RESEARCH ARTICLE

Growth Performance, Nutritional Behaviour, and Faecal Consistency Score of Feedlot Nellore Brown Lambs Fed Diets with Probiotic and Sodium Bicarbonate

Maram Harani*, Vannam Yugandhar, Elluru Sireesha, Korra Balaji Naik, Malavathu Mallikarjun, Chandra Radhakumari

Abstract

A study was undertaken at IFS shed, KVK, Kalyandurg, (AP, India) to determine the effect of feeding probiotic and sodium bicarbonate on growth performance, nutritional behaviour, and faecal consistency score in Nellore brown lambs. Twenty four ram lambs were randomly assigned to three group on the basis of body weight, *viz.,* T1 (control): Super napier, Hedge lucerne and Concentrate mixture with 20% protein, T2 (treatment): control feed with 15 g of probiotics, and T3 (treatment): control feed with 20 g sodium bicarbonate per kg DMI. The final body weights, average daily weight gain and feed conversion ratio were significantly higher in both the treatment groups than in the control group. The behaviour parameters like ingestion, rumination, chewing and idleness were also significantly higher in probiotic and sodium bicarbonate supplemented groups. However, the rumination time in min/day, was recorded to have negative linear association with feed additive supplemented groups. The faecal consistency scores for T1, T2 and T3 differed significantly among treatment groups, whereas normal faeces were recorded in probiotics supplemented groups.

Key words: Nellore brown, Probiotic, Ram lambs, Sodium bicarbonate, Yeast.

Ind J Vet Sci and Biotech (2024): 10.48165/ijvsbt.20.4.20

Introduction

Low productivity of local sheep produced by traditional farmers in India might be due to poor genetics and nutrition. Munir and Kardiyanto (2015) reported that local sheep fed with Elephant grass as the main diet had ADG of only 56.5 g/head/day. Nowadays, the farmers have also been challenged for lack of high-quality forages as many pastures have changed into industrial and housing areas. Lone forage feeding for sheep, *i.e.* whole maize silage containing 10.7 % CP, will not reach a maximum ADG and need supportive high-quality feed such as concentrate and nutritional supplements. However, feeding high concentrate diet will cause a decrease of rumen pH leading to an increased risk of rumen acidosis (Gaylean and Rivera, 2003). In such cases, sodium bicarbonate is widely used in sheep diet, a minimal dose as a buffer, to normalize rumen pH at 6.0-7.0. At normal pH, rumen microbes will function well to degrade feeds leading to improved nutrient absorption and nutrient conversion into meat and other sheep products.

In the last few decades, antibiotics that are used as growth promoters in animal feed have been under severe attention since they pose a potential threat to consumers by generating antibiotic-resistant bacteria (Sultan *et al.,* 2015) Therefore, to improve the health and productivity of animals without having any negative consequences, it is crucial to develop alternatives to antibiotic growth promoters, such as acidifers, alkanizers, essential oils, probiotics, and prebiotics (Babazadeh *et al.,* 2011; Allen *et al.,* 2013). Feed additives have not only used to promote growth, but they used to stabilize the benefcial gut microfora by inhibiting harmful microorganisms (Hashemi and Davoodi, 2011; Abudabos *et al.,* 2017). Recently, supplemented diets with phytogens as feed additives showed signifcant effects on growth parameters, immune response and gut health status in animals (Saeed *et al.,* 2017). Chand *et al.* (2016) demonstrated that increasing the surface area of the villi increases intestinal digestion and nutrient absorption. The goal of probiotics is to maintain the proper balance of the microbial flora, allowing for better nutrient digestion and better food transformation in milk and meat. Thus, the objective of this experiment was to find out the effect of probiotic and sodium bicarbonate powders in the diet on growth, DMI, FCR, behavioural traits and the faecal consistency index of feedlot sheep.

ICAR - Krishi Vigyan Kendra, Kalyandurg, Anantapur-515761, ANGRAU, Andhra Pradesh, India

Corresponding Author: M. Harani, Scientist, ICAR- Krishi Vigyan Kendra, Kalyandurg, Anantapur-515761, ANGRAU, Andhra Pradesh, India. e-mail: hariniredd555@gmail.com.

How to cite this article: Harani, M., Yugandhar, V., Sireesha, E., Naik, K. B., Mallikarjun, M., & Radhakumari, C. (2024). Growth Performance, Nutritional Behaviour, and Faecal Consistency Score of Feedlot Nellore Brown Lambs Fed Diets with Probiotic and Sodium Bicarbonate. Ind J Vet Sci and Biotech. 20(4), 95-99.

