Bandeswaran and Karunakaran, 2016
J. basic appl. Res 2(2): 198-201

JBAAR
Journal of Basic And Applied Research
ISSN 2413-7014

Effect of Feeding Time and Nutrient Degradability in Sorghum Stover Based Feeding System on Ruminal Microbial Protein Synthesis in Crossbred Cattle

Dr. Bandeswaran, C*., Dr. R. Karunakaran

Department of Animal Nutrition, Madras Veterinary College, Tamil Nadu Veterinary and Animal Sciences University, Chennai- 600 007

*corresponding author: bandeswaran@gmail.com

Received: 28-3-2016
Revised: 15-4 -2016
Published: 6-5-2016

Keywords:
Sorghum stover, feeding time, degradation rate, nutrient synchronization, rumen microbial protein synthesis

Abstract: Farmers fed sorghum stover as staple roughages for low milk yielding dairy cattle was surveyed followed by *in vitro* and *in vivo* experiments to enhance rumen microbial protein synthesis in cattle without altering the quantity of forage / feed ingredients. The survey revealed that majority of farmers fed roughages twice daily during morning and evening and supplemented with groundnut cake at forenoon and evening along with de-oiled rice bran in drinking water. The *in vitro* degradability characteristics of the sorghum stover and supplemental feeds *viz*., groundnut cake, sesame cake, coconut cake and de-oiled rice bran were studied by Rumen Simulation Technique (RUSITEC). The half time ($t_{1/2}$) of organic matter and nitrogen for sorghum stover were 27 ± 4 and 34 ± 4 hour, respectively. The respective $t_{1/2}$ time of organic matter and nitrogen for the commonly fed supplemental feeds *viz.*, coconut cake and de-oiled rice bran were 7 ± 1 and 15 ± 2 and 8 ± 0 and 7 ± 1 hour, respectively. Altering the feeding strategy based on $t_{1/2}$ value of organic matter and nitrogen sources did not increased the rumen microbial protein yield by *in vitro* / *in vivo* experiments. There was comparable microbial nitrogen synthesis per kg metabolic body weight of animal between evolved and farmer's feeding strategies in sorghum stover based feeding system (0.480 vs. 0.485 g / d). Hence, it was concluded that altering the feeding time based on nutrient degradability in sorghum stover based feeding system did not increased the rumen microbial protein synthesis.

INTRODUCTION

In semi arid tropical regions of India, sorghum (*Sorghum bicolor*) is cultivated as a dual purpose crop; both grain and stover are highly valued outputs. In these areas, sorghum stover represents major roughage, especially in drought periods. Synchronized delivery of organic matter and nitrogen in rumen ensured continuous supply of balanced proportions of nitrogen and organic matter, so that rumen microbes will multiply and supplies microbial protein to the host. Therefore, an attempt was made to evolve a new feeding strategy based on the degradability of organic matter and nitrogen ($t_{1/2}$ value) of the feed ingredients that were fed to cow by farmers without altering the feed ingredients or its quantity. Two factors *viz*., a. appropriate time of feeding and b. appropriate order of feeding of ingredients were addressed and due consideration was accorded to propose feeding time during day time while evolving the feeding strategy.

MATERIALS AND METHODS

A survey on farmer feeding practices for low milk yielding dairy cattle (5-8 kg / day) was undertaken in parts of state of Tamil Nadu, India, wherever sorghum stover was customarily fed to dairy cattle with supplementation of cereal grains, oil cakes, rice bran etc. The *in vitro* degradability characteristics of the sorghum stover and supplemental feeds *viz*., groundnut cake, sesame cake, coconut cake and de-oiled rice bran were studied by Rumen Simulation Technique (RUSITEC) as described by Czerkawski and Brackenridge (1977). The half time ($t_{1/2}$) required for the respective roughage or supplemental feeds to deliver half organic matter were calculated as, ln 2/c = 0.693/c, where, c is the degradation rate of organic matter (Orskov et al., 1980). The difference between $t_{1/2}$ of organic matter sources and $t_{1/2}$ of nitrogen sources was calculated and the difference was used to fix the feeding time of ingredients. Thus, in this experiment, two feeding strategies were tested in semi continuous culture system (RUSITEC). The feeding regimen followed by farmers will be hither to mention as farmer's feeding strategy (FFS). The feeding time and order of feeding ingredients altered based on the $t_{1/2}$ time of roughage or de-oiled rice bran organic matter and the $t_{1/2}$ time of oil cake nitrogen will be hither to refer as evolved feeding strategy (EFS).

