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Effect of Palm Press Fibre and Sheanut Cake Based Complete Diet on Rumen Fermentation Pattern in Graded Murrah Buffalo Calves

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Abstract- The rate of increase in buffalo population is emphasizing the need to utilize unconventional feed stuffs in buffalo rations. The present study was aimed to study the effect of palm press fibre and sheanut cake based complete diet (PPF-SNC) on rumen fermentation pattern. The experiment was conducted on permanently fistulated graded Murrah buffalo calves in 3 x 3 latin square design (LSD) each trial consisting of 6 days with a switch over period of 20 days. Three experimental diets, D-I (conventional ration), D-II (complete diet with 18.5% NC and 20% PPF) and D-III (complete diet with 28% SNC and 15% PPF) were fed to the three groups of animals. The PPF-SNC based complete diet had significant effect on total volatile fatty acid (TVFA) concentration and pH values with highest concentration of TVFA (95.17^b ± 14.81 mEq/L) and least value of pH (6.45^a ±0.02) at inclusion of 28 % SNC and 15% PPF. The experimental diet and time of sampling did not have any effect on temperature and ammonia nitrogen (NH_3-N) concentration. There was significant effect of time of sampling on TVFA concentration, pH and NH_3-N concentration with maximum values of TVFA (123.12^d ± 2.08 mEq/L) and NH_3-N (16.78^d ± 0.44 mg/100ml) at 4h post feeding. It can be concluded that PPF and SNC can be safely used as a feed ingredient in buffalo rations with maximum efficiency at 15% PPF and 28 % SNC.

Index Terms- Unconventional feed stuff, total volatile fatty acids, temperature, pH, ammonia nitrogen.

I. INTRODUCTION

Buffaloes occupy an important place in livestock economy of Asia. India is the largest producer of milk (86.96 million tonnes) with 97.9 million buffaloes contributing to half of the total milk production[1]. The increasing buffalo population in India is emphasizing the need to utilize unconventional feed stuffs like agricultural crop residues and agro-industrial by-products in buffalo rations. The utility of crop residues in feeding livestock is limited due to the presence of anti-nutritional factors, low nitrogen, high fibre content and decreased palatability[2, 3]. Sheanut (Vitellaria paradoxa) cake (SNC), a solid residue from shea fat industry is available to the tune of 122,100 MT[4]. It is now receiving attention as a potential feed ingredient for poultry[5]. Complete diet feeding system involves blending of forages, agricultural wastes, concentrates, minerals and vitamin supplements in a balanced ration and this provides a way of avoiding individual preferences as existing with conventional feeding system. This system also facilitates the incorporation of fibrous crop residues and agro-industrial byproducts.

Thus the present study was aimed to study the effect of incorporating palm press fibre (PPF) and SNC as feed ingredients in the complete diet of buffalo calf ration based on rumen fermentation pattern.

II. MATERIALS AND METHODS

Experimental design: The experiment was carried out on 18 fistulated graded Murrah buffalo calves (Average body weights of 95.67 ± 18.65 kg for Diet I, 95.17 ± 15.11 for Diet II and 94.83 ± 18.01 for Diet III) in 3 x 3 Latin Square Design (LSD). All the buffalo calves were stall fed under hygienic conditions in well ventilated stall barn. Clean, fresh and wholesome water was made available to each animal in buckets thrice daily throughout the experimental period.

Ration Formulation & Feeding: Three experimental diets (D-I, D-II & D-III) were formulated as per the nutrient requirements suggested by ICAR (1998)[6] and the ingredient composition of the diets is presented in Table 1. The conventional diet (D-I) consisted of concentrate mixture and roughage of which roughage was offered separately. The animals were offered concentrate mixture twice daily at 8.00h and 16.00h *ad libitum* and roughage was offered in between twice daily *ad libitum*. Complete diets (D-II and D-III) were offered twice daily *ad libitum* at 8.00h and 16.00h.

Rumen kinetic studies: The animals were fed with the experimental diets for 180 days. Rumen liquor was collected from fistulated animals at 0h (before feeding), 2h, 4h and 6h after feeding for 6 days in each period. Approximately 150ml of rumen liquor was siphoned from different depths and location of reticulo rumen and strained through a fourfold muslin cloth. The temperature, pH, ammonia nitrogen (NH_3-N) of strained rumen liquor (SRL) were estimated immediately after collection and samples were preserved in deep freezer at -20^0C after adding 1ml of saturated mercuric chloride solution per 100ml of SRL for analysis of total volatile fatty acids (TVFA).