Source of support: Nil

Conflict of interest: None

Submitted 03/03/2024 **Accepted** 29/04/2024 **Published** 10/07/2024

Materials and Methods

A feeding experiment was conducted at Krishi Vigyan Kendra, Kalyandurg, Anantapur district, Andhra Pradesh (India) on

eighteen weaned ram lambs (3-4 months old). The lambs on the basis of body weights were randomly distributed into 3 groups (T1, T2 and T3) of eight lambs each in a completely randomized design. The lambs of T1, T2 and T3 had an initial body weight of 11.5-12.0 kg and were fed with CoFs-31, Hedge lucerne fodder and concentrate feed. The concentrate feed was fed 50-100 g/day to meet their nutrient requirement for the body weight gain. Further, no feed additive was given to T1 group (control), while T2 and T3 groups were provided with 15 g probiotic and 20 g sodium bicarbonate per kg DM of feed, respectively, for 120 days. The probiotic product "RumEest-ESF" (*Saccharomyces cerevisiae* @ 5 billion CFU/gram) used in the present study was procured from Neospark Drugs and Chemicals Private Limited, Hyderabad, and sodium bicarbonate was procured locally. The lambs were fed according to the experimental diets at 9 00 and 15 00 h by weighing on electronic balance and the leftover feed if any was recorded next day morning to calculate dry matter intake (DMI). At the start and halfway through the study, all of the lambs received deworming treatment with albendazole at a dose of 10 mg/kg body weight. All the animals were kept in a well ventilated shed with adequate space requirement providing access to *ad libitum* hygienic water. The shed was routinely cleaned and disinfected with bleaching water, and it was given enough time to dry.

Body Weight Measurement: Regular weighing of the lambs was practiced prior to feeding and watering at fortnightly intervals to know the effect of experimental diets on average daily gain (ADG) and feed efficiency using standard formulae.

Faecal Consistency Index: According to physical appearance of faeces, faecal fluidity score developed by Di francia *et al*. (2008) was used in this study. The faecal consistency was assessed daily using a numerical score of 0-4 (*i.e.,* 0 = severe scours,1 = scours, 2 = soft, 3 = normal, 4 = firm). No treatment for scours was initiated if diarrhoea was assessed to be occurring.

Nutritional Behavioural Parameters, *viz.,* eating (lamb's head was in feed manger), total ruminating time (lying and ruminating + standing and ruminating), chewing time, and idleness time used in this study were as explained by Dias *et al.* (2018). Data obtained were subjected to one-way analysis of variance (version 23.0; SPSS, 2015) and the treatment means were ranked using Duncan's multiple range test with a significance at $p<0.05$.

Results and Discussion

The proximate analysis of Hedge lucerne and Super napier revealed dry matter content 25.0 and 20.5%, crude protein 18.2% and 8.64%, and ether extract 2.6% and 1.43%, respectively, while other components did not differ much.

Dry Matter Intake, Growth and FCR:

The mean values of DMI (g/day), ADG (g/head/day) and FCR of feedlot sheep fed with diets containing probiotic and sodium bicarbonate are presented in Table 1. The results showed that the initial weights for T1, T2 and T3 groups were 11.52, 11.56 and 11.99 kg, and the final body weights 25.1, 26.7 and 28.4 kg, respectively. Addition of probiotics and buffer to the diet, showed significant ($p<0.05$) positive effect on rumen health and also improved the intake of nutrients and performance over non-supplemented control group. A profound increment ($p<0.05$) was noticed in the ADG of Nellore brown lambs of T2 (126.9 g) and T3 (136.7 g) groups over control T1 (112.3 g). The highest ADG was noticed in sodium bicarbonate supplemented group. The feed conversion efficiency also showed positive linear effect ($p<0.05$) in the supplemented groups. The DMI (g/day) also showed an increasing linear effect in the supplemented groups T2 and T3, being highest ($p<0.05$) in bicarbonate supplemented group (Table 1).

Similar to our study, Shoukry *et al.* (2023) also recorded increased feed intake, growth rate, average daily gain, and feed efficiency of lambs on feed additive supplementation with marginally higher values in probiotic-supplemented group (1.00 g/kg CFM) than the control. El-Mehanna *et al*. (2017) found that growing lambs fed probiotics or prebiotics showed greater ultimate weights and average daily growth than control groups. Feed conversion was also better in lambs fed ration containing either 2.00 g or 0.50 g of prebiotic/head/day (Dirandeh, 2018). Zapata *et al.* (2021) found that prebiotic and probiotic (*Saccharomyces cerevisiae*)

Table 1: Mean DMI, ADG and FCR of feedlot sheep fed diets containing probiotic and sodium bicarbonate

