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Original Article

Effect of Feeding Processed Sweet Sorghum (*Sorghum bicolour* (L.) moench) Bagasse based Total Mixed Ration on Growth and Chewing Behaviour in Graded Murrah Buffalo Calves

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Abstract

Sweet sorghum bagasse (SSB), a by-product obtained after juice extraction from the stalks of sweet sorghum (*Sorghum bicolour* (L.) moench) emerging as the new roughage source for ruminants in India. The effect of feeding differently processed SSB based total mixed ration (TMR) on growth and chewing behaviour were studied in 24 graded Murrah buffalo calves distributed randomly into four experimental groups of six animals each in a completely randomized design. Experimental TMR were formulated with SSB and concentrate in 50:50 ratio and processed in to chopped SSB and concentrate (SSBC), mash (SSBM) and expander-extruder pellets (SSBP) and compared with sorghum straw (SS) based TMR formulated in the same roughage to concentrate ratio and processed in to mash form (SSM). Eating, rumination and total chewing time (min/d, min/kg DMI and min/kg NDFI) and number of chews for eating, rumination and total chewing (per d, per kg DMI and per kg NDFI) were higher ($P<0.01$) in calves fed SSBC ration and lower ($P<0.01$) in SSBP ration and comparable among SSBM and SSM rations. Sorting and selection of ration against large fibrous particles in favour of concentrate portion of the ration was observed in SSBC ration and was not observed in SSBP, SSBM and SSM rations. Higher ($P<0.01$) average daily gain (g), lower feed conversion ratio (FCR) and lower ($P<0.05$) cost of feeding per kg gain were observed in calves fed SSBP ration, while comparable among SSBC, SSBM and SSM rations. From the results it was inferred that SSBP ration decreased the chewing time by 22 and 16 per cent respectively compared to SSBC and SSBM or SSM rations and sorting behaviour in calves was prevented in SSBP, SSBM and SSM rations compared to SSBC ration. SSBP ration also increased the feed intake and growth rate and decreased the cost/kg weight gain by 16, 14 and 30 per cent in buffalo calves compared to feeding of SSBC, SSBM and SSM rations, respectively.

Key words: Sweet sorghum bagasse, total mixedration, buffalo calves, growth, chewing behavior

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Abbreviations

SSB	Sweet sorghum bagasse
SS	Sorghum straw
SSBC	Sweet sorghum bagasses chopped plus concentrate
	SSBMSweet sorghum bagasse based mash
SSBP	Sweet sorghum bagasse based pellets
SSM	Sorghum straw based mash
TMR	Total mixed ration
DMI	Dry matter intake
NDFI	Neutral detergent fibre intake
FCR	Feed conversion ratio
Rs	Indian Rupees

Introduction

Sweet sorghum bagasse (SSB), a by-product obtained after juice extraction from the stalks of sweet sorghum (*Sorghum bicolour* (L.) moench) emerging as the new roughage source for ruminants in India. The bagasses provide a valuable feed resource that will potentially add considerable value to the sweet sorghum bio-fuel value chain (Blümmel et al. 2009). However, the dried sweet sorghum bagasse (SSB) is hard to chew, poor in palatability resulting low intake. Feeding of crop residues and industrial by-products in the form of total mixed rations improves palatability and utilization of nutrients (Kundu at al. 2005). Further, various processing methods like grinding and expansion-extrusion processing total mixed ration improved the dry matter intake and digestibility of nutrients in buffaloes (Nagalakshmi et al. 2004). However, low- quality roughages require more energy for chewing which reduces the amount of ME available for production, resulting poor growth and less milk production of ruminants in tropical countries like India (Raghavendra Bhatta et al. 2006). This fact might be mainly responsible for less efficient utilization of ME in roughages than in other feedstuffs (Ørskov and Macleod, 1990). Although some chewing and rumination is essentially required to reducing the particle size and proper mixing of the saliva with the feed particles, excessive chewing and rumination needs extra energy expenditure, resulting in wastage of biological energy. Studies on the relationship between chewing and feed characteristics can be used for increased animal productivity (Forbes, 2007). Sorting behaviour of the cattle resulted a balanced total mixed ration became imbalanced ration which further effects animal productivity.

Therefore, main objective of the present study is to find out the effect of feeding differently processed SSB based TMR on chewing and sorting behaviour in graded Murrah buffalo calves and also comparing the effect of feeding SSB based TMR with conventional sorghum straw based TMR on growth rate in buffalo calves.

Materials and Methods

Required quantity of SSB was procured from the decentralized sweet sorghum crushing unit, established by ICRISAT at Ibrahimbad village of Medak District of Andhra Pradesh. Experimental TMR were formulated with SSB and concentrate in 50:50 ratio and processed in to chopped SSB and concentrate (SSBC), mash (SSBM) and expander-extruder pellets (SSBP). The control diet was SS based TMR formulated in the same roughage to concentrate ratio and processed in to mash form (SSM).

