



Effect of Feeding Straw Based Complete Diet Supplemented with Thermotolerant Probiotic Yeast on Rumen Fermentation Pattern in Nellore Rams

Ch. Harikrishna* and M. Mahender

Department of Livestock Production Management, College of Veterinary Science, PVNR Telangana Veterinary University, Rajendranagar, Hyderabad, Andhra Pradesh, INDIA

*Corresponding Author: drhkvvet@gmail.com

How to cite this paper: Cherala, H., & Mallam, M. (2021). Effect of Feeding Straw Based Complete Diet Supplemented with Thermotolerant Probiotic Yeast on Rumen Fermentation Pattern in Nellore Rams. *International Journal of Livestock Research*, 11(1), 167-171. <http://dx.doi.org/10.5455/ijlr.20200921113110>

Received : Sep 11, 2020
Accepted : Dec 31, 2020
Published : Jan 31, 2021

Copyright © Harikrishna *et al.*, 2021

This work is licensed under the Creative Commons Attribution International License (CC BY 4.0). <http://creativecommons.org/licenses/by/4.0/>



Abstract

*An experiment was conducted in a 4 x 4 LSD trial to find out the effect of thermotolerant probiotic yeast (*Saccharomyces cerevisiae*, OBV-9) on rumen fermentation pattern in Nellore rams (live weight 39.75±0.24 kg, 36±0.02 months age) fed with straw based complete diet. Probiotic yeast was supplemented at 0 (D1), 0.1 (D2), 0.2 (D3) and 0.3% (D4) level in the complete diet. Rumen liquor analysis revealed that, all the nitrogen fractions of rumen fluid (except food and protozoal nitrogen), pH and TVFA were significantly ($P<0.01$) higher on rations D2, D3 and D4 compared to D1. Time of sampling also had significant ($P<0.01$) effect on concentration of all rumen nitrogen fractions and TVFA, which peaked at 4 h post feeding, while ammonia nitrogen and pH were peaked at 2 h post feeding irrespective of rations. The study indicated that supplementation of thermotolerant yeast had favorable effect on pattern of nitrogen fractionalization, its absorption and utilization from the rumen in Nellore rams.*

Keywords: Complete Diet, Nellore Rams, Rumen Metabolites, Thermotolerant Yeast

Introduction

In India, large number of feed ingredients of variable chemical composition, digestibility and nutrient quality are being utilized as animal feed. However, good quality forages and concentrates are not always available to the livestock and several new technologies are being tried to improve the digestibility of straw-based diets. One such effort in recent years is supplementation of yeast to livestock rations to improve the utilization of cellulosic materials, health, productivity and reproduction by improving the balance of microbial flora in the rumen (Moallem *et al.*, 2009). A number of studies reported increased concentration of specialized bacteria associated with fiber digestion and lactic acid utilization in rumen on supplementation of yeast (Khadem *et al.*, 2007 and Malik and Singh, 2009). But the yeast '*Saccharomyces cerevisiae*' used so far, was mesophilic in nature and may not exert more beneficial action due to the harsh environmental (temperature and variation in pH) conditions in the rumen. Recently thermo and acid tolerant strain of yeast (*Saccharomyces cerevisiae*, OBV-9), which grows at >42°C temperature and pH 2 has been isolated (Bhima *et al.*, 2008). Hence, the present experiment was carried to find out the effect of feeding straw based complete diet supplemented with different levels of live thermotolerant yeast (*Saccharomyces cerevisiae*, OBV-9) on rumen fermentation pattern in Nellore rams.