The pH of the rumen liquor was analyzed by digital pH meter, NH3-N was analyzed by the method described by

Conway[7] and TVFAs were analyzed by the method described by Barnett and Reid[8]. The statistical analysis was done using SPSS software.

III. RESULTS & DISCUSSION

The average temperature, pH, TVFA concentration and NH_3-N concentration of SRL in graded Murrah buffalo calves as affected by feeding experimental diets and time of sampling are presented in Table 2 and Graphs 1-8. There was no significant difference in mean rumen liquor temperature values (^{0}C) among the experimental diets and hours of sampling (Graphs 1 & 2). The experimental diet and time of sampling had significant effect ($P < 0.01$) on the ruminal TVFA concentration and pH value. Higher TVFA concentration and lower pH values were recorded in rumen liquors of complete diet (D-II and D-III) fed animals and at 4h post feeding (Graphs 3-6). The type of diet had no significant effect on the ruminal NH_3-N concentration (Graph 8) but time of sampling had significant effect ($P < 0.01$) with peak values at 4h post feeding (Graph 7).

The mean rumen liquor temperature was unaffected by type of diet and time of sampling. The effect of time of sampling on rumen liquor temperature was studied by Gilchrist and Clark[9]. Non significant increase in the rumen liquor temperature was reported from 0-6h post feeding. The effect of diet and time of sampling on rumen liquor temperature was studied by Ramana Rao[10]. No significant difference in rumen liquor temperature was reported in cross bred bull calves fed with 55:45, 60:40, 70:30 and 80:20 forage and concentrate based diets without yeast culture and at 0, 2, 4 and 6h post feeding. The results of the present study are in agreement with the available literature and it can be concluded that the type of diet and post feeding time of collection had no influence on rumen liquor temperature.

TVFA concentration and pH were significantly affected by the diet and time of sampling. TVFA production depends upon several factors like particle size, type of carbohydrate in the diet and roughage to concentrate ratio. Higher TVFA production and lower pH in complete diet fed animals when compared to conventional diet fed animals in the present study indicated a better plane of nutrition and digestibility of nutrients with complete diets. It also indicated better ruminal microbial digestion of mash form of complete diets than conventional ration.

Similar findings were reported by Reddy and Reddy[11] with mash or pellets containing either dried mixed forest grass or sorghum straw as sole source of roughage. Rumsey et al[12] studied diurnal variations of the ruminal TVFA at different DM intake levels and found increase in TVFA concentration with increase in the level of DM intake in steers. Ramana Rao[10] reported inverse relationship between pH and TVFA concentration of rumen liquor in crossbred bull calves when fed forage based diets. Similar findings regarding inverse relationship between pH and TVFA were reported by Briggs et al.[13] and Reddy and Reddy[14]. Williams et al[15] reported increase in rumen pH with corresponding increase in forage and concentrate ratio.

Highest TVFA production and least pH in diet III when compared to diet II revealed that decrease in the level of inclusion of PPF (20% in diet II to 15% in diet III) and increase in the proportion of SNC (18.5% in diet II to 28% in diet III) had significantly increased the production of TVFAs. Highest TVFA concentration at 4h post feeding indicated optimum metabolism of nutrients at 4h post feeding irrespective of experimental diets. These results corroborated with those of Reddy and Reddy[11], Reddy and Reddy[14], Bhargava et al[16], Mallikarjun[17] and Murali et al[18] who also reported peak concentration of TVFA at 4h post feeding.

In the present study, highest TVFA concentration and least pH were recorded with diet III which indicated that 28% of SNC and 15% of PPF in diet III had maximum production of TVFAs revealing better utility of nutrients.

Though there was no significant effect of type of diet on ruminal NH_3-N concentration, an apparent increase in NH_3-N concentration was seen in rumen liquors of complete diet fed animals over conventional diet fed animals. This was attributed to slow rate of degradation of jowar straw in conventional diet. Among the two complete diets (diet II and diet III) maximum NH_3-N concentration was obtained with diet III which indicated that lower proportion of PPF (15%) and higher proportion of SNC (28%) in diet III produced slight increase in NH_3-N concentration which was not significant. This could be due to slow degradation of PPF in diet II.