Twenty four graded Murrah buffalo calves with uniform body weight (137 kg) and age (1year 2 months) were distributed randomly into four experimental groups of six animals each in a completely randomized design. The TMR offered to four groups of buffalo calves randomly for a period of 150 days. Fresh drinking water was made available throughout the experimental period. The animals were weighed fortnightly for 3 consecutive days before offering feed and water in the morning.

Eating and ruminating behaviours were monitored visually for a 24 h period in shifts of 8 hours during the last 3 days of the growth trial. Eating and ruminating activities were noted every 5 min, and each activity was assumed to persist for the entire 5 min. To estimate the time spent for eating, ruminating and total chewing per kg dry matter intake (DMI) and neutral detergent fibre intake (NDFI), the actual intake for that day was used. A period of rumination was defined as at least 5 min of rumination occurring after at least 5 min without rumination activity. Total chewing time was determined as the sum of total eating and ruminating times. The number of chews per day

was calculated by the following formulas (Allen 1997). Eating chews (number day) = -5854 + 84.75 X eating time (min/d). Ruminating chews (number per day) = -81 + 71.29 X ruminating time (min/d).

Table 1: Ingredient composition (%) of experimental TMR

Ingredient	SSM	SSBC	SSBM	SSBP
Maize	31.0	31.0	31.0	31.0
Ground nut cake	16.5	16.5	16.5	16.5
Sunflower cake	20.0	20.0	20.0	20.0
Deoiled rice bran	23.0	23.0	23.0	23.0
Molasses	5.0	5.0	5.0	5.0
Urea	1.5	1.5	1.5	1.5
Mineral mixture	2.0	2.0	2.0	2.0
Salt	1.0	1.0	1.0	1.0
Sweet sorghum bagasse	-	50.00	50.00	50.00
Jowar straw	50.00	-	-	-
ANF (Vitamin A supplement)	200g	200g	200g	200g

Total chews (number per d) = -12390 + 80.59 X total chewing time (min/d). Sorting behaviour of the calves observed physically during feeding time of the growth trial. Statistical analysis of the data was carried out according to the procedures suggested (Snedecor and Cochran, 1994). The costs of the rations were calculated on the basis of processing cost and the prevailing market prices of the feed ingredients.

Results and Discussion

Eating, rumination and total chewing time (min/d, min/kg DMI and min/kg NDFI) and number of chews for eating, rumination and total chewing (per d, per kg DMI and per kg NDFI) were higher ($P<0.01$) in buffalo calves fed SSBC ration and lower ($P<0.01$) in calves fed SSBP ration and comparable among SSBM and SSM rations (Table 2). Significantly higher ($P<0.01$) eating time and more number of chews for eating, rumination and total chewing in calves fed SSBC ration might be due larger particle size and less dense nature of the ration compared to SSBP, SSBM and SSM rations. Lower eating and chewing time in buffalo calves fed SSBP ration might be due to easier consumption of the pellets (Islam *et al.,* 2000) resulting on higher intakes (McDonald *et al.,* 2002). Provenza and Villalba (2006) found that grinding and chopping can reduce time spent for chewing radically, as well as increase intake. The rumination time per unit DM intake decreased with decreasing dietary particle size (Beauchemin *et al.* 2003). With decreasing quality of roughages, energy requirement for eating and ruminating can increase from 10 percent to approximately 30 percent of the ME provided by the feedstuff and the energy requirement for this activity should be taken as an important criterion among others for evaluating methods for improving roughage quality (Raghavendra Bhatta et al. 2006). Feeding SSBP ration decreased the total chewing time by 22 and 16 per cent compared to SSBC and SSBM/SSM rations, respectively.

Sorting and selection of ration against larger particles of SSB in favour of smaller particles and concentrate portion of the ration was observed in buffalo calves fed SSBC ration compared to SSBP, SSBM and SSM rations. However, sorting was not observed in SSBP, SSBM and SSM rations. Selective behaviour is often related to particle size of forage as cattle usually select in favour of smaller particles and select for maximum bite weight, together with maximum intake rate (Cozzi et al. (2009). Similar findings were reported by Greter *et al.* (2008) in HF heifers. Sorting of the TMR can be prevented by pelleting and grinding of the feed reported by Van Soest and Robertson, (1994) corroborating the present findings.

Table 2: Effect of feeding processed SSB based TMR on chewing behaviour in graded Murrah buffalo calves