The dry matter and organic matter degradability of the rations, pH, ammonical nitrogen (NH_3-N) and microbial protein concentrations in the ruminal fluid were determined at nitrogen $t_{1/2}$ of oil cake. The concentration of NH_3-N was estimated colorimetrically as per the method of Weatherburn (1967). Microbial protein in terms of bacterial protein was estimated as described by Makkar et al.

(1982). In order to estimate the flow of microbial protein at post rumen in the animal, the total effluent volume was multiplied with the concentration of microbial protein (mg / dl) to estimate microbial protein synthesis per day. The efficiency of microbial protein synthesis (EMPS) was measured by calculating quantity of microbial crude protein synthesized per day to kilogram of apparently degraded organic matter (ADOM).

The results of *in vitro* studies on influence of feeding strategies on rumen microbial protein synthesis was validated in 8 crossbred cattle male calves using switch over design. Feed intake, dung and urine voided were collected for analysis of nitrogen and total ash (AOAC, 2006) and purine derivatives in the urine (IAEA, 1997).The amount of microbial nitrogen supplied to the animal was calculated using the formula described by Chen and Gomes (1995). The efficiency of microbial N synthesis was expressed as grams of microbial N supply per kg apparently digestible organic matter intake (ADOMI) or grams of microbial N supply per kilogram of apparently digested organic matter in the rumen (ADOMR). The model (ARC, 1984) assumes digestible organic matter in the rumen (DOMR) to be 0.65 of the digestible organic matter intake (DOMI). The data obtained in different parameters of the study were subjected to statistical analysis as per the procedure of Snedecor and Cochran (1980) and SPSS (2001).

RESULTS

The survey result on existing feeding practices in the sorghum stover based feeding system revealed that about 53.33 per cent of the farmers fed sorghum stover both during morning (8:00-10:00 h) and evening (14:00-16:00 h) at the rate of 3.08 ± 0.17 and 2.34 ± 0.10 kg on DM basis, respectively to dairy cows. Among the total farmers surveyed, 13.3 per cent of them supplemented cereal grains and 26.7, 13.3, 33.3, 10.0 and 3.3 per cent of farmers supplemented groundnut oil cake, sesame oil cake, coconut oil cake, cotton seed / cake and mixed oil cakes, respectively. About 13.3 per cent of them did not feed any oil cake to their dairy cows. Among coconut oil cake feeding farmers, 80 per cent of them fed it during forenoon (11:30-12:30 h) and in evening (17:00-18:00 h) at the rate of 0.49 ± 0.05 and 0.42 ± 0.03 kg, respectively. The de-oiled rice bran was fed at the rate of 0.70 ± 0.11 and 0.51 ± 0.11 kg, respectively during forenoon and evening twice daily along with coconut oil cake by 60 per cent of sorghum stover feeding farmers. From the survey, it was concluded that majority of the farmers practiced feeding of sorghum stover twice daily, supplementing it with coconut oil cake and de-oiled bran in the forenoon and evening. The dietary dry matter of dairy cow of majority of the farmers in sorghum stover based feeding system constituted 71.8, 12.1 and 16.1 per cent for sorghum stover, coconut oil cake and de-oiled rice bran, respectively.