Attributes	T1	T2	T3
Initial body weight (kg)	$11.52^{a}\pm0.13$	$11.56^{a}\pm0.18$	$11.99^{b}\pm0.25$
Final body weight (kg)	$25.01^{a}\pm1.12$	$26.7^{ab}\pm1.86$	$28.4^{b}\pm2.20$
Overall b.wt. gain (kg)	$13.41^{a}\pm1.13$	$15.25^{ab}\pm1.93$	$16.43^{b}\pm2.22$
Average daily gain (ADG, gm)	$112.32^{a}\pm9.47$	$126.95^{ab}\pm16.1$	$136.74^{ab}\pm18.5$
Feed conversion ratio (FCR)	$10.72^{a}\pm0.79$	$9.91^{a}\pm1.92$	$9.35^{a}\pm2.2$
Average daily feed intake (kg)	$1.20^{a}\pm0.8$	$1.23^{a}\pm0.13$	$1.24^{a}\pm0.13$
Total feed intake in 120 days (kg)	$144.61^{a}\pm9.8$	$148.30^{a}\pm16.3$	$149.52^{a}\pm15.2$
Dry matter intake (g/day)	$333.25^{a}\pm31.89$	$359.53^{ab}\pm19.32$	$369.62^{b}\pm18.33$

Means within the same row with different superscripts (a,b,c) differ significantly ($p<0.05$.)

supplementation enhanced the digestibility of practically all nutrients in lambs. Elliethy *et al.* (2022) similarly concluded that, in terms of feed intake, average daily growth, feed efficiency, and nutrients digestibility, growing Barki lambs fed rations containing prebiotic (MOS+BG) or probiotic (*Bacillus subtilis*) outperformed those in the control group. According to Hady *et al.* (2012), growth performance metrics have been beneficially affected by the use of feed additives. Yeast culture enhances feed intake, weight gain, and feed conversion in growing ruminants (El-Waziry *et al.,* 2000). Moreover, yeast provides vitamins and helps create rumen fungus (Chaucheyras-Durand and Fonty, 2001).

The inclusion of probiotic and buffer may have improved the ruminal pH, which could account for the significant response in the DMI in the present study. Buffers alter ruminal fermentation by either raising or decreasing the pH of the rumen. This helps improve feed intake because animals suffering from acidosis tend to eat less (Nagaraja and Chengappa, 1998). When lambs were fed high concentrate diets supplemented with sodium bicarbonate, Santra *et al.* (2003) observed an increase in ruminal pH as the amount of sodium bicarbonate (10, 20, and 30 g/kg DM) increased. The lambs getting the probiotic and buffer also had greater ADGs demonstrating that increased growth performance is a result of a better rumen environment. Tripathi *et al.* (2004) supplemented feedlot lambs high-concentrate diets with 15 g DM of sodium bicarbonate and found quadratic responses in feed intake in grams/day. Masters *et al.* (2005) and Gonzalez *et al.* (2008) determined that DMI of sheep and heifers decreased linearly when they received increased sodium bicarbonate supplementation per kg DM.

The higher ADG for probiotic and sodium bicarbonate can be justified by the higher DMI of this treatment, which enabled higher energy intake, since the ADG is influenced by the energy intake of the animals (NRC, 2007). The present results are in agreement with those observed by Tripathi *et al.* (2004). They also found higher ruminal pH for lambs fed diet containing Sodium bicarbonate, which contributed to a higher DMI and ADG. The lower ADG for control is justified by the lower DMI of the animals fed with this treatment; with lower intake, the energy available for the animals to use for weight gain was also lower. In general, diets high in dietary energy can raise the ADG (Ebrahimi *et al.,* 2007).

Nutritional Behavioural Studies:

Table 2: Effect of Probiotic and sodium bicarbonate supplementation on nutritional behaviour of feedlot Nellore brown lambs

Minutes/day	T1	T2	T3
Ingestion	137.80^{b}±18.5	132.80^{b}±11.9	116.40^{a}±11.8
Rumination	170.90^{c}±19.8	133.70^{b}±13.6	112.71^{a}±4.9
Chewing	307.17^{c}±18.6	265.15^{b}±12.7	229.11^{a}±8.4
Idleness	13.05^{a}±4.9	32.90^{b}±7.5	9.28^{a}±1.3

Means within the same row with different superscripts (a,b,c) differ significantly ($p<0.05$).

