Biological Forum – An International Journal **13(4): 85-89(2021)**

ISSN No. (Print): 0975-1130
ISSN No. (Online): 2249-3239

Effect of Dietary Non-structural Carbohydrate Levels on Faecal characteristics in Mecheri Lambs

P. Senthilkumar[1], P. Vasan[2*], B. Mohan[3], P. Selvaraj[4] and J. Muralidharan[5]

[1]Assistant Professor, Mecheri Sheep Research Station, Pottaneri-636 453, (Tamil Nadu), India.
[2]Professor and Head, Department of Animal Nutrition,
Veterinary College and Research Institute, Theni- 625602, (Tamil Nadu), India.
[3]Controller of Examinations, Tamil Nadu Veterinary and Animal Sciences University,
Madhavaram, Chennai -51, (Tamil Nadu), India.
[4]Professor and Head, Department of Veterinary Physiology, Veterinary College and Research Institute,
Namakkal, Tamil Nadu Veterinary and Animal Sciences University, (Tamil Nadu), India.
[5]Professor and Head, Mecheri Sheep Research Station, Pottaneri-636453, (Tamil Nadu), India.

(Corresponding author: P. Vasan)*
(Received 06 August 2021, Accepted 07 October, 2021)
(Published by Research Trend, Website: www.researchtrend.net)

ABSTRACT: An experiment was conducted in thirty-two Mecheri ram lambs, aged about 15 days with uniform body weight. Animals were randomly allotted into four groups of 8 lambs each viz., T1, T2, T3, and T4 in a completely randomized design and reared for 3 months of weaning age. The four isonitrogenous and isocaloric complete diets varying in non-structural carbohydrate (NSC) levels were prepared and offered to the respective treatment groups *ad libitum* throughout the study in addition to milk suckling from their dam. The DMI and BCS were lower in T1 and were increased as dietary NSC levels increases. Among the treatment groups, lambs on a higher NSC diet (T4) had significantly (P<0.05) higher faecal scores and a better score was observed for T2. The faecal DM, NDF content was significantly (P<0.05) lower and the NSC content was higher in T4 group. It could be concluded that a higher level of NSC in the diet increased the faecal score, indicates that the disturbance in the rumen fermentation and need dietary intervention to improve faecal consistency when such high NSC feed used for higher weight gain.

Keywords: Lambs, Non-structural carbohydrate, Body condition score, Faecal consistency.

INTRODUCTION

In recent years with sheep production systems becoming more and more intensive, various attempts in feed processing technology has been made to increase their feed efficiency. To attain maximum bodyweight over the conventional production system, it is necessary to include an energy supplement in the ruminant diet at a higher level. Forages are often viewed as inexpensive sources of energy for ruminants, but when unit (Mcal of ME) energy of starch is concerned, sugars are less expensive and fibre digestion is considered as energetically less favourable (VandeHaar and St-Pierre, 2006). Many studies indicate that rumen conditions for fibrolysis may become adverse when the level of energy supplements in the diet increases. However, the extent of this depression depends on the level of energy supplement (Henning *et al*., 1980). Carbohydrates contribute the largest proportion required for ruminants (Nocek and Russel, 1988).

In the past, the energy supply to the animals was studied on the basis of dietary roughage-to-concentrate ratios and its effect on animal performances. However, after the development of the Cornell Net Carbohydrate and Protein (CNCP) system by Sniffen *et al*., (1992) to evaluate the nutritional composition of feedstuffs, researchers felt that the study on structural carbohydrate (SC) and non-structural carbohydrate (NSC) of the diet would be more rational to assess the performance of the animals. Dietary NSC level significantly influences rumen fermentation (Liu *et al*., 2013; Ma *et al*., 2015). Bodine *et al*., (2001) reported that a specific amount of readily fermentable carbohydrate (non-structural carbohydrate -NSC including sugars, starch and organic acids) is needed to satisfy the activity of rumen microbes which could alter the microbial protein and VFA production. The dietary NSC level is more rational and provides the potential for improving the sheep's performance. In this context, the studies are very limited. The faecal characteristics are the simple indices to assess the gut health of the animals. Hence the present study was aimed to investigate the effect of dietary NSC levels on faecal characteristics, dry matter intake (DMI) and body condition score (BCS) in Mecheri lambs.