Materials and Methods

Experiment was conducted at the Livestock Experimental Station, Livestock Research Institute (LRI), Rajendranagar, Hyderabad. A 4 x 4 Latin Square design using four Nellore rams (live weight 39.75 ± 0.24 kg, 36 ± 0.02 months age), the trial was conducted. Complete diets were formulated with roughage to concentrate ratio of 50:50 and processed into mash. The lyophilized thermotolerant yeast (*S. cerevisiae*, OBV-9) obtained from DBT project on "Development and Application of Thermotolerant Probiotic Yeast for Enhanced Animal Productivity", Department of Animal Nutrition, College of Veterinary Science, Rajendranagar, Hyderabad was used in the present study and supplemented at 0 (D₁), 0.1(D₂), 0.2(D₃) and 0.3% (D₄) level in the complete diet containing 50% Sorghum straw. The ingredient composition of complete diets has been presented in Table 1. The complete diet feed samples were analyzed for proximate composition (AOAC, 2002) and fibre fractions (Van Soest *et al.*, 1991).

Rumen liquor was obtained with the help of a stomach tube fitted with vacuum pump from each animal at 0 (before feeding) 2nd, 4th and 6th h after feeding for five consecutive days. Approximately 150 ml of rumen liquor was siphoned from different depths and directions of reticulo-rumen and transferred into pre heated thermos flask, strained through a fourfold muslin cloth. pH of strained rumen liquor (SRL) was estimated immediately after collection using glass electrode pH meter and samples were preserved in deep freeze after adding 1 ml of saturated mercuric chloride solution per 100 ml SRL for further analysis. Rumen liquor samples were analyzed for total nitrogen (Micro-Kjeldahl), Trichloro acetic acid (TCA), TCA-insoluble nitrogen (Cline *et al.*, 1958), Residual nitrogen, Food and protozoal nitrogen, (Singh *et al.*, 1968), Ammonia nitrogen (Conway, 1957) and TVFA (Barnett and Reid, 1956).

Data on pattern of nitrogen fractionalization, pH and TVFA in the ruminal fluid were analyzed according to the procedures suggested by Snedecor and Cochran (1994). Analysis of variance (ANOVA) was utilized to test the significance of various treatments and the difference between treatment means was tested for significance by Duncan's multiple-range and F Test (Duncan, 1955).

Results and Discussion

The chemical constituents (% of DM) complete diets used in the present study are presented in Table 1. The per cent dry matter (DM), organic matter (OM), crude protein (CP), ether extract (EE), crude fibre (CF), nitrogen free extract (NFE), total ash (TA), neutral detergent fibre (NDF), acid detergent fibre (ADF), hemicellulose and cellulose ranged between 89.16 to 89.90%, 90.87 to 91.59%, 11.80 to 11.94%, 1.39 to 1.59%, 26.98 to 27.14%, 50.70 to 51.00%, 8.41 to 9.13%, 54.70 to 56.55%, 34.63 to 37.12%, 19.41 to 20.07% and 27.84 to 28.56%, respectively in different complete diets on DM basis. The chemical composition of complete diets with or without yeast was comparable and the minor differences in the chemical constituent's concentration of complete diets might be due to variation in quantity of molasses and yeast in the diets.

Table 1: Ingredients and chemical constituents concentration of complete diets

Particulars	Complete diets ¹			
	D ₁	D ₂	D ₃	D ₄
Ingredients (g/kg DM)				
Sorghum straw	500	500	500	500
Maize	140	140	140	140
Groundnut cake	135	135	135	135
Sunflower cake	140	140	140	140
Molasses	70	69	68	67
Mineral and vitamins*	10	10	10	10
Common salt	5	5	5	5
Thermotolerant yeast culture	--	1	2	3
Nutrient (% DM basis)				
Dry matter	89.9	89.2	89.18	89.16
Organic matter	90.87	91.55	91.57	91.59
Crude protein	11.8	11.9	11.92	11.94
Ether extract	1.39	1.56	1.58	1.59
Crude fibre	26.98	27.09	27.12	27.14
Nitrogen free extract	50.7	51	50.95	50.92
Total ash	9.13	8.45	8.43	8.41
Neutral detergent fibre	54.7	56.55	56.53	56.51
Acid detergent fibre	34.63	36.63	37.12	37
Hemicellulose	20.07	19.92	19.41	19.51
Cellulose	27.84	28.12	28.21	28.56