The time of sampling had significant ($P < 0.01$) effect on the ruminal NH_3-N concentration with peak concentration of 16.78 ± 0.44 mg/100ml at 4h post feeding. This indicated that maximum digestion was completed at 4h post feeding irrespective of the type of diet (conventional or complete diet) and composition of ration (proportion of SNC). Similar results were observed by Sreedhar et al[19] in buffaloes fed with PPF based rations, Reddy and Reddy[11] with complete diets (mash or pellets) containing either dried mixed forest grass or sorghum straw as source of roughage and Ramana Rao[10] with forage based diets in crossbred bull calves.

IV. CONCLUSION

It can be concluded from the results of the present study that inclusion of SNC and PPF in the diet of buffalo calves had beneficial effect on the rumen fermentation pattern which was evidenced as increase in TVFA concentration, decrease in ruminal pH (within the normal range) and increase in NH_3-N concentration. Diet III proved to be the most efficient. SNC can be safely used as a potential feed ingredient in buffalo ration.

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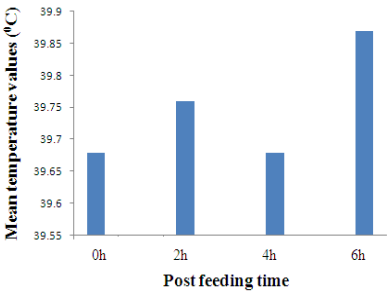
Table 1: Ingredient composition (kg/100kg) of concentrate mixture and complete diet

Ingredients	Conventional diet	Complete diet	
	Concentrate mixture (D-I)	Diet II (D-II)	Diet III (D-III)
Chopped Jowar straw (kutti)	-	20.00	25.00
Palm press fibre	-	20.00	15.00
Maize	30.00	10.00	10.00
Deoiled rice bran	17.00	10.50	4.00
Wheat bran	20.00	9.00	5.00
Ground nut cake	15.00	9.00	10.00
Cotton seed cake	15.00	-	-
Sheanut cake	-	18.50	28.00
Salt	1.00	1.00	1.00
Mineral mixture**	2.00	2.00	2.00
Total	**100.00**	**100.00**	**100.00**
Nicomix* (g/qt)		10.0(g)	10.0 (g)

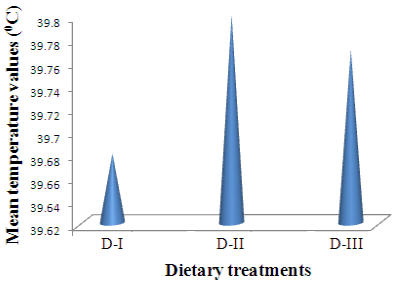
Table 2: Rumen fermentation pattern in buffalo calves fed PPF-SNC based complete diets

Rumen parameter	Hours of sampling	Experimental diet			
		Diet I	Diet II	Diet III	Overall mean
Rumen temperature (^{0}C)	0h	39.54	39.75	39.75	**39.68 ±0.07**
	2h	39.75	39.81	39.74	**39.76±0.02**
	4h	39.56	39.73	39.75	**39.68±0.06**
	6h	39.87	39.90	39.83	**39.87±0.02**
	Overall mean	**39.68 ± 0.08**	**39.80±0.04**	**39.77±0.02**	**39.75±0.04**
Rumen pH	0h	6.75	6.58	6.51	**6.61^a ± 0.07**
	2h	6.68	6.45	6.43	**6.52^a ± 0.08**
	4h	6.63	6.43	6.42	**6.49^a ± 0.07**
	6h	6.73	6.42	6.44	**6.53^a ± 0.10**
	Overall mean	**6.70^b ± 0.03**	**6.47^a ± 0.04**	**6.45^a ±0.02**	**6.54 ± 0.03**
TVFA concentration (mEq/L)	0h	53.67	55.63	55.93	**54.41^a ± 0.62**
	2h	97.70	102.53	106.13	**102.12^c ±2.44**
	4h	119.30	126.47	123.60	**123.12^d ± 2.08**
	6h	94.77	95.50	97.03	**95.77^b±0.67**
	Overall mean	**91.36^a ± 13.70**	**95.03^b ±14.71**	**95.17^b ± 14.81**	**93.86± 14.39**
NH_3-N concentration (mg/100ml)	0h	8.84	8.36	8.30	**8.50^a ± 0.17**
	2h	13.53	14.09	14.28	**13.97^b ± 0.23**
	4h	16.05	16.75	17.56	**16.78^d ± 0.44**
	6h	14.09	15.19	15.36	**15.15^c ± 0.13**
	Overall mean	**13.33 ± 1.58**	**13.60 ± 1.83**	**13.88 ± 1.98**	**13.60 ± 1.79**