MATERIALS AND METHODS

An experiment was conducted in thirty-two Mecheri lambs with an average body weight of 5.23±0.012 kg, aged about 15 days. Animals were randomly allotted into four groups of 8 lambs each in a completely randomized design and reared for 3 months of weaning age. The experimental animals were reared at Mecheri Sheep Research Station (MSRS), Tamil Nadu Veterinary and Animal Sciences University, Pottaneri, Salem, Tamil Nadu. All the animals were housed in well-ventilated pen with individual feeding and watering facility. Experimental animals were dewormed and vaccinated as per the Animal Death Reporting Committee of the University. For this study, four isonitrogenous and isocaloric complete diets but with varying levels of NSC were prepared in mash form to meet the nutrient requirements as recommended by ICAR (2013). The NSC levels in the diet were achieved by altering the sorghum hay and molasses, while the energy in the ration was maintained by adding palm oil. The physical and chemical composition of experimental rations is presented in Table 1.

Table 1: Physical and chemical composition of experimental diets.

Item	Experimental Groups			
	T1	T2	T3	T4
Ingredient Composition [a] (%)				
Sorghum hay	32	22	18.2	-
Maize	33.8	36	41.2	41
Soybean meal	27.7	27	27.5	23.7
DORB	1.4	7.1	3.5	26.7
Palm oil	1.5	1.0	-	-
Molasses	-	3.3	6.0	5.0
Calcite Powder	2.5	2.5	2.5	2.5
Sodium bicarbonate	0.5	0.5	0.5	0.5
Salt	0.5	0.5	0.5	0.5
Trace Mineral Mixture	0.1	0.1	0.1	0.1
Chemical composition (% DM)				
DM	89.53	88.95	88.34	88.53
OM	82.28	81.92	81.27	81.35
CP	18.08	18.10	18.43	18.37
NDF	34.94	28.24	25.35	21.30
ADF	21.46	16.87	14.74	7.19
Hemicellulose	13.48	11.37	10.61	14.11
ME (kcal/kg)	2534	2561	2598	2561
NSC	40.87	45.13	50.26	55.67
Ca	1.14	1.13	1.13	1.07
P	0.31	0.40	0.36	0.71

[a]Vitamin A 8250 IU, Vitamin D 12000 IU and Vitamin K 1mg per kg feed was added.

Respective rations were offered to the animals twice daily at 9.00 h and 15.00 h. Animals were offered weighed quantities of respective diet *ad libitum* throughout the study. The amount of feed offered was always 10 per cent higher than the previous intake to ensure *ad libitum* intake. During the study period, lambs were allowed about 10 minutes in the morning and evening to suckle milk from respective dams. The milk intake of lambs was calculated by the difference in weights of lambs before and after suckling. BCS (Body condition score, 1-5 scale) was performed by feeling the fat deposition over and around the vertebrae in the loin region as described by Kenyon *et al*., (2014). The DMI, BCS and faecal composition were calculated during experimental period of 3 months (15-90 days).

Feed and faecal samples were analysed for nitrogen and DM according to procedures (nos. 4.1.02 and 4.1.03, respectively) described by AOAC (1997). The neutral detergent fibre (NDF) was estimated using sodium sulfite and acid detergent fibre (ADF) as described by Van Soest *et al.,* (1991). Calcium was estimated as per the method described by Talapatra *et al.,* (1940). Phosphorus was determined colorimetrically as per the method of Ward and Johnston (1962). NSC concentration was calculated according to Sniffen *et al.,* (1992): NSC = 100 – [(NDF – NDIP*) + CP +EE + ash]; * nitrogen bound to NDF.

Fresh faecal samples were collected in plastic bags and transported immediately to the laboratory for an on the spot evaluation. Faecal scores were assigned for each sample using a 5-point scale. The faecal scores were assigned based on the following criteria for scoring, 1 = normal, 2 = soft to loose, 3 = loose to watery, 4 = watery, mucous, slightly bloody, 5 = watery, mucous, and bloody as per the method described by Heinrichs *et al*., (2003). Faecal scoring was done in alternative days up to the weaning age of lambs.

Data were subjected to analysis of variance according to the procedures suggested by Snedecor and Cochran, (1994). The difference between treatments means was tested for significance by Duncan's new multiple range (Duncan, 1955).