*Vitamin supplement was added @ 10 g/100 kg complete diet and composition per 1 kg contained (vitamin A, 4,50,000 IU; vitamin D₃, 1,100,000 IU; vitamin E, 3.18g; Mn, 10.9 g; I, 1.09 g; Zn, 22.73 g; Fe, 22.73 g; Cu, 2.73 g; Co, 0.635; Mg, 100 g; Se, 0.1g)

Rumen profiles in respect of nitrogen constituents, pH and total volatile fatty acids (TVFA) of treatment diets are presented in Table 2. Total nitrogen, TCA insoluble nitrogen, ammonia nitrogen, residual nitrogen, pH and TVFA concentrations in rumen fluid of ram lambs fed with complete diets D₂, D₃ and D₄ were significantly ($P < 0.01$) higher compared to control (D₁), while there was no significant difference observed among the complete diets containing different levels of thermotolerant yeast.

Table 2: Least square means for rumen profiles in the SRL of Nellore rams fed complete diets

Rumen Profiles	Complete Diets ¹				
	D ₁	D ₂	D ₃	D ₄	SEM ²
Rumen nitrogen constituents (mg/100 ml)					
Total nitrogen	90.38 ^a	131.75 ^b	134.75 ^c	133.88 ^b	4.84
TCA insoluble nitrogen	43.25 ^a	63.81 ^b	64.38 ^b	64.56 ^b	2.36
Ammonia nitrogen	15.15 ^a	26.90 ^{bc}	26.50 ^b	27.70 ^c	1.34
Residual nitrogen	24.54 ^a	33.10 ^b	35.06 ^c	32.61 ^b	1.1
Food and protozoal nitrogen	7.44	7.94	8.81	9	0.33
Rumen pH and TVFA (Meq/l)					
Rumen pH	6.29 ^a	6.57 ^b	6.54 ^b	6.58 ^b	0.03
Total volatile fatty acids	62.86 ^a	65.66 ^b	65.40 ^b	65.76 ^b	0.32

¹Complete diets were (1) without yeast-control (D₁; n = 4) (2) with 0.1% thermotolerant yeast (D₂; n = 4) (3) with 0.2% thermotolerant yeast (D₃; n = 4) (4) with 0.3% thermotolerant yeast (D₄; n = 4); ²Standard error of pooled means; ^{a, b, c}: Means with different superscripts row wise differ significantly ($P < 0.01$)

Differences in the ruminal total nitrogen, TCA insoluble nitrogen, ammonia nitrogen, residual nitrogen, food and protozoal nitrogen, pH and TVFA concentrations due to time of sampling were also significantly ($P < 0.01$) different (Table 3). Peak concentrations of ruminal total nitrogen, TCA insoluble nitrogen, residual nitrogen and TVFA were recorded at 4 h post feeding, whereas ammonia nitrogen and pH concentrations were peaked at 2 h post feeding, in all the treatment diets.

Higher total nitrogen concentration recorded with the complete diets D₂, D₃ and D₄, might be due to higher intake

and better digestibility of nitrogen with the addition of yeast (Petkova *et al.*, 2002). The total nitrogen concentration was highest at 4 h after feeding in all the test rations. This might be due to active degradation of protein and hydrolysis of NPN substances in rumen and stimulatory effect of thermotolerant yeast on protease producing bacteria resulting in enhanced microbial metabolism and synthesis of microbial protein (Mahender, 2004). A similar trend observed with TCA insoluble nitrogen and peak concentration was observed at 4 h post feeding, this could be due to active degradation of protein, synthesis of microbial protein in the rumen and subsequent decline in its concentration due to change in the rumen volume through inflow of saliva (Murali *et al.*, 1989). Higher levels of rumen ammonia nitrogen and residual nitrogen observed with complete diets D₂, D₃ and D₄, compared to control might be due to active degradation of protein and hydrolysis of NPN substances in rumen (Rohilla *et al.*, 2009).

