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Effect of Sheanut Cake Based Complete Diets on Eating and Rumination Behaviour in Murrah Buffalo Calves

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ABSTRACT

Two complete diets, processed into mash were formulated using palm press fibre (20% and 15%) and chopped jowar straw (20% and 25%) as roughage source and sheanut cake (18.5% and 28%) along with locally available concentrate ingredients with roughage concentrate ratio of 40:60 and processed into mash (R II and R III). These two diets were compared with conventional ration (R I) consisting of chopped jowar straw, green jowar fodder and concentrate mixture fed separately to study their effect on eating and rumination behaviour in Murrah buffalo calves. Twelve Murrah buffalo calves were randomly allotted to these three diets and fed for a period of 180 days. Statistical analysis of eating and rumination behaviour indicated that rumination time, percent of time spent for rumination and chewing time were significantly higher, whereas resting time and percent of time spent for resting was lower on conventional diet when compared with complete diets in growing buffalo calves.

Key words: Calves, Chewing, Palm press fibre, Rumination, Sheanut cake

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INTRODUCTION

According to the reports of ICAR (2013), India is in the net deficit of 28% green fodder, 23% dry crop residues and 65% compounded feeds. Such deficit can be minimized by using crop residues and agro-industrial by-products in preparation of complete diets of livestock (Nagalakshmi et al., 2010). The Sheanut cake and palm press fibre, the by-products of shea fat industry and palm oil industry could be utilized as concentrate ingredients as protein and roughage source, respectively. The production of Shea nut cake is approximately 18,000 tons per year from M/s. Foods, Fats and Fertilizers Pvt. Ltd. located in West Godavari District A.P. It is the only industry that is importing Sheanut cake in Andhra Pradesh. The present study made an attempt to utilize palm press fibre and sheanut cake at different levels along with other locally available concentrate ingredients in complete diets for Murrah buffalo calves to assess the effect of these complete diets on, eating and rumination behaviour of calves.

MATERIALS AND METHODS

Diet and animals

Two complete diets (roughage concentration ratio, 40:60) were formulated with Sheanut cake as concentrate ingredient and palm press fibre as roughage component being incorporated at 18.5% and 20.0% (R II) and 28.0% and 15.0% (R III) level. The other roughage used was chopped jowar straw. The complete diets (R II and R III) were compared with conventional ration (R I) consisting of chopped jowar straw, jowar green and concentrate mixture. The ingredient composition of concentrate mixture and complete diets has been shown in Table 1.

Table 1. Ingredients composition of experimental diets

Ingredient	Concentrate mixture	Complete diets	
	R I	RII	R III
Chopped jowar straw (kutti)	-	20.0	25.0
Palm press fibre	-	20.0	15.0
Maize grain	30.0	10.0	10.0
Deoiled rice bran	17.0	10.5	4.0
Wheat bran	20.0	9.00	5.0
Groundnut cake	15.0	9.00	10.0
Cottonseed cake	15.0	-	-
Sheanut cake	-	18.5	28.0
Common salt	1.00	1.00	1.00
Mineral mixture	2.00	2.00	2.00
Vitamin AD_3 (g/q)	20.0	10.0	10.0

Twelve graded murrah buffalo calves were distributed randomly into three groups of four animals each in a complete randomized design. The animals were housed in a well ventilated conventional stall barn maintained in hygienic conditions and stall fed with the respective diets throughout180 days of experimental period. In order to assess the effect of these complete diets on intake, eating behaviour and rumination of calves, a 7 day digestion trial was conducted at the end of the experiment. The complete diets were offered twice daily Ad lib. while in conventional group, the roughages and concentrates were offered separately to meet the maintenance and production requirements of calves (ICAR, 1998).

Monitoring eating and rumination

Eating time was defined as time spent for ingestion of feed with the help of lips, teeth and tongue into mouth. Time spent for regurgitation of the swallowed feed through chewing and finally swallowing was considered as the rumination time (Wilson and Brigstocke, 1981). A period of rumination was defined as at least 5 minutes of ruminating activity, followed by at least 5 minutes without ruminating activity. Total time spent for chewing was calculated as the total time spent for eating and ruminating. Total time spent for resting was calculated as total time monitored the animal for observing the behaviour minus time spent for chewing (Maekawa et al., 2002b). Eating and ruminating behaviour of all calves fed on three experimental rations (R I, R II and R III) was monitored visually for a period of 8 hours in a day (4h period immediately after each feeding). Eating and ruminating activities were noted every 5 minutes and each activity was assumed to persist for the entire 5 minutes interval. To estimate time spent for eating or ruminating per kilogram of DM intake, the average intake for the total time monitored the animal (8h) for observing the behaviour was used.

