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Study of Feeding Palm Press Fibre and Sheanut Cake Based Complete Diets on Eating Behaviour and Rumination in Lactating Buffaloes

M. Kishan Kumar*

College of Fishery Science, P.V. Narsimha Rao Telangana Veterinary University, Pebbair, Wanaparthy Dist. Telangana State-509104, India

**Corresponding author*

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A B S T R A C T

Three experimental rations formulated in the study were conventional diet (RI), and two complete diets (RII and RIII). Two complete diets, processed into mash were formulated using palm press fibre (20% and 15%) (PPF) and Chopped Jowar straw (20% and 25%) as roughage source and sheanut cake (18.5% and 28%) (SNC) (R II and R III) along with locally available concentrate ingredients (roughage: concentrate ratio of 40:60) were compared with conventional ration (RI) (Chopped Jowar Straw, green Jowar fodder and concentrate mixture fed separately) to study the effect of these diets on intake, eating behaviour and rumination of Lactating Murrah buffaloes. Twelve Lactating Murrah buffaloes were randomly allotted to these three diets and fed for a period of 120 days. Feeding of PPF-SNC based complete diets significantly (P <0.01) higher eating time, percent of time spent for eating and eating time per kg DMI were observed on conventional ration (RI) than complete diets. Statistical analysis revealed significant (P <0.01) differences in the number of rumination periods, length of rumination and rumination periods per kg DMI among the experimental rations. Higher chewing time (P <0.01) was observed with conventional ration than complete diets. Lesser resting time (P <0.01) and percent of time spent for resting and lesser resting time per kg DMI was observed with conventional ration than complete diets. Eating and Rumination behaviour indicated that eating time, rumination time, rumination period and chewing time were significantly (P <0.01) higher, whereas resting time was lower on conventional ration (RI) when compared with complete diets (RII and RIII). The Present study indicated that incorporation of palm press fibre (15%) and sheanut cake (28%) in complete diet had no adverse effect on eating and rumination behavior of lactating buffaloes.

Introduction

In many developing countries like India, there is a need to utilize agro-industrial byproducts and crop residues to narrow down the existing gap between availability and requirement of feed stuffs for livestock. Our country presently faces a net deficit of 28% green fodder, 23.5% dry crop residues and 65% compounded feeds (ICAR, 2013). Utilization of crop residues and agro-industrial byproducts could be effectively used by incorporating them in complete diets (Nagalakshmi *et al.*, 2010). The sheanut cake (SNC) and palm press fibre (PPF), the byproducts of shea fat industry and palm oil industry, could be utilized as concentrate

ingredients as protein and roughage source, respectively. Sheanut cake a solid residue of sheanuts, could be a potential ingredient available in West Africa (Dei *et al.*, 2007).

In the present study, an attempt was made to utilize palm press fibre and sheanut cake at different levels along with other locally available concentrate ingredients in complete diets for lactating Murrah buffaloes to assess the effect of these complete diets on intake, eating behaviour and rumination of lactating buffaloes.

Materials and Methods

Two complete diets (roughage concentration ratio, 40:60) were formulated with SNC as concentrate ingredient and PPF 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 stover. The complete diets (R II and R III) were compared with conventional ration (R I) consisting of chopped jowar stover, Jowar green and concentrate mixture. The ingredient composition of concentrate mixture and complete diets has been shown in Table 3.

Twelve lactating graded murrah buffaloes (3-4 lactations) of uniform milk yield and in their early stage of lactations 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 throughout the experimental period of 120 days. A 7 day digestion trial was conducted at the end of the experiment to assess the effect of these complete diets on intake, eating behaviour and rumination of lactating buffaloes.

The complete diets were offered twice daily *ad libitum*, while in conventional group, the roughages and concentrates were offered separately to meet the maintenance and production requirements of milch buffaloes (ICAR, 1998).

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 lactating buffaloes 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.

Results and Discussion

The chemical composition of complete diets, concentrate mixture, Sheanut cake and Palm press fibre on DM basis is given in Table 1. Average CP and CF of complete diets was 12.2% and 24% respectively.

The mean DMI values (Table 2) were 6.07 ± 0.03, 6.27 ± 0.09 and 5.90 ± 0.23 kg during 480 minutes of behavioural observation, for

experimental animals fed with rations I, II and III, respectively. Statistical analysis revealed no significant difference among the rations (Table 2).

The mean eating time was 100.82 ± 0.86, 94.50 ± 0.36 and 90.61 ± 1.88 minutes in lactating buffaloes fed with rations I, II and III respectively, during 480 minutes of behavioural observation (Table 2).

The buffaloes spent an average 21.01 ± 0.18, 19.69 ± 0.08 and 18.88 ± 0.39 percent of time towards eating the feed and the mean values for eating time per kg DMI were 16.62 ± 0.06, 15.09 ± 0.22 and 15.42 ± 0.35 minutes in groups I, II and III, respectively.

Significantly (P<0.01) higher eating time, percent of time spent for eating and eating time per kg DMI was observed with conventional ration than complete diets (Table 2).