The $t_{1/2}$ for organic matter of sorghum stover calculated in this study was 27 h which was lower than the *in vivo* dry matter $t_{1/2}$ value of Parra *et al.* (1984) for sorghum silage. The time required to deliver half of the nitrogen was 34 h, which was lower, when compared to *in vivo* reported value of Parra *et al.* (1984). The $t_{1/2}$ of de-oiled rice bran organic matter was 8 h but coconut oil cake nitrogen $t_{1/2}$ was 15 h. The difference is 7 h. Hence, the de-oiled rice bran was fed twice at 7 h later from the time of feeding of coconut oil cake (Table 1). In the farmer's feeding strategy, sorghum stover was introduced in to RUSITEC reaction vessel twice at 09:00 and 15:00 h and coconut oil cake along with de-oiled rice bran at 11:30 and 17:30 h. In EFS, sorghum stover and coconut oil cake were fed twice daily at 08:00 and 20:00 h and de-oiled rice bran at 15:00 and 03:00 h.

The influence of feeding strategy in sorghum stover based feeding system on the diet degradability and rumen parameters is presented in Table 2. Even though the microbial protein concentration at nitrogen $t_{1/2}$ of oil cake in the EFS was comparable with FFS, the microbial protein synthesized per day in EFS was significantly ($p=0.014$) higher compared to FFS and numerical increased in the efficiency of microbial protein synthesized were in agreement with the findings of Ayyappan et al. (2007).

Table 1: Time and order of introduction of feed ingredients into RUSITEC reaction vessels for *in vitro* evaluation of microbial protein synthesis in sorghum stover based feeding system

Farmer's feeding strategy (FFS)			**Evolved feeding strategy (EFS)**		
Feeding time (h)	Feed ingredients	Quantity (g)	Feeding time (h)	Feed ingredients	Quantity (g)
09:00	Sorghum stover	8.2	08:00	Coconut oil cake	1.4
11:30	Coconut oil cake	1.4		Sorghum stover	8.2
	De-oiled rice bran	1.8	15:00	De-oiled rice bran	1.8
15:00	Sorghum stover	6.2	20:00	Coconut oil cake	1.0
17:30	Coconut oil cake	1.0		Sorghum stover	6.2
	De-oiled rice bran	1.4	03:00	De-oiled rice bran	1.4
Total		20	Total		20

Table 2: Influence of feeding strategy in sorghum stover based feeding system on the diet degradability and rumen parameters in RUSITEC (Mean* ± SE)

Parameter	Farmer's feeding strategy (FFS)	Evolved feeding strategy (EFS)	P value
Apparent DM degradability			
at 24 h, %	34.70 ± 0.34	36.10 ± 0.28	0.015
at 48 h, %	41.20 ± 0.37	43.09 ± 0.34	0.019
Apparent OM degradability			
at 24 h, %	33.12 ± 0.42	35.08 ± 0.22	0.004
at 48 h, %	39.86 ± 0.42	41.75 ± 0.34	0.023
Ruminal parameters at N $t_{1/2}$ of oil cake			
pH	6.97 ± 0.04	6.98 ± 0.03	0.816
Rumen NH_3-N, mg %	4.94 ± 0.29	4.69 ± 0.21	0.351
MP concentration, mg %	39.97 ± 3.63	42.78 ± 2.35	0.533
Microbial protein synthesized, mg / day	263.31 ± 6.49	294.19 ± 6.84	0.014
EMPS, g Microbial protein / kg ADOM	43.56 ± 1.04	45.96 ± 1.20	0.117

*Mean of 8 observations; P> 0.05 do not differ significantly

Table. 3: Influence of feeding strategy on nutrient intake, nutrient digestibility and rumen microbial synthesis in crossbred cattle male calves fed sorghum stover based ration (Mean* ± SE)