Statistical analysis of the data was carried out according to the procedures suggested by Snedecor and Cochran (1989) and the means were compared by Least Significant Difference (LSD) test.

RESULTS AND DISCUSSION

Diet composition and behavioural observation

The chemical composition of complete diets, concentrate mixture, Sheanut cake and Palm press fibre on DM basis is given in Table 2.

Table 2. Chemical composition of experimental rations (%DM) fed to calves

Nutrient	Ration II (Mash I)	Ration III (Mash II)	Concentrate mixture	Chopped jowar straw	Jowar green fodder	Sheanut cake	Palm press fiber
			Proximate principle				
Dry matter	89.2	89.4	93.6	91.8	24.9	93.2	89.2
Organic matter	92.7	93.4	91.3	88.2	91.7	92.1	90.7
Crude protein	12.1	12.3	17.9	3.46	7.18	13.2	8.28
Crude fibre	23.8	24.2	9.56	30.1	28.0	9.82	38.7
Ether extract	1.50	1.79	5.34	1.11	1.24	2.12	9.16
NFE	55.3	55.1	58.4	53.5	55.3	67.0	34.5
Total ash	7.22	6.52	8.68	11.7	8.26	7.81	9.24
			Cell wall constituent				
NDF	59.9	56.2	33.2	70.2	66.4	60.2	72.1
ADF	46.6	46.9	17.2	50.7	46.3	41.1	53.1
Hemicellulose	13.3	9.28	16.0	19.5	20.1	19.1	19.0
Cellulose	18.4	15.9	13.2	42.1	33.5	7.22	33.2
			Mineral				
Ca	0.96	1.12	1.08	0.64	0.74	1.16	0.62
P	0.68	0.72	0.82	0.38	0.18	0.22	0.21

Average CP and CF of complete diets was 12.2% and 24.0% respectively. The mean DMI values (Table 3) for experimental animals fed with rations I, II and III, were 1.70± 0.11, 1.66 ± 0.10 and 1.69± 0.03 kg respectively during 480 minutes of behavioural observation, Statistical analysis revealed no significant difference among the rations (Table 3).

Table 3. Eating and rumination behaviour in graded Murrah buffalo calves under different experimental rations

	DMI (Kg/8 hrs)	Eating time			Rumination time			Rumination period			Chewing time (Min.)	Resting time		
		Min.	% of time spent	Min./kg DMI	Min.	% of time spent	Min./kg DMI	No.	Length (Min.)	No. / kg DMI		Min.	% of time spent	Min./kg DMI
Ration I (Conventional ration)														
Mean	1.70	57.5	11.9	34.6	148.0^{b}	30.8^{b}	89.7	9.30	16.1	5.61	205.5^{b}	274.4^{a}	57.1^{a}	167.5
± SE	0.11	2.48	0.52	2.37	1.41	0.29	5.91	0.35	0.59	0.38	3.54	3.54	0.74	12.15
Ration II (Complete diet –Mash I)														
Mean	1.66	52.50	10.9	32.3	143.0^{a}	29.8^{a}	88.8	8.83	16.3	5.46	195.5^{a}	284.4^{b}	59.2b	178.2
± SE	0.10	0.92	0.19	1.75	0.79	0.17	6.56	0.26	0.39	0.36	1.42	1.42	0.30	15.48
Ration III (Complete diet -Mash II)														
Mean	1.69	55.9	11.6	33.1	147.7^{b}	30.7 ^{b}	88.0	8.67	17.1	5.15	203.6^{b}	276.4^{a}	57.5^{a}	165.1
± SE	0.03	1.11	0.23	0.76	0.57	0.12	1.52	0.24	0.47	0.15	1.54	1.54	0.32	3.01

Means with different superscripts in a column differ significantly (P<0.01)