RESULTS AND DISCUSSION

Effects of dietary NSC level on DMI and BCS are presented in Table 2. The DMI was affected by dietary NSC level in the present study. However, the DM consumed from milk was similar among the treatment groups. The DMI was lower in T1 and was increased as dietary NSC level increases up to 50.96 per cent DM level. This indicated higher palatability of NSC of the feed (Nocek and Russel, 1988). The DMI on per cent body weight was significantly higher in the low NSC diet group. This can be attributed to lower weight gain in that T1 group. But, the DMI of lambs in the T4 group was significantly ($P<0.006$) lower as compared to other groups. Similarly, the DMI on per cent body weight was also lower among the treatment groups. This may be attributed to the change in rumen fermentation of nutrients like increased VFAs and lowered ruminal pH caused by an increased level of easily fermentable NSC in the diet (Nagaraja and Town, 1990).

Table 2: Effect of dietary NSC levels on dry matter intake and body condition score in Mecheri lambs.

Parameters	Experimental Groups				SEM	P-Value
	T1	T2	T3	T4		
DMI-feed, g/day	242.1[b]	261.2[ab]	268. 6[a]	212.7[c]	0.034	0.007
DMI-Milk, g/day	35.00	31.82	43.38	34.05	0.018	0.077
Total DMI, % of BW	2.24[a]	2.02[ab]	1.98[ab]	1.76[b]	0.052	0.025
BCS	2.13[b]	2.88[a]	3.00[a]	3.13[a]	0.124	0.013

[a,b,c]Means with different superscript in the same row differ significantly ($p<0.05$)

The BCS improved in proportion to incremental increase of NSC in the diet. This can be attributed to an increase in body weight in all the groups except the low NSC diet group which had significantly lower BCS. Increased weight gain in the higher NSC group in spite of lower DMI could be due to increased CP intake, retention, and digestibility of OM (Ma *et al*., 2015).

In the present study, faecal scores of 4 and 5 were not recorded in any of the experimental lambs (Table 3). In all the treatment groups, lambs had a higher faecal score for the first two weeks, which reduced later. It shows the ability of lambs to accustom to the diet in the later part of the pre-weaning period.

Table 3: Effect of dietary NSC levels on faecal score in Mecheri lambs.

Age (Days)	Experimental Groups				SEM	P-Value
	T1	T2	T3	T4		
15-30	1.81[b]	1.54[b]	1.56[b]	2.19[a]	0.07	0.002
31-45	1.5[b]	1.04[c]	1.16[c]	2.02[a]	0.04	0.001
46-60	1.05[b]	1.14[b]	1.18[b]	2.07[a]	0.08	0.001
61-75	1.05[b]	1.04[b]	1.06[b]	2.08[a]	0.08	0.001
76-90	1.09[b]	1.04[b]	1.03[b]	1.79[a]	0.06	0.001
Overall	1.3[b]	1.16[c]	1.19[bc]	2.03[a]	0.07	0.001

[a,b,c]Means with different superscript in the same row differ significantly ($p<0.05$)

Among the groups, the higher dietary NSC group had a significantly ($P<0.001$) higher faecal score in all the study periods. Overall mean faecal score was significantly ($P<0.001$) higher (2.03) in high dietary NSC group T4, while better score (1.16) was observed in T2 group lambs. The faecal composition evaluation revealed that lambs fed higher NSC diet had significantly ($P<0.001$) lower faecal DM and NDF, while containing higher NSC levels in the faeces (Table 4). Lambs fed with high NSC diet had faeces that were visually large porridge in nature, dome shaped and had no pellets, whereas in groups T1, T2 and T3 the faeces were firm and in pellet form (Fig. 1).

Table 4: Effect of dietary NSC levels on faecal composition in Mecheri lambs.

Parameters	Experimental Groups				SEM	P-Value
	T1	T2	T3	T4		
DM, %	88.33[a]	88.03[a]	85.63[b]	83.32[b]	0.568	0.001
NDF, % of DM	41.16[a]	39.28[a]	39.55[a]	33.76[b]	0.659	0.001
NSC, % of DM	21.89[b]	15.47[c]	10.24[d]	38.16[a]	2.28	0.001
CP, % of DM	29.04	29.11	28.32	29.49	0.245	0.375

[a,b,c, d]Means with different superscript in the same row differ significantly ($p<0.05$)

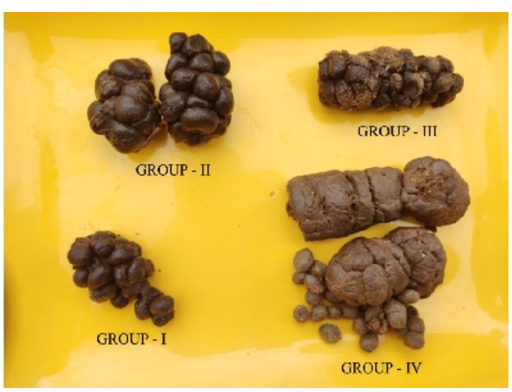

Fig. 1. Faecal images of different dietary groups.

