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Effect of exclusive feeding of rice straw on rumen microbiology in buffalo calves (*Bubalus bubalis*)

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Abstract

Eight apparently healthy rumen fistulated buffalo calves were used to study the effect of exclusive feeding of rice straw on rumen microbiology. These animals were divided into control group and experimental group having four animals in each group. The animals of control group were kept on conventional diet comprising of wheat straw, green fodder, concentrate and mineral mixture whereas the animals of experimental group were fed rice straw exclusively for a period of 21 days for microbial adaptation. Rumen liquor samples were collected before feeding (0 hr) and subsequently at 1, 2, 4 and 6 hrs postprandial for 3 consecutive days after the period of microbial adaptation. The results revealed that initially there was drop in total bacterial and protozoal count followed by progressive increase which attained peak levels at 4 hrs after feeding in both the groups. Further decline in microbial count at 6 hrs postprandial was observed in both the groups. Relatively, per cent holotrichs were found to be lower while entodiniomorphs were higher with rice straw feeding as compared to control feeding. Overall mean indicated that there was significant decline in microbial population with exclusive feeding of rice straw as compared to control group.

Key words: Buffalo, entodiniomorphs, holotrichs, rice straw, rumen microbiology, total bacterial count, total protozoal count.

Introduction

Rumen is essentially a fermentation chamber in which the resident microbial population helps to digest the feed. Rumen microbial population remains the same if the same diet is provided throughout the life of ruminant, but a sudden change in the diet causes drastic changes in the microbial population which can greatly affect digestion and animal performance. As the diet of ruminants mainly consists of lignocellulosic feeds especially in developing countries including India where agricultural by-products are the major sources of feed for the ruminants, the role of symbiotic microbial ecosystem is very significant. Especially during lean period, it becomes very difficult for the landless and small farmers to offer green fodder to their animals, which is the major cause of dependence of farmers to utilize cheaply available rice straw as the only source of feed in many parts of the country. Unfortunately, the nutritive value of rice straw is very poor with high levels ligno-cellulosic materials, a low level of fermentable carbohydrates and good quality proteins and almost deficient in many essential minerals and vitamins (Wanapat, 2000). Therefore, the present study was designed to investigate the effect of exclusive feeding of rice straw on rumen microbial population.

Material and Methods

Experimental animals and feeding schedule

The study was conducted on eight permanently rumen fistulated male buffalo calves of 10-12 months age (125±4.5 kg body weight) The animals were divided into two groups having four animals in each. The animals of group I were subjected to conventional diet consisting of wheat straw, green fodder, concentrate and mineral mixture which served as control whereas the animals of group II were fed exclusively on rice straw. Dry matter requirement was computed as per the recommendations of NRC (NRC, 2001). The animals of both the groups were fed twice daily on their respective diets individually for a period of 21 days for microbial adaptation. Fresh and clean drinking water was provided *ad libitum* immediately after feeding.

Collection and preservation of rumen liquor samples

Rumen liquor samples were collected through rumen fistula with the help of suction pump for three consecutive days after the period of microbial adaptation. First sample was taken before feeding (0 hr) and subsequent samples were taken at 1, 2, 4 and 6 hrs after feeding. Rumen liquor samples were preserved in equal volume of

10% formalin solution and stored at –20°C until analyzed for microbial count.

Total bacterial count was made according to the method of Gall *et al.* (1949) using nigrosine slide technique. Total protozoal count was done as per the method described by Naga and El-Shazly (1969). Differential counting of holotrichs and entodiniomorphs was carried out on the basis of morphological features compiled by Hungate (1966).

Statistical analysis

The data obtained during the present study was subjected to two way analysis of variance without replication as described by Snedecor and Cochran (1989).

Results and Discussion

Total bacterial and protozoal count

Initially there was drop in population of bacteria and protozoa from 0 to 1 hr post feeding followed by progressive increase which attained peak levels at 4 hrs post feeding in both the groups (Table 1). Total bacterial and protozoal count further declined at 6 hrs post feeding in two groups. The overall mean values indicated that exclusive rice straw feeding resulted in significant decrease in total bacterial ($7.00\pm0.15\times10^9$) and protozoal count ($2.63\pm0.08\times10^5$) as compared to control feeding. These results are in agreement with the findings of Iqbal *et al.* (1993) and Singh *et al.* (1996) who recorded peak levels of microbial count at 2 hrs and significantly low populations of bacteria and protozoa in the rumen liquor of buffaloes maintained on wheat straw. Randhawa *et al.* (1991) observed that there was significant decrease in total protozoal count but total bacterial count did not alter significantly in paddy straw induced alkaline indigestion.