The mean eating time was 57.5 ± 2.48, 52.5± 0.92 and 55.90 ± 1.11 minutes in buffalo calves fed with rations I, II and III respectively, during 480 minutes of behavioural observation (Table 3). The buffalo calves spent an average 11.9 ± 0.52, 10.9 ± 0.19 and 11.6 ? 0.23 percent of time towards eating the feed and the mean values for eating time per kg DMI was 34.6 ± 2.37, 32.3 ± 1.75 and 33.1 ± 0.76 minutes in groups I, II and III, respectively. Statistical analysis revealed non-significant differences in eating time, percent of time spent for eating and eating time per kg DMI among the experimental rations. The buffalo calves on R I, R II and R III spent an average 148.0 ± 1.41, 143.0 ± 0.79 and 147.7 ± 0.57 minutes and 30.8 ± 0.29, 29.8 ± 0.17 and 30.7 ? 0.12 percent of time spent towards rumination respectively. The mean values for rumination time per kg DMI were 89.7 ± 5.91, 88.8 ± 6.56 and 88.0 ± 1.52 minutes, in groups I, II and III respectively, (Table 3).

The mean values for number of rumination periods were 9.30 ± 0.35, 8.83 ± 0.26 and 8.67 ± 0.24 and the length of rumination was 16.1 ± 0.59, 16.3 ± 0.39 and 17.1 ± 0.47 minutes, for buffalo calves fed with rations I, II and III, respectively (Table 3). The number of rumination periods per kg DMI were 5.61 ± 0.38, 5.46 ± 0.36 and 5.15 ± 0.15 in buffalo calves fed rations I, II and III respectively. Statistically no significant differences found in the number of rumination periods, length of rumination and rumination periods per kg DMI among the experimental rations.

Chewing and resting observation

The three groups of buffalo calves spent on an average 205.5 ± 3.54, 195.5 ± 1.42 and 203.6 ± 1.54 minutes of time towards chewing, when fed with rations I, II and III, respectively (Table 3). Significantly less chewing time was observed in ration II when compared to ration I and ration III. Resting time was 274.4 ± 3.54, 284.4 ± 1.42 and 276.4 ± 1.54 minutes in buffalo calves fed with experimental rations I, II and III, respectively during 480 minutes of behavioural observation (Table 3). The buffalo calves spent an average 57.1 ± 0.74, 59.2 ± 0.30 and 57.5 ± 0.32 per cent of time towards resting and the mean values for resting time per kg DMI were 167.5 ± 12.10, 178.2 ± 15.4 and 165.1 ± 3.01 minutes in groups I, II and III, respectively.

Significantly lower resting time was observed with conventional ration than complete diets and significant differences were observed in per cent of time spent for resting and resting time minutes per kg DM intake among the experimental rations (Table 3). Eating and rumination behaviour of all buffalo calves fed on three experimental rations (R I, R II and R III) in the present study was monitored visually for a period of 8 hours (480 minutes) in a day (4-h period immediately after each feeding).

There was no significant difference in the DMI values among the experimental rations (R I, R II and R III) in calves (Table 3) during behavioural study period (8h). A non-significant difference in the DMI among the experimental rations was observed in buffalo calves during behavioral observation. Non-significant due to succulent green fodder offered to buffalo calves. Maekawa et al. (2002a,b) reported a non-significant difference in DMI of lactating Holstein cows fed on total mixed rations (TMR) containing 40:60, 50:50 and 60:40 forage to concentrate ratio. However, lower palatability due to higher lignin and fibre content in PPF based diets in buffalo calves were reported earlier by Syama Dayal (1997) and Sreedhar et al. (1997). Maekawa et al. (2002a,b) reported a non-significant difference in DMI of Holstein cows fed on total mixed rations (TMR) containing 40:60, 50:50 and 60:40 forage to concentrate ratio.

A non- significant difference in the DMI with R I and R II and R III was observed in buffalo calves (Table 3). This could be due to more roughage in addition to the large forage (green fodder) staple length in control ration and small particle size in complete diets resulted in smaller and larger meal size, respectively. Deswysen et al. (1987) reported that heifers with greater intake (faster and large meal size) spent lesser time on eating. Time spent on eating tends to increase with forage particle length (Santini et al., 1983). Increasing concentrate level in ration decreases eating time per kg DMI (Bines and Davey, 1970). Maekawa et al. (2002a,b) reported that eating time depends on the type of diet.