Faeces DM concentration increased with increased DMI and vice versa in an isonitrogenous and isocaloric diet in the present study. Lambs in higher NSC diet group consumed less DM and had faeces that appeared soft-loose in consistency which increased the faecal score in the present study. The higher faecal score can be attributed to the lower DM in the faeces. This result is in agreement with that of Ewing and Smith, (1917), who stated that those faeces that visually appear more liquid in consistency would have higher moisture.

The lower NDF content in faeces can be attributed to the lower NDF concentration in the feed. The low faecal NDF content in the higher NSC diet and the negative correlation between dietary NDF and faecal consistency also could be the reason for higher faecal score (Marynard *et al.*, 1979). Similar to the fact that higher NSC level decrease the NDF content in the formulated diet, higher dietary NSC level also alters the RUDP and RDP especially the later content on the higher side. The higher water intake was evidenced in higher NSC diet fed lambs in the present study. This may be due to the excessive intake of protein or high levels of rumen degradable protein (RDP) that lead to increased water intake in order to excrete nitrogen through urine. This is in agreement with Ma *et al.*, (2015) who reported increased nitrogen excretion in urine and nitrogen retention in higher NSC fed lambs. However, the CP content in the faeces was not affected by dietary NSC level in the present study. The numerically higher CP level in the faeces of group T4 may be due to excess intake of protein which escaped rumen fermentation and microbial debris (Ireland-Perry and Stallings, 1993). Similarly, higher NSC present in the faeces of higher NSC diet fed lambs may be attributed to higher passage rate of the high grain diet that escaped rumen fermentation and hindgut digestion and thereby excess present in the faeces (Ireland-Perry and Stallings, 1993) which contributed to the faecal consistency. The lower faecal score in groups T1, T2 and T3 may be due to more retention time of feed in the rumen, the structural appearance of faeces was improved due to lower NSC or higher fibre level in the faeces (Mgbeahuruike, 2007).

The effect of dietary NSC level was mostly quadratic in the tested range (Fig. 2). The quadratic regression equation for mean faecal score; y = 21.212+ -0.890X + 0.010X2, R2 = 0.865.

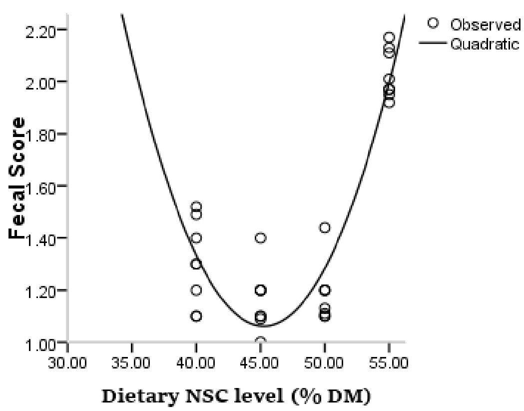

Fig. 2. Correlation between dietary NSC levels and fecal score in Mecheri lambs.

A better faecal consistency was noticed for T2 group lambs, a diet containing 45.13% NSC in the diet. It could therefore be concluded that increasing dietary NSC level significantly increases the BCS and DMI, but a higher NSC level decreases the DMI without affecting the BCS. The faecal score increased as the dietary NSC level increased. But, faecal scores of 4 and 5 were not recorded in any of the experimental lambs. However, maintaining a higher NSC level in the diet with the aim of attaining higher body weight gain increases the faecal score, indicating disturbances in the rumen fermentation pattern. Hence, under such instances, necessary measures have to be taken to maintain rumen health which in turn improves the faecal consistency.

Acknowledgment. The authors are thankful to Tamil Nadu Veterinary and Animal Sciences University for providing necessary facilities and financial support to carry out this research work.

Conflicts of Interest. There is no conflict of interest

REFERENCES

AOAC, Association of Official Analytical Chemists International (1997). Official Methods of Analysis, 16th edition. Arlington, VA, USA.

Bodine, T. N., Purvis, H. T., & Lalman, D. L. (2001). Effects of supplement type on animal performance, forage intake, digestion, and ruminal measurements of growing beef cattle. *Journal of Animal Science, 79*: 1041-1051.

Duncan, D. B. (1955). Multiple range and multiple F tests. *Biometrics, 11*: 1−42.