Parameter	Farmer's feeding strategy (FFS)	Evolved feeding strategy (EFS)	p value
DM intake, g / day			
Total DMI	2899 ± 304	2782 ± 282	0.804
DMI as % of BW	3.01 ± 0.14	2.87 ± 0.07	0.412
Organic matter intake, g /d	2657 ± 279	2544 ± 170	0.776
Nitrogen intake, g / d	38.92 ± 3.96	37.19 ± 3.46	0.771
Apparent digestibility , g / day			
Dry matter	1822 ± 205	1798 ± 203	0.936
Organic matter	1737 ± 194	1706 ± 190	0.912
Nitrogen	22.45 ± 2.57	20.94 ± 1.87	0.649
Nitrogen retained	9.16 ± 0.88	9.41 ± 0.52	0.756
Microbial Nitrogen supply, g / day			
MN supply	14.59 ± 1.54	14.31 ± 1.24	0.897
Per kg $BW^{0.75}$	0.480 ± 0.049	0.485 ± 0.060	0.963
Per kg ADOMI	8.74 ± 0.96	9.12 ± 1.30	0.848
Per kg ADOMR	13.45 ± 1.48	13.99 ± 1.99	0.963

*Mean of 8 observations; P> 0.05 do not differ significantly

The effect of feeding strategy on the dry matter intake, nutrient digestibility and microbial nitrogen synthesis in calves maintained on sorghum stover based feeding system is presented in Table 3. The effect of changing the feeding time for synchronization did not influence the digestibility of nutrients, which was in line with the report of Kolver et al. (1998) and contradictory with the report of Bohnert et al. (2002). The comparable quantity of nitrogen retention between FFS and EFS was contrary to the report of Matras et al. (1991). There was no improvement in microbial nitrogen synthesis efficiency in calves when feeding time was altered to synchronize the energy and nitrogen from sorghum stover or de-oiled rice bran and coconut cake, respectively.

DISCUSSION

The observed feeding practices agreed to that of Gowda et al. (2008) who observed that finger millet straw was a major roughage source and were supplemented with oil cakes and bran. The measured nutrient degradability values in this study were lower than the reported values of Dhore et al. (2005) and Misra et al. (2009) might be due variation in rumen inoculums and other factors. In contrast, the sorghum stover organic matter degradability at 24 h of incubation was in line with reported *in vivo* value of Abdul et al. (2008) in cattle. The per cent dry matter or organic matter *in vitro* degradability of the diet at 24 and 48 h of incubations were significantly ($P<0.024$) higher in EFS compared to FFS in sorghum stover based feeding system which concur with the observation of Ayyappan et al. (2007). The pH and NH_3-N concentration at nitrogen $t_{1/2}$ of oil cake in the ruminal fluid of reaction vessels were comparable between the two feeding strategies were not in line with the findings of Kolver et al. (1998). The medium rate of nitrogen degradation in coconut cake may synchronize little with the slowly degradable energy from sorghum stover in both strategies. The average quantity of apparent digestible organic matter and nitrogen were 1.72 kg and 21.70 g, respectively in sorghum stover based feeding system. About 65 per cent (ARC, 1984) of digestible organic matter (1.12 kg) is available in the rumen and it required 33.96 g of nitrogen when considering optimum microbial nitrogen synthesis efficiency of 33 g per kg fermentable organic matter in the rumen (McMeniman et al., 1976). However, only 14.10 g nitrogen is available when

assuming the same proportion (65 per cent) of digestible nitrogen is available in the rumen. Hence, there was 58.48 per cent degradable nitrogen deficit in sorghum stover based feeding system. Merely improving the degree of synchronization between energy and N release rates in the rumen does not increase microbial yield (Henning et al., 1993). Therefore, there was only a comparable microbial yield between FFS and EFS.

CONCLUSION

From this study, it was concluded that evolved feeding strategy in sorghum stover based feeding systems for cattle did not significantly enhanced the rumen microbial nitrogen synthesis.

REFERENCES

Abdul, S.B., Yashim, S.M & Jokthan, G.E. (2008). Effects of supplementing sorghum stover with poultry litter on performance of Wadara cattle. *American-Eurasian Journal of Agronomy*, 1: 16-18.

AFRC, (1992). Nutritive requirements of ruminant animals: Protein. Agricultural and Food Research Council, Nutritional Abstract Reviews (Series B), 62: 787-835.