Parameter	Ration				SEM
	SSM	SSBC	SSBM	SSBP	
Eating					
Min/d	237.00^{b}	256.80^{a}	236.30^{b}	196.00^{c}	231.50±5.72
Min/kg DMI	51.97^{b}	57.37^{a}	51.30^{b}	41.67^{c}	50.57±1.54
Min/Kg NDFI	96.61^{b}	108.98^{a}	92.01^{b}	79.11^{c}	94.17±2.90
No. of chews/d	9892.55^{b}	12274.03^{a}	9799.33^{b}	7316.15^{c}	9820.51±454.02
Chews/kg DMI	2168.60^{b}	2743.84^{a}	2127.86^{b}	1555.82^{c}	2149.03±111.05
Chews/kg NDFI	4031.60^{b}	5212.47^{a}	3816.11^{b}	2953.34^{c}	4003.38±212.82
Ruminating					
Min/d	480.50^{b}	514.00^{a}	481.50^{b}	401.50^{c}	469.38±10.77
Min/kg DMI	105.36^{b}	114.87^{a}	104.56^{b}	85.39^{c}	102.54±2.96
Min/Kg NDFI	195.88^{b}	218.23^{a}	187.51^{b}	162.09^{c}	190.92±5.56
No. of chews/d	22520.50^{b}	26256.10^{a}	22327.90^{b}	18332.20^{c}	22359.18±724.62
Chews/kg DMI	4938.09^{b}	5867.74^{a}	4847.90^{b}	3897.55^{c}	4887.82±186.07
Chews/kg NDFI	9180.32^{b}	11146.93^{a}	8694.23^{b}	7398.53^{c}	9105.00±358.65
Total chewing					
Min/d	717.50^{b}	770.80^{a}	717.80^{b}	597.50^{c}	700.86±16.45
Min/kg DMI	157.33^{b}	172.24^{a}	155.86^{b}	127.06^{c}	153.12±4.49
Min/Kg NDFI	292.49^{b}	327.21^{a}	279.52^{b}	241.19^{c}	285.10±8.44
No. of chews/d	32413.03^{b}	38600.02^{a}	32127.32^{b}	25648.34^{c}	32197.17±1183.29

Each value is the average of six observations

^{abc}values bearing different superscripts in a row differ significantly (P<0.01)

Growth Rate and Cost Economics

The higher (P<0.05) feed intake and higher (P<0.01) average daily gain (g) in buffalo calves fed SSBP ration (Table 3) might be due to easier consumption of pelleted ration and efficient digestibility of nutrients (Nagalakshmi et al. 2004) compared to chopped form of the ration. Even though the average daily feed intake (kg/d) among SSBM, SSBP and SSM rations were not significantly (P>0.05) different, higher (1.32%) daily feed intake (kg/d) in buffalo calves fed SSBP ration was observed compared to SSBM and SSM rations.

Table 3. Effect of feeding differently processed sweet sorghum bagasse based complete rations on growth rate, feed efficiency and cost economics in graded Murrah buffalo calves

Parameter	SSM	SSBC	SSBM	SSBP	SE
Initial Weight (kg)	136.90	137.00	137.30	136.90	0.37
Final weight (kg) **	209.60^{b}	205.20^{b}	209.70^{b}	224.70^{a}	2.56
Weight gain (kg) **	72.70^{b}	68.20^{b}	72.40^{b}	87.80^{a}	2.05
Average daily gain (g/d)**	484.67^{b}	454.66^{b}	482.67^{b}	585.33^{a}	13.67
Feed intake (kg/d) *	4.50^{ab}	4.42^{b}	4.49^{ab}	4.56^{a}	0.02
Feed conversion Ratio (kg/kg gain)**	9.29^{b}	9.84^{b}	9.36^{b}	7.80^{a}	0.23
Cost/kg gain (Rs) **	74.55^{a}	63.22^{b}	61.07^{b}	52.44^{c}	4.55

Each value is the average of six observations

^{a,b}values bearing different superscripts in a row differ significantly

*P<0.05; **P<0.01

The FCR and cost per kg gain was lower (P<0.01) in buffalo calves fed SSBP ration compared to those fed SSBC, SSBM and SSM rations (Table 3). Feeding of SSB in the form of expander extruder pellets decreases the cost per kg weight gain in buffalo calves by 16, 14 and 30 per cent than feeding SSBC, SSBM and SSM rations, respectively. This might be due increased feed intake, reduced chewing behaviour (Provenza and Villalba, 2006) and efficient digestibility of protein and carbohydrates due to expander extruder processing (Solanas et al., 2007 and Reyes-Jaquez al., 2011) in buffalo calves fed SSBP ration than those fed SSBC, SSBM and SSM rations. Reddy et al. (2002) also reported the increased feed efficiency for the expander-extruder pelleted ration over mash and conventional ration in Ongole bull calves corroborating the present findings. Compared with the chopped and mash farms of SSB based TMR, cost/kg gain was reduced by 2 per cent in SSBM ration compared to SSM ration due to decreased chewing and sorting behaviour in calves fed TMR in mash form. Even though FCR was almost similar in buffalo calves fed either SSM or SSBM rations, the cost/kg gain was 18 per cent lower in buffalo calves fed SSBM ration than those fed SSM ration due to higher cost of sorghum straw (Rs 4) compared to SSB (Rs 1).

Conclusion

From the results it was concluded that expander extruder processing of the SSB based TMR decreased the chewing time by 22 and 16 per cent respectively compared to chop and mash form of the ration and mash and expander extruder processing of TMR prevented sorting behaviour compared to chopped form of the ration in buffalo calves. Expander extruder processing also increased the feed intake and growth rate and reduces the cost/kg weight gain by 16, 14 and 30 per cent in buffalo calves compared to feeding of SSBC, SSBM and SSM rations, respectively.

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