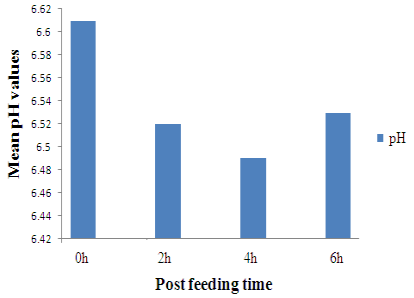
Mean with different superscripts in a row and column differ significantly (P < 0.01)



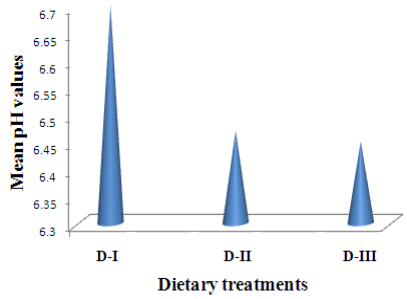
Graph 1: Effect of post feeding time on rumen temperature (*Mean temperature values represent mean of temperature values of 6 animals in each diet of all the three diets at a given post feeding time. There is no significant difference between time of sampling (P > 0.01)*



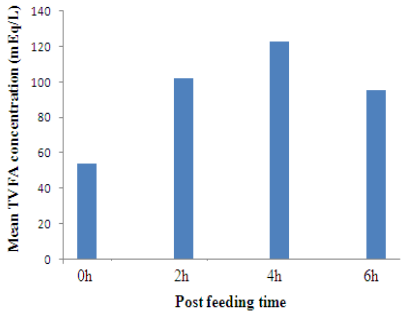
Graph 2: Effect of diet on rumen temperature (*Mean temperature values represent mean of temperature values of 6 animals in each diet of all the four post feeding times (0h, 2h, 4h & 6h). There is no significant difference between dietary treatments (P > 0.01)*



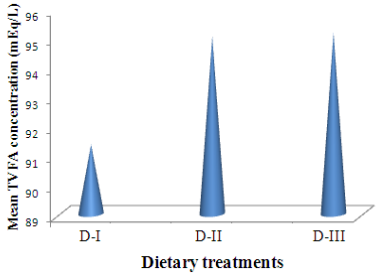
Graph 3: Effect of post feeding time on rumen pH *(Mean pH values represent mean of pH values of 6 animals in each diet of all the three diets at a given post feeding time. There is significant difference between times of sampling (P < 0.01).*



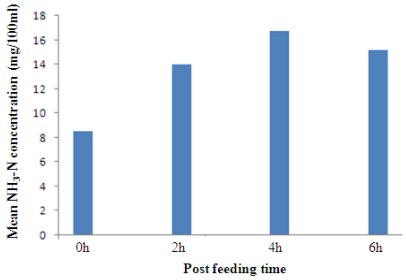
Graph 4: Effect of diet on rumen pH *(Mean pH values represent mean of pH values of 6 animals in each diet of all the four post feeding times (0h, 2h, 4h & 6h). There is significant difference between dietary treatments (P < 0.01).*



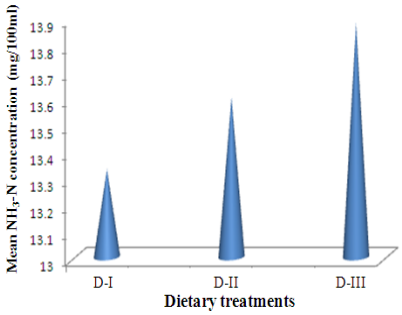
Graph 5: Effect of post feeding time on rumen TVFA concentration *(Mean TVFA concentration values represent mean of TVFA concentration values of 6 animals in each diet of all the three diets at a given post feeding time. There is significant difference between time of sampling (P < 0.01).*



Graph 6: Effect of diet on rumen TVFA concentration *(Mean TVFA concentration values represent mean of TVFA concentration values of 6 animals in each diet of all the four post feeding times (0h, 2h, 4h & 6h). There is significant difference between dietary treatments (P < 0.01).*



Graph 7: Effect of post feeding time on rumen NH_3-N concentration *(Mean NH_3-N values represent mean of NH_3-N values of 6 animals in each diet of all the three diets at a given post feeding time. There is significant difference between time of sampling ($P < 0.01$).*



Graph 8: Effect of diet on rumen NH_3-N concentration *(Mean NH_3-N values represent mean of NH_3-N values of 6 animals in each diet of all the four post feeding times (0h, 2h, 4h & 6h). There is no significant difference between the dietary treatments ($P > 0.01$).*