The buffaloes spent an average 213.50 ± 1.58, 178.93 ± 0.82 and 179.43 ± 1.85 minutes and 44.48 ± 0.33, 37.28 ± 0.17 and 37.38 ± 0.38 percent of time towards rumination in groups I, II and III, respectively. The mean values for rumination time per kg DMI were 35.21 ± 0.14, 21.88 ± 0.32 and 23.39 ± 0.97 minutes, in groups I, II and III respectively (Table 2). Statistical analysis revealed significantly (P<0.01) higher rumination time, percent of time spent for rumination and rumination time per kg DMI with conventional ration than complete diets.

The mean values for number of rumination periods were 8.57 ± 0.06, 6.07 ± 0.12 and 6.64 ± 0.26 and the length of rumination was 24.99 ± 0.09, 29.77 ± 0.68 and 27.42 ± 0.82 minutes, for groups fed with rations I, II and III, respectively (Table 2). The number of rumination periods per kg DMI were 1.42 ± 0.01, 0.97 ± 0.03 and 1.15 ± 0.09, respectively. Statistical analysis revealed significant (P<0.01) differences in the number of rumination periods, length of ruminations and rumination periods per kg DMI among the experimental rations (Table 2).

Three groups of buffaloes spent an average 314.3 ± 2.38, 273.4 ± 1.17 and 270.0 ± 1.06 minutes of time respectively towards chewing (Table 2). Significantly (P<0.01) higher chewing time was observed with conventional ration than complete diets.

Resting time was 165.68 ± 2.38, 206.56 ± 1.17 and 209.96 ± 1.06 minutes in buffaloes fed with experimental rations I, II and III, respectively during 480 minutes of behavioural observation (Table 2).

The buffaloes spent an average 34.5 ± 0.50, 43.40 ± 0.24 and 43.74 ± 0.22 percent of time towards resting and the mean values for resting time per kg DMI were 27.34 ± 0.53, 33.00 ± 0.55 and 35.84 ± 1.52 minutes in groups I, II and III, respectively. Significantly (P<0.01) lesser resting time and per cent of time spent for resting and lesser resting time per kg DMI was observed with conventional ration than complete diets.

Eating and rumination behaviour of all lactating buffaloes 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 lactating buffaloes (Table 2) during behavioural study period (8h). 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.

Table.1 Chemical composition of experimental rations (%DM) fed to lactating buffaloes

Nutrient	Complete diet		Ration I (Control)			Sheanut cake	Palm press fiber
	Ration II (Mash I)	Ration III (Mash II)	Concentrate mixture	Chopped jowar straw	Jowar green fodder		
Proximate principle							
Dry matter	89.27	89.44	93.69	91.88	24.92	93.26	89.22
Organic matter	92.78	93.48	91.32	88.24	91.74	92.19	90.76
Crude protein	12.12	12.30	17.94	3.46	7.18	13.21	8.28
Crude fibre	23.84	24.22	9.56	30.12	28.02	9.82	38.74
Ether extract	1.50	1.79	5.34	1.11	1.24	2.12	9.16
NFE	55.32	55.17	58.48	53.55	55.30	67.04	34.58
Total ash	7.22	6.52	8.68	11.76	8.26	7.81	9.24
Cell wall constituent							
NDF	59.92	56.20	33.26	70.20	66.48	60.27	72.14
ADF	46.62	46.92	17.22	50.70	46.31	41.13	53.12
Hemicellulose	13.30	9.28	16.04	19.50	20.17	19.14	19.02
Cellulose	18.41	15.93	13.28	42.12	33.52	7.22	33.28
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

Table.2 Eating and rumination behaviour in lactating graded Murrah buffaloes under different experimental rations

