Kim Thang et al., 2004; Seresinhe and Pathirana, 2008). Expander extrusion resulted in the greatest allantoin excretion and allantoin absorption suggesting that any increase in microbial N synthesis was related to increase in diet digestion. Microbial N increased almost linearly with DOMI and N intake. Feeding of expander extruded pellets could enhance the DOMI which increased the level of microbial N. The improved efficiency of the microbial protein synthesis of SSBP fed lambs might be due to matching supply of energy and nitrogen to the microbes. Most of the values obtained were below the mean value (32 g N/kg of RDOM) established by the ARC (1984) for sheep fed different diets since the diets were crop residue based diets.

5 Conclusion

In this study, lambs fed expander extruded SSB based complete diet had shown significant improvement in nutrient intake, utilization, balance and efficiency of microbial protein synthesis over chopped and mash form of complete diets. It can be concluded that, the additional cost of expander extruding processing can be overcome by efficient digestibility and utilization of nutrients. Further, lambs fed SSB based complete diet in mash form had shown almost similar nutrient intake, utilization, balance and efficiency of microbial protein synthesis as that of sorghum stover based complete mash diet indicating that sweet sorghum bagasse can effectively replace the traditional sorghum stover in the diets of ruminants in arid and semi arid tropics.

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Table 1
Ingredient composition (g/kg) of experimental diets

Ingredient	Diet[a]			
	SSM	SSBC	SSBM	SSBP
Sorghum stover	500	-	-	-
SSB	-	500	500	500
Maize	155.0	155.0	155.0	155.0
Groundnut cake	82.5	82.5	82.5	82.5
Sunflower cake	100.0	100.0	100.0	100.0
Deoiled rice bran	115.0	115.0	115.0	115.0
Molasses	25.0	25.0	25.0	25.0
Urea	7.5	7.5	7.5	7.5
Mineral mixture	10.0	10.0	10.0	10.0
Salt	5.0	5.0	5.0	5.0

Vitamin A, D_3 supplement was added @ 0.1g/ kg complete diet.
[a] roughage to concentrate ratio of 50:50
SSM- Sorghum stover based complete diet in mash form
SSBC- Chopped sweet sorghum bagasse+ concentrate mixture
SSBM- Sweet sorghum bagasse based complete diet in mash form
SSBP- Sweet sorghum bagasse based complete diet in expander extruder pallet form

Table 2
Chemical composition (weight %) of experimental diets[a]

Nutrient	Diet			
	SSM	SSBC	SSBM	SSBP
Proximate principles				
Dry matter	91.5	91.9	92.2	94.1
Organic matter	90.3	90.3	90.2	90.3
Crude protein	11.2	11.6	11.7	11.7
Ether extract	1.3	2.0	2.0	2.0
Crude fibre	27.4	26.9	27.1	27.
Nitrogen free extract	50.4	49.9	49.5	49.6
Total ash	9.7	9.7	9.8	9.7
Cell wall constituents				
Neutral detergent fibre	52.5	52.0	52.6	52.5
Acid detergent fibre	31.1	29.5	30.2	29.7
Cellulose	21.5	23.3	23.7	23.4
Acid detergent lignin	4.2	3.4	3.9	3.8
Minerals				
Calcium	1.06	1.06	1.12	1.12
Phosphorus	0.48	0.59	0.56	0.55
Energy				
Gross energy (MJ/kg)	18.4	18.4	18.5	18.6

[a]On DM basis except for DM
SSM- Sorghum stover based complete diet in mash form
SSBC- Chopped sweet sorghum bagasse+ concentrate mixture
SSBM- Sweet sorghum bagasse based complete diet in mash form
SSBP- Sweet sorghum bagasse based complete diet in expander extruder pallet form

Table 3
Effect of feeding differently processed SSB based complete diets on DMI, nutrient digestibility and nutritive value in growing Nellore x Deccani ram lambs

Nutrient	**Diet**				**SEM**
	SSM	**SSBC**	**SSBM**	**SSBP**	
Body wt. (kg)	20.08	19.51	21.10	23.5	0.57
DMI (g/kg $w^{0.75}$)**	86.22^{b}	83.59^{b}	87.64^{b}	92.61^{a}	1.04
Digestibility (%)					
DM**	60.92^{b}	59.50^{b}	61.10^{b}	64.01^{a}	0.54
OM**	63.21^{b}	61.07^{c}	63.40^{b}	65.85^{a}	0.53
CP**	62.79^{b}	56.21^{c}	62.85^{b}	68.04^{a}	1.21
NDF	59.61	57.05	60.48	63.30	0.88
ADF	53.80	51.04	54.11	56.13	0.93
Cellulose*	44.44^{bc}	41.11^{c}	49.01^{ab}	52.13^{a}	1.45
Nutritive value					
DCP (g/kg DM)**	70.3^{b}	64.9^{c}	73.3^{b}	79.8^{a}	1.5
DE (MJ/kg DM)**	11.42^{bc}	11.06^{c}	11.67^{ab}	12.09^{a}	0.11
ME (MJ/kg DM)**	9.25^{b}	8.76^{b}	9.55^{ab}	10.36^{a}	0.20