AOAC, (2006). *Official Methods of Analysis*, 18th edition. Association of Official Analytical Chemists, Maryland.

ARC, (1984). The Nutrient Requirement of Ruminant Livestock. Agricultural Research Council, CAB, Farham Royal, UK.

Ayyappan, K., Singh, B., & Singhal, K.K. (2007). Synchronization of dietary energy and nitrogen availability for microbial protein synthesis *in vitro*. *Indian J. Anim.,Nutr*., 24: 223-229. of microbial protein in rumen liquor. *J. Dairy Sci.*, 65: 2170-2713.

Bohnert, D.W., Schauer, C.S, & DelCurto, T. (2002). Influence of rumen protein degradability and supplementation frequency on performance and nitrogen use in ruminants consuming low quality forage: Cow performance and efficiency of nitrogen use in wethers. *J. Anim. Sci.*, 80: 1639.

Chen, X.B., & Gomes, M.J. (1995). Estimation of microbial protein supply to sheep and cattle based on urinary excretion of purine derivatives- An overview of the technical details. Occasional Publication 1992, International Feed Resources Unit, Rowett Research Institute, Aberdeen (UK), p. 21.

Czerkawski, J.W., & Brackenridge, G. (1977). Design and development of a long term rumen simulation technique (RUSITEC). *British J. Nutri.*, 38: 371.

Dhore, R.N., Mahurkar, A.V., & Udar, S.A. (2005). *In vitro* digestibility of sorghum stovers supplemented with oil seed cakes. *Indian J. Anim. Nutr.*, 22 : 59-60.

Gowda, N.K.S., Prasad, C.S., Selvaraju, S., Reddy, I.J., Ananthram, K., & Sampath, K.T. (2008). Feeding practices and nutrient status of dairy cows under field conditions. *Indian Vet. J.*, 85: 745-748.

Henning, P.H,, Steyn, D.G., & Meissner, H.H. (1993). Effect of synchronization of energy and nitrogen supply on ruminal characteristics and microbial growth. *J. Anim. Sci.*, 71: 2516-2528.

IAEA. (1997). Estimation of rumen microbial protein production from purine derivatives in urine. IAEA-TECDOC-945, International Atomic Energy Agency, Vienna.

Kolver, E., Muller, L.D., Varga, G.A., & Cassidy, T.J. (1998). Synchronization of ruminal degradation of supplemental carbohydrate with pasture nitrogen in lactating dairy cows. *J. Dairy Sci.*, 81: 2017-2028.

Matras, J., Bartle, S.J., & Preston, R.L. (1991). Nitrogen utilization in growing lambs: Effects of grain (starch) and protein sources with various rates of ruminal degradation. *J. Anim. Sci*., 69: 339–347.

McMeniman, N.P., Ben Ghedalia, B., & Armstrong, D.G. (1976). Protein metabolism and nutrition., p. 217, *EAAP* publ. No. 16, Butterworth, London.

Misra, A.K., Vimlesh Chauhan, Yadav, S.K., & Maruthi Sankar, G.R. (2009). Nutritive value of commonly used feed resources in Telangana region of Andhra Pradesh. *Indian J. Anim. Nutr.*, 26: 23-28.

Orskov, E.R., DeB Hovell, F.D., Mould, F. (1980). The use of nylon bag technique for the evaluation of feed stuffs. *Tropical Anim. Prod.*, **5**: 195-213.

Parra, A., Combellas, J., & Dixon, Y.R., (1984). Rumen degradability of some tropical stuffs. *Tropical Animal Production*. 9: 196-199.

Snedecor, G.W., & Cochran, W.G. (1980). Statistical methods. 7th Edn. Oxford and IBH Publishing Company, Calcutta.

SPSS. (2001). Statistical packages for Social Sciences, version 11, SPSS Inc., Illinosis, USA.

Weatherburn, M.W. (1967). Phenol-Hypochlorite reaction for determination of ammonia. *Analytical Chem*., 39: 971-973.