	Animal No.	DMI (kg/ 8hrs)	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
Conventional ration (Ration I)															
Control	457	5.98	98.86	20.60	16.52	211.14	43.99	35.29	8.57	24.73	1.44	310.00	170.00	35.42	28.46
Control	430	6.06	100.43	20.92	16.58	210.86	43.93	34.81	8.43	25.09	1.39	311.28	168.71	35.15	27.86
Control	408	6.09	101.00	21.04	16.59	214.43	44.67	35.23	8.57	25.10	1.41	315.43	164.57	34.29	27.04
Control	409	6.13	103.00	21.46	16.80	217.57	45.33	35.49	8.71	25.04	1.42	320.57	159.43	33.21	26.01
Mean		**6.07**	**100.82^{b}**	**21.01^{b}**	**16.62^{b}**	**213.50^{b}**	**44.48^{b}**	**35.21^{b}**	**8.57^{c}**	**24.99^{a}**	**1.42^{c}**	**314.32^{b}**	**165.68^{a}**	**34.52^{a}**	**27.34^{a}**
± SE		**0.03**	**0.86**	**0.18**	**0.06**	**1.58**	**0.33**	**0.14**	**0.06**	**0.09**	**0.01**	**2.38**	**2.38**	**0.50**	**0.53**
Complete diet –Mash I (Ration II)															
Mash	357	6.04	94.57	19.70	15.68	178.71	37.23	22.72	6.00	30.02	1.00	273.29	206.71	43.07	34.28
Mash	458	6.45	95.43	19.88	14.80	181.00	37.71	21.26	5.86	31.30	0.91	276.43	203.57	42.41	31.60
Mash	473	6.23	94.29	19.64	15.15	179.00	37.29	22.01	6.43	28.01	1.03	273.29	206.71	43.07	33.22
Mash	432	6.37	93.71	19.52	14.72	177.00	36.88	21.52	6.00	29.73	0.94	270.71	209.29	43.6	32.88
Mean		**6.27**	**94.50^{a}**	**19.69^{a}**	**15.09^{a}**	**178.93^{a}**	**37.28^{a}**	**21.88^{a}**	**6.07^{a}**	**29.77^{c}**	**0.97^{a}**	**273.43^{a}**	**206.57^{b}**	**43.04^{b}**	**33.00^{a}**
± SE		**0.09**	**0.36**	**0.08**	**0.22**	**0.82**	**0.17**	**0.32**	**0.12**	**0.68**	**0.03**	**1.17**	**1.17**	**0.24**	**0.55**
Complete diet -Mash II (Ration III)															
Mash	381	6.11	92.43	19.26	15.16	180.43	37.59	22.5	6.57	27.76	1.09	272.86	207.14	43.15	34.03
Mash	464	5.92	92.86	19.35	15.73	177.43	36.96	23.21	6.71	26.67	1.14	270.29	209.71	43.69	35.50
Mash	462	5.26	85.00	17.71	16.19	184.14	38.36	26.15	7.29	25.72	1.40	269.14	210.86	43.93	40.25
Mash	397	6.32	92.14	19.20	14.58	175.71	36.61	21.69	6.00	29.53	0.95	267.86	212.14	44.196	33.59
Mean		**5.90**	**90.61^{a}**	**18.88^{a}**	**15.42^{a}**	**179.43^{a}**	**37.38^{a}**	**23.39^{a}**	**6.64^{b}**	**27.42^{b}**	**1.15 ^{b}**	**270.04^{a}**	**209.96^{b}**	**43.74^{b}**	**35.84^{b}**
± SE		**0.23**	**1.88**	**0.39**	**0.35**	**1.85**	**0.38**	**0.97**	**0.26**	**0.82**	**0.09**	**1.06**	**1.06**	**0.22**	**1.52**

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

Table.3 Ingredients composition of experimental diets

Ingredient	Concentrate mixture (R I)	Complete diets (R II)	(R III)
Chopped jowar straw (kutti)	-	20.00	25.00
Palm press fibre	-	20.00	15.00
Maize	30.0	10.00	10.00
Deoiled rice bran	17.0	10.50	4.00
Wheat bran	20.0	9.00	5.00
Groundnut cake	15.0	9.00	10.00
Cottonseed cake	15.0	-	-
Sheanut cake	-	18.50	28.00
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

The apparently higher intake on complete diet mash (R II) in the present study 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).

Significantly (P<0.01) higher eating time, per cent of time spent for eating and eating time per kg DMI were observed on conventional ration (R I) than complete diets (R II and R III) in lactating buffaloes (Table 2). In the present study eating time was less with complete diets in mash form as compared to conventional diet in lactating buffaloes.

The rumination time, percent of time spent for rumination and rumination time per kg DMI were significantly (P<0.01) higher on conventional ration (R I) than complete diets (R II and R III) in lactating buffaloes (Table 2). 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 lactating 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), specific fragility (Chai *et al.,* 1988) and specific gravity (Des Bordes and Welch, 1984). Maekawa *et al.,* (2002a, 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.

Significantly (P<0.01) higher total number of rumination periods and rumination periods per kg DMI were observed on conventional ration (R I) followed by complete diets ((R III) and (R II) in lactating buffaloes (Table 2). But the length of rumination period (min) was significantly (P<0.01) higher (29.77 min) on complete diet (R II) when compared with complete diet RIII (27.42 min) and control

ration RI (24.99 min). Bosch *et al.,* (1986) found a shorter ruminating period per kg DMI when changing from restricted to *ad lib* feeding of lactating cows receiving herbage products. Physical properties of the 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 (P<0.01) higher chewing time was observed on conventional ration (R I) than complete diets (R II and R III) in lactating buffaloes (Table 2). 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. 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 (P<0.01) 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 lactating buffaloes (Table 2). This could be due to lower eating, ruminating and chewing time on complete diets. Similar results were also observed by Maekawa *et al.,* (2002a,b) in multiparous and primiparous lactating cows when fed one of four diets (three TMR containing 40, 50 or 60% silage and a separate ingredient diet containing 50% concentrate). There was a significant (P<0.01) increase in resting time per kg DMI on complete diet R III than conventional ration (R I) in lactating buffaloes.

Eating and rumination behaviour indicated that eating time, rumination time, rumination period and chewing time were significantly (P<0.01) higher, whereas resting time was lower on conventional ration (RI) when compared with complete diets (R II and R III) in lactating buffaloes. The Present study indicated that incorporation of palm press fibre (15%) and sheanut cake (28%) in complete diet had no adverse effect on eating and rumination behaviour of lactating buffaloes.

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