Initial drop in total bacterial and protozoal population could be attributed to dilution factor due to feed, water and saliva and also due to lodging of freely floating microbes to the new feed particles after feeding (Gill, 1993). Postprandial increase in total bacteria and protozoa could be ascribed to increased availability of substrate required for microbial growth and dislodging of microbes while subsequent decrease in microbial count at 6 hrs might be the result of either decreased substrate availability or onward passage of microbes to the next compartment along with digesta (Singh *et al.*, 1980 and Iqbal *et al.*, 1993). Higher microbial population under control feeding might be due to the presence of higher amount of soluble carbohydrates, vitamins and nitrogen content in the diet, which allowed better utilization of ration and thus promoted the microbial growth (Hungate, 1968 and Michalowski, 1975). Green fodder included in conventional diet, being a good source of soluble carbohydrates may promote the growth of microorganisms. However, poor counts of rumen microbes during exclusive feeding of rice straw might be attributed to sub-maintenance diet and poor source of substrates especially proteins needed for the synthesis of microbial proteins (Pant and Roy, 1970).

Differential protozoal count

Per cent holotrichs showed progressive rising trend upto 1 hr post feeding followed by decline in population upto 4 hrs after feeding and then increase in percentage population at 6 hrs post feeding in both the groups. Iqbal *et al.* (1993) found maximum percentage of holotrichs at 2 hrs post feeding with declining trend for rest of the time intervals after feeding. Post feeding variations in the percentage of holotrichs was due to sequesterization. Holotrichs normally sequester on the wall of reticulum and migrate rapidly from reticulum to rumen after feeding and sequestering again on the reticular wall after few hrs in response to a chemical stimuli originating from diet (Abe *et al.*, 1981). Overall mean values indicated low percentage of holotrichs on rice straw feeding (6.76±0.29%) as compared to conventional diet (13.24±0.26%) probably due to the fact that rice straw being a coarse and dry roughage containing scanty soluble sugars.

It is clear from the table 2 that both the diets reflected a greater percentage of entodiniomorphs before feeding. However, the population decreased after feeding which was followed by a rising trend. Value reached maximum at 4 hrs post feeding in both the groups and approached almost to their pre feeding levels at 6 hrs post feeding. These findings are in accordance with the observations of Singh *et al.* (1993).

Overall, a significant increase in the percent entodiniomorphs (93.24±0.29%) was noticed with rice straw feeding as compared to conventional diet (86.76±0.26%) which might be due to relative decrease in the percentage population of holotrichs. These findings are in agreement with Randhawa *et al.* (1991) and

Table 1. Change in total bacterial and protozcal count in buffalo rumen liquor at different time intervals during exclusive feeding of rice straw (Mean±SE)

Time (hrs) after feeding	Total bacterial count ($x10^9$/ml)		Total protozoal count ($x10^5$/ml)	
	Group I	Group II	Group I	Group II
0 (before feeding)	9.61±0.40^a	6.21±0.17^{ab}	5.71±0.07^a	2.97±0.03^a
1	9.47±0.42^a	5.67±0.14^a	4.91±0.08^b	1.91±0.07^b
2	10.70±0.44^b	7.03±0.20^{bd}	5.36±0.08^c	2.00±0.08^b
4	11.60±0.46^c	8.33±0.15^c	6.25±0.09^d	3.23±0.03^c
6	10.99±0.43^{bc}	7.74±0.18^{cd}	6.14±0.09^d	3.06±0.04^{ac}
Overall Mean±SE	10.47±0.22^a	7.00±0.15^b	5.67±0.07^a	2.63±0.08^b

* Each figure is a mean of 12 observations representing triplicate samples from 4 experimental animals

** The figures having different superscripts within the columns and in the last row of overall means differ significantly ($P<0.05$)

Table 2. Change in percentage of holotrichs and entodiniomorphs in buffalo rumen liquor at different time intervals during exclusive feeding of rice straw (Mean±SE)

Time (hrs) after feeding	Per cent holotrichs		Per cent entodinomorphs	
	Group I	Group II	Group I	Group II
0 (before feeding)	13.84±0.16^a	6.45±0.38^a	86.16±0.16^a	93.55±0.38^a
1	16.03±0.33^b	9.10±0.60^b	83.97±0.33^b	90.90±0.60^b
2	13.66±0.31^a	7.77±0.70^c	86.34±0.31^a	92.24±0.70^c
4	10.53±0.28^c	5.01±0.26^d	89.47±0.29^c	94.98±0.26^d
6	12.13±0.13^d	5.45±0.32^{ad}	87.87±0.13^d	94.55±0.32^{ad}
Overall Mean±SE	13.24±0.26^a	6.76±0.29^b	86.76±0.26^a	93.24±0.29^b

* Each figure is a mean of 12 observations representing triplicate samples from 4 experimental animals

** The figures having different superscripts within the columns and in the last row of overall means differ significantly ($P<0.05$)

Singh *et al.* (1996) who also noticed relative increase in per cent entodiniomorphs with exclusive wheat straw feeding in buffalo calves. Warner (1965) found that animals fed hay or green fodder rich in soluble sugars exhibit high concentration of holotrichs and animals fed high starch diet often have high concentration of entodiniomorphs in their rumen.

It can be concluded from the present investigation that exclusive feeding of rice straw brings about drastic decrease in population of ruminal microflora which in turn leads to rumen dysfunction. Therefore, rice straw must be incorporated with green fodder or concentrate feed in order to maintain optimum microbial fermentation in the rumen for proper health and production of animals.

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