$^{a, b, c}$values bearing different superscripts in a row differ significantly (**$P<0.01$; *$P<0.05$)
SSM- Sorghum stover based complete diet in mash form
SSBC- Chopped sweet sorghum bagasse+ concentrate mixture
SSBM- Sweet sorghum bagasse based complete diet in mash form
SSBP- Sweet sorghum bagasse based complete diet in expander extruder pallet form

Table 4
Energy balance in growing Nellore x Deccani ram lambs fed differently processed SSB based complete diets

Parameter	Diet				SEM
	SSM	SSBC	SSBM	SSBP	
Gross energy intake (MJ/d)	15.07^{b}	14.24^{b}	15.98^{b}	18.34^{a}	0.48
Digestible energy intake (MJ/d)	9.33^{bc}	8.57^{c}	10.06^{b}	11.94^{a}	0.36
Gross energy digestibility (%)	61.97^{bc}	60.22^{c}	63.06^{ab}	65.08^{a}	0.57
Metabolizable energy intake (MJ/d)	7.54^{bc}	6.79^{c}	8.22^{b}	10.24^{a}	0.36

$^{a, b, c}$values bearing different superscripts in a row differ significantly ($P<0.01$)
SSM- Sorghum stover based complete diet in mash form
SSBC- Chopped sweet sorghum bagasse+ concentrate mixture
SSBM- Sweet sorghum bagasse based complete diet in mash form
SSBP- Sweet sorghum bagasse based complete diet in expander extruder pallet form

Table 5

Effect of feeding differently processed SSB based complete diets on nitrogen balance in growing Nellore x Deccani ram lambs

Parameter	Diet				SEM
	SSM	SSBC	SSBM	SSBP	
N intake (g/d)**	14.65^{b}	14.32^{b}	16.10^{b}	18.54^{a}	0.51
Faecal N (g/d)	5.46	6.27	5.97	5.92	0.14
Urinary N (g/d)	3.02	2.54	3.49	3.96	0.31
N balance (g/d)*	6.18^{b}	5.51^{b}	6.65^{b}	8.67^{a}	0.40

$^{a, b, c}$values bearing different superscripts in a row differ significantly (**P<0.01; *P<0.05)
SSM- Sorghum stover based complete diet in mash form
SSBC- Chopped sweet sorghum bagasse+ concentrate mixture
SSBM- Sweet sorghum bagasse based complete diet in mash form
SSBP- Sweet sorghum bagasse based complete diet in expander extruder pallet form

Table 6

Effect of feeding differently processed SSB based complete diets on daily urinary purine derivatives excretion and microbial N flow in Nellore x Deccani ram lambs

Parameter	Diet				
	SSM	SSBC	SSBM	SSBP	SEM
DOMI (g/d)**	466.53^{bc}	427.43^{c}	493.55^{b}	587.09^{a}	17.22
PD excreted in urine(mmol/d)					
Allantoin**	9.30^{c}	8.29^{d}	9.84b	14.66a	0.64
Uric acid**	1.52^{c}	1.20^{d}	1.80b	2.80^{a}	0.16
Xanthine and hypoxanthine**	0.32^{a}	0.16^{c}	0.33^{a}	0.25^{b}	0.02
Total PD excreted in urine					
mmol/d**	13.21^{c}	11.39^{d}	14.20^{b}	17.71^{a}	0.61
µmol/kg of B.W $^{0.75}$**	1392.64^{c}	1227.86^{d}	1450.38^{b}	1663.25^{a}	43.18
PD absorbed (mmol/d)**	12.75^{b}	11.23^{c}	13.10^{b}	21.07^{a}	0.99
Microbial N supply (g/d)**	9.60^{c}	8.28^{d}	10.32^{b}	15.32^{a}	0.69
Microbial N supply (g/ kg DOM)**	20.57^{b}	19.41^{b}	21.09^{b}	26.15^{a}	0.74
Microbial CP (g) per MJ of ME*	7.98^{b}	7.70^{b}	7.89^{b}	9.38^{a}	0.25

$^{a, b, c}$values bearing different superscripts in a row differ significantly (**P<0.01; *P<0.05)
SSM- Sorghum stover based complete diet in mash form
SSBC- Chopped sweet sorghum bagasse+ concentrate mixture
SSBM- Sweet sorghum bagasse based complete diet in mash form
SSBP- Sweet sorghum bagasse based complete diet in expander extruder pallet form