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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 × Deccani ram lambs (9 months 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.

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

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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 t fresh stalk/ha with 60% extractability would yield about 6–7.5 t/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 1 m. Seed rate was 7–8 kg/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 d 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°12′ N, 78°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° 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.

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 at 0.1 g/kg complete diet.
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 pellet form.
[a] Roughage to concentrate ratio of 50:50.

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 °C in the preheating chamber and added into the mixer directly while mixing. The diet was mixed for 10 min 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 °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 × 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 (4 m × 3 m). 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.