Ewing, P. V., & Smith, F. H. (1917). A study of the rate of residues through the steer and its influence on digestion coefficients. *Journal of Agricultural Research, 10*: 55.

Heinrichs, A. J., Jones, C. M., VanRoekel, L. R., & Fowler, M. A. (2003). Calf Track: A system of dairy calf workforce management, training, and evaluation and health evaluation. *Journal of Dairy Science 86* (*Suppl. 1*): 115.

Henning, P. A., Van der Linden, Y., Mattheyse, M. E., Nauhaus, W. K., & Schwartz, H. M. (1980). Factors affecting the intake and digestion of roughage by sheep fed maize straw supplemented with maize grain. *Journal of Agricultural Science, 94*: 565-573.

ICAR, Indian Council of Agricultural Research (2013). Nutrient Requirements of Sheep, Goat and Rabbit. 3rd Edition.

Ireland-Perry, R. L., & Stallings, C. C. (1993). Fecal Consistency as Related to Dietary Composition in Lactating Holstein Cows. *Journal Dairy Science, 76*: 1074-1082.

Kenyon, P. R., Maloney, S. K., & Blache, D. (2014). Review of sheep body condition score in relation to production characteristics. *New Zealand Journal of Agricultural Research, 57*: 38-64.

Liu, D. C., Zhou, X. L., Zhao, P. T., Gao, M., Han, H. Q., & Hu, H. L. (2013). Effects of increasing non-fiber carbohydrate to neutral detergent fiber ratio on rumen fermentation and microbiota in goats. *Journal of Integrated Agriculture, 12*: 319-326.

Ma, T., Tu, Y., Zhang, N. F., Deng, K. D., & Diao, Q. Y. (2015). Effect of the Ratio of Non-fibrous Carbohydrates to Neutral Detergent Fiber and Protein Structure on Intake, Digestibility, Rumen Fermentation, and Nitrogen Metabolism in Lambs. Asian Australas. *Journal of Animal Science, 28*(10): 1419-1426.

Marynard, L. A., Loosli, J. K., Hintz, H. F., & Warme, R. G. (1979). Animal Nutrition. 7th ed. McGraw Hill, New York. NY.

Mgbeahuruike, A. C. (2007). Fecal characteristics and production of dairy cows in early lactation. MSc Thesis, Swedish University of Agricultural Science, Skara, Sweden.

Nagaraja, T. G., & Town, G. (1990). Ciliated Protozoa in relation to ruminal acidosis and lactic acid metabolism. In: Oneora, R., Minota, H., Itabashi, H. (Eds.). Rumen ecosystem: Microbial metabolism and regulation, Pringer Veriag, New Yark, NY, pp194.

Nocek, J. E., & Russell, J. B. (1988). Protein and energy as an integrated system. Relationship of ruminal protein and carbohydrate availability to microbial synthesis and milk production. *Journal of Dairy Science, 71*(8): 2070-2107.

Snedecor, G. W., & Cochran, W. G. (1994). Statistical Methods, The Iowa State University Press, Iowa.

Sniffen, C. J., O'connor, J. D., Van Soest, P. J., Fox, D. G., & Russel, J. B. (1992). A Net Carbohydrate and Protein System for evaluating cattle diets: II. Carbohydrate and protein availability. *Journal of Animal Science, 70*: 3562-3577.

Talapatra, S. K., Roy, S.C., & Sen, K. C. (1940). Estimation of phosphorus, chlorine, calcium, magnesium, sodium and potassium in food stuffs. *Indian Journal of Veterinary Science and Animal Husbandry, 10*: 243−258.

Van Soest, P. J., Robertson, J. B., & Lewis, B. A. (1991). Methods for dietary fiber, neutral detergent fiber and non- starch polysaccharides in relation to animal nutrition. *Journal of Dairy Science, 74*: 3583−3597.

VandeHaar, M. J., & St-Pierre, N. (2006). Major advances in nutrition: relevance to the sustainability of the dairy industry. *Journal of Dairy Science, 89*(4):1280-1291.

Ward, G. M., & Johnston, F. B. (1962). Chemical methods of plants analysis. Research Branch, Canada, Department of Agriculture. Publ. 1064.

How to cite this article: Senthilkumar, P.; Vasan, P.; Mohan, B.; Selvaraj, P. and Muralidharan, J. (2021). Effect of Dietary Non-structural Carbohydrate Levels on Faecal characteristics in Mecheri Lambs. *Biological Forum – An International Journal, 13*(4): 85-89.