Table 3: Least square means for rumen profiles in the SRL of Nellore rams fed complete diets as affected by time of sampling

Rumen Profiles	Hours of Sampling				
	0	2	4	6	SEM ¹
Rumen nitrogen constituents (mg/100 ml)					
Total nitrogen	101.63 ^a	117.50 ^b	152.00 ^c	119.63 ^b	3.35
TCA insoluble nitrogen	50.50 ^a	57.56 ^b	69.69 ^c	58.25 ^b	1.45
Ammonia nitrogen	13.35 ^a	33.30 ^c	24.70 ^b	24.90 ^b	1.14
Residual nitrogen	29.31 ^b	21.39 ^a	44.05 ^c	30.57 ^b	1.24
Food and protozoal nitrogen	8.47 ^b	5.25 ^a	13.56 ^c	5.91 ^a	0.55
Rumen pH and TVFA (Meq/l)					
Rumen pH	6.34 ^a	6.67 ^c	6.60 ^b	6.36 ^a	0.03
Total volatile fatty acids	63.39 ^a	65.98 ^b	66.67 ^c	63.64 ^a	0.26

^{a, b, c}: Means with different superscripts row wise differ significantly ($P < 0.01$); ¹Standard error of pooled means

Ruminal food and protozoal nitrogen concentration were comparable among the complete diets and supplementation of yeast had no significant effect (Table 2). This result is consistent with the findings of Arcos Garcia *et al.* (2000) in Suffolk sheep fed yeast-based diets. Time of sampling had significant ($P < 0.01$) effect on concentration of food and protozoal nitrogen, peak concentrations were recorded 4 h post feeding with all the complete diets and it could be due to increase in cellulolytic bacteria (Monika Singhla *et al.*, 2000). The pH of strained rumen liquor was significantly ($P < 0.01$) higher with complete diets however, no significant difference was observed among the complete diets. Increase in rumen pH with yeast supplementation might be attributed to decrease in the concentration of lactic acid as a result of stimulation for removal of lactate by ruminal lactate utilizing bacteria in the presence of yeast (Nisbet and Martin, 1991). Time of sampling had significant ($P < 0.01$) effect on ruminal pH values, and highest concentration of pH value was observed at 2 h post feeding with all the four diets. Similarly, concentration of TVFA has been increased significantly with yeast supplementation, however no significant difference was observed among the complete diets indicating better digestibility of fibre in the rumen (Malik and Singh, 2009). Peak TVFA concentrations were recorded at 4 h post feeding with all the four diets. These results corroborated with that of Salem *et al.* (2002).

The study indicated that supplementation of thermotolerant yeast had favorable effect on pattern of nitrogen fractionalization, its absorption and utilization from the rumen in Nellore rams that would probably lead to better performance for the benefit of livestock producers.

Acknowledgements

The authors are extremely thankful to the financial assistance from DBT Project, Department of Animal Nutrition, College of Veterinary Science, Rajendranagar, Hyderabad. Appreciation is expressed to Dept. of Animal Nutrition and technical staff of LRI for conducting this experiment.

Conflict of Interests

There is no conflict of interest.

Publisher Disclaimer

IJLR remains neutral concerning jurisdictional claims in published institutional affiliation.