In the present study eating time was less with complete diets in mash form as compared to conventional diet in buffalo calves. Higher intake on complete diet mash could be due to smaller particle size and variation in ingredient and chemical composition and the feed was eaten faster thus resulting in larger meal. Putnam et al. (1966) observed higher feed intake as the feed particle size decreased. Higher DMI due to larger meal was also reported earlier by Metz (1975) and Vasilatos et al. (1980). Variation in DMI due to chemical composition and physical form of the diet was reported by Dado and Allen (1994). A non-significant difference in the DMI among the experimental rations was observed in buffalo calves during behavioral observation (Table 3). A non-significantly higher DMI on control ration in the present study contrary to buffaloes non-significant due to succulent green fodder offered to buffalo calves. Maekawa et al. (2002 a,b) reported a non-significant difference in DMI of Holstein cows fed on total mixed rations (TMR) containing 40:60, 50:50 and 60:40 forage to concentrate ratio. However, lower palatability due to higher lignin and fibre content in PPF based diets in buffalo calves were reported earlier by SyamaDayal (1997) and Sreedhar et al. (1997).

Eating time, per cent of time spent for eating and eating time per kg DMI was non- significant increase with R I and R II and R III was observed in buffalo calves (Table 3). This could be due to more roughage in addition to the large forage (green fodder) staple length in control ration (R I) and small particle size in complete diets (R II and R III) resulted in smaller and larger meal size, respectively. Deswysen et al. (1987) reported that heifers with greater intake (faster and large meal size) spent lesser time on eating. Time spent on eating tends to increase with forage particle length (Santini et al., 1983). Increasing concentrate level in ration decreases eating time per kg DMI (Bines and Davey, 1970). Maekawa et al. (2002 a,b) reported that eating time depends on the type of diet. In the present study eating time was less with complete diets in mash form as compared to conventional diet in both and buffalo calves. The rumination time, percent of time spent for rumination and rumination time per kg DMI were significantly higher on conventional ration (R I) than complete diets (R II and R III) in calves (Table 3). With regard to percent of time spent

for rumination and rumination time per kg DMI significantly higher in calves fed ration I than ration II and ration III which could be due to large staple length of forage and separate feeding of roughage and concentrates in R I. These results were in agreement with Maekawa et al. (2002a,b) who observed linear increase in rumination time with increasing proportion of silage as fibre in the TMR of Holstein cows. Rumination time further depends on the ease of comminuting fibrous particles and on the physical properties of the fibre like length (Santini et al., 1983; Woodford and Murphy, 1988), and specific fragility (Chai et al.,1988). Maekawa et al. (2002 a,b) reported that rumination time depends on the type of diet. The data of behavioural study indicated the difference in the type of diet with conventional as an important factor for higher rumination time, percent time spent on rumination and rumination time per kg DMI when compared with two complete diets which were in mash form.

Rumination periods, length of rumination period (min) and rumination periods per kg DMI showed non-significant differences in buffalo calves in all three experimental rations. The physical properties of fibre play a role in the separation and differential clearance of particles from the reticulorumen which affects rumination period (Sutherland, 1987). The more number of rumination periods, more length of rumination period and rumination periods per kg DMI with conventional ration in the present study might be attributed character and staple length of forage as compared to mash form of complete diets.

Significantly higher chewing time was observed on conventional ration (R I) than complete diets in buffalo calves. This could be due to higher level of succulent green fodder in the conventional ration, which resulted in higher eating, rumination and chewing time in order to increase DMI and to degrade fibre into smaller particles. Balch (1958) proposed to measure total chewing time per kg DMI as an indicator of the fibre content of feed. Further, Woodford et al. (1986), Lu (1987) and Woodford and Murphy (1988) have determined chewing activity on different feedstuffs and rations intending to develop a roughage value system. Coulon et al. (1987) concluded that cows increase their ingestion either by extending chewing time (during eating and/or ruminating) if the latter initially is short or by forcing up chewing rate when the corresponding duration is long. More chewing time with conventional ration in the present study compared to mash form of complete diets may be attributed to type and nature of diet. Significantly higher total resting time (min) and per cent of time spent for resting was observed on complete diets (R II and R III) than conventional ration (R I) in buffalo calves (Table 3). This could be due to lower eating, ruminating and chewing time on complete diets. Similar results were also observed by Maekawa et al. (2002 a,b) in multiparous and primiparous calves when fed one of four diets (three TMR containing 40, 50 or 60% silage and a separate ingredient diet containing 50% concentrate).

CONCLUSION

Eating and rumination behaviour indicated that rumination time, percent of time spent for rumination and chewing time were significantly higher, whereas resting time and percent of time spent for resting was lower on conventional diet when compared with complete diets in growing buffalo calves.

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