References

1. Arcos Garcia, J. L., Castrejon, F. A., Mendoza, G. D. and Perez, G. E. P. (2000). Effect of two commercial yeast cultures (*S. cerevisiae*) on ruminal fermentation and digestion in sheep fed sugar cane tops. *Livestock Production Science*. 63: 153–157.
2. Association of Official Analytical Chemist (2002). *Official methods of analysis*, 16th ed., AOAC, Arlington, VA, USA.
3. Barnett, A. J. and Reid, R. C. (1956). Studies on the production of volatile fatty acids from the grass by rumen liquor in an artificial rumen. 1. VFA production from grass. *Journal of Agriculture Science*. 48: 315.
4. Bhima, B., Reddy, M. S., Pavana Jyothi, Ch., Reddy, Y. R. and Rao, L. V. 2008. Optimization of conditions for large scale production of thermotolerant probiotic yeast (*S. cerevisiae*) by Taguchi methodology. Proceedings of the 3rd International Congress on Bioprocesses in Food Industries: Abstr. IL 12.
5. Cline, H., Hershberger, T. N. and Bensely. (1958). Utilization and or synthesis of valeric acid during the digestion of glucose, starch and cellulose by rumen microorganism *in vitro*. *Journal of Animal Science*. 17: 284-291.
6. Conway, E. J. (1957). *Microdiffusion Analysis and Volumetric Error*. 3rd edition, Crosby Lockwood Publishers, London.
7. Duncan, D. B. (1955). Multiple range and multiple F tests. *Biometrics*. 11: 1-42.
8. Khadem, A. A., Pahlavan, M., Afzalzadeh, A. and Rezaeian, M. (2007). Effects of live yeast *S. cerevisiae* on fermentation parameters and microbial populations of rumen, total tract digestibility of diet nutrients and on the *in situ* degradability of alfalfa hay in Iranian Chall sheep. *Pakistan Journal of Biological Science*. 10: 590-597.
9. Mahender, M. (2004). *Effect of feeding yeast culture based complete diets for economical milk and meat production*. Ph.D Thesis submitted to ANGRAU, Hyderabad.
10. Malik, R. and Singh, R. (2009). Effect of yeast and fungi culture on *in vitro* ruminal fermentation. *Indian Journal of Animal Nutrition*. 26: 40-45.
11. Moallem, U., Lehrer, H., Livshitz, M., Zachut, M. and Yakoby, S. (2009). The effects of live yeast supplementation to dairy cows during the hot season on production, feed efficiency and digestibility. *Journal of Dairy Science*. 92: 343-351.
12. Monika Singla, Kumar, U., Sarean, V. K. and Singh, S. (2000). Effect of yeast culture (yea sacc¹⁰²⁶) supplement on fermentation and *in sacco* digestibility of some roughage in buffalo calves. *Indian Journal of Animal Science*. 70: 289–293.
13. Murali, S., Reedy, G. V. N. and Reddy, M. R. (1989). Effect of particle size on utilization of maize cobs in complete feeds of cross bred bulls. *Indian Journal of Animal Science*. 59: 1299-1303.
14. Nisbet, D. J. and Martin. (1991). Effect of yea sacc 1026 on lactate utilization by the ruminal bacterium *Selenomonas ruminatiam*. *Biotechnology in the Feed Industry* (Ed.) Lyons T P, Alltech Technical Production, Nicholasville, Kentucky. pp. 563-567.
15. Petkova, M., Schindarska, Z. and Odjakova, T. (2002). Comparative study of effects of yea sacc 1026 and Enterosan on fermentation in rumen of lambs. *International Journal of Animal Sciences*. 9: 117–121.
16. Rohilla, P. P., Patil, N. V. and Bohra, H. C. (2009). Effects of probiotics and nutri mix on kids and goats. *Indian Veterinary Journal*. 86: 640-641.
17. Salem, F. A., El Mahdy, M. R., Zaza, E. H. and Abo Donia, F. M. A. (2002). Effect of non-hormonal growth promoters on digestibility, rumen fermentation, some blood constituents and growth in sheep. *Annals Agricultural Sciences. Moshtohor*. 40: 1449-1460.
18. Singh, A. K., Sudarshan, P. N., Langer, G. S., Sidhu, A. S., Kochar. and Bhatia. (1968). Study of rumen biochemical activity in the buffaloes and Zebu cattle under non urea feeding regimens. *Indian Journal of Veterinary Science and Animal Husbandry*. 38: 674-681.
19. Snedecor, G. W. and Cochran, W. G. (1994). *Statistical methods*. 8th edn, Iowa State University Press, Ames, Iowa, USA-50010.
20. Van Soest P J, Robertson J B and Lewis B A. (1991). Methods for dietary fibre, neutral detergent fibre and non-starch polysaccharides in relation to animal nutrition. *Journal of Dairy Science*. 74: 3583–3597.