The effects of probiotic and sodium bicarbonate supplementation on nutritional behaviour of feedlot Nellore brown lambs are presented in Table 2. There was a significant effect ($p<0.01$) on ingestion time among the supplemented groups, the lowest value was recorded in sodium bicarbonate supplemented group (116.40 min/day), and the highest value in T1 control (137.80 min/day). It is recorded to have negative linear association between feed additives and rumination time in min/day, with lower values for animal received probiotic and sodium bicarbonate (T2, T3). The rumination time min/day was higher for the control compared to treatment groups ($p=0.05$). There was a significant ($p<0.01$) difference among treatments in chewing time and idleness time, with a lowest recorded values in T3 group (229.11 and 9.28 min/day). The idleness time recorded was however highest in T2 group (32 min/day).

One of the key elements influencing an animal's nutritional behaviour is the quantity of non-digestible fibre (NDF) in the meal; if the NDF content is low or the particle size is tiny, the animal will spend less time chewing (feeding and rumination; Carvalho *et al.,* 2014). This indicates that chewing time and rumination are higher for control group. The animals that got sodium bicarbonate in diet had lower times (min/g DM) for ingesting, chewing, and rumination among the treatments. This suggests that the animals had more time per unit of DM to devote to these activities due to their greater DMI. Higher DMI/time was likely the consequence of faster passage rate and rumen emptying brought on by the addition of the sodium bicarbonate, which improved ruminal conditions. According to Galvani *et al.* (2010), there was a negative association ($r=0.77$) between the DMI and the amount of time sheep spent ruminating when their feed intake was reduced. Thus, the present study's ruminative period merely adhered to the DMI trend.

Nonetheless, the current investigation discovered that none of the experimental sheep showed any clinical signs of rumen acidosis, supporting the idea that sodium bicarbonate powders with smaller particles might work better as a buffer. Despite being a weak base, sodium bicarbonate can effectively buffer excess acid in the rumen, particularly when it comes to organic acid hydrogen ions (Marden *et al.,* 2008). By lowering the rate of starch digestion and inclining the ruminal fluid dilution, sodium can also indirectly increase water consumption by lowering the acidity of the rumen (Lean *et al.,* 2014).

Faecal Consistency Parameters:

The faecal consistency scores for T1, T2 and T3 groups were 2.47± 0.1, 1.03 ± 0.12 and 1.65 ± 0.2, respectively. Significant ($p<0.05$) difference was found among treatment groups, being lowest in the probiotic group. On the other hand, Riddell *et al.* (2010) reported no variation in the occurrence of diarrhoea among neonates given probiotic supplements (*Bacillus subtilis* and *Bacillus licheniformis*). After adding brewer's yeast at a rate of 10 g/kg dry feed, Kowalski *et al.*

(2009) observed a numerical decrease in the number of days with scours primarily due to vitamins and amino acids supplied by *S. cerevisiae*. Additionally, it has been demonstrated that yeast contributes to the development of healthy intestinal microbes, the creation of regular intestinal fermentation, and the ensuing decrease in stress and unsettled stomach. Crossbred calves given live *S. cerevisiae* also favourably reduced the length and incidence of diarrhoea (Agarwal *et al.,* 2002), however, Lesmeister *et al.* (2004) reported no difference in the outcomes of adding yeast culture to a calf starter on scouring days at concentrations of 10 and 20 g/kg of DM. It was crucial to note that none of the animals in either treatment showed scores lower than two, which is not indicative of diarrhoea.

Conclusion

The study concludes that addition of probiotics and sodium bicarbonate buffer to the diet, showed a positive effect on rumen health and improved the intake of nutrients and performance of Nellore lambs. The higher ADG for probiotic and sodium bicarbonate supplemented groups might be due to the higher DMI of the treatment, which enabled higher energy intake, and thereby ADG. The inclusion of the probiotic and buffer may have improved the ruminal pH, which could account for the significant response in the DMI. This shows that the chemical effect of the probiotic and buffer was efficient and provided greater safety for this type of diets, enabling the animals to have a good intake, weight gain, and rumination time and better faecal scores. Among the treatments, the best growths were observed in the treatments as they altered the rumen environment and improved animal growth, rumination behaviour. The inclusion of probiotic shows that the faecal scores can be within the range as a strategy for diets.

Acknowledgement

Authors deeply acknowledge the contribution and support of ATARI zone X, ANGRAU, Lam and KVK, Kalyandurg for successful execution of the work.

References

Abudabos, A.M., Alyemni, A.H., Dafalla, Y.M., & Khan, R.U. (2017). Effect of organic acid blend and *Bacillus subtilis* alone or in combination on growth traits, blood biochemical and antioxidant status in broilers exposed to *Salmonella typhimurium* challenge during the starter phase. *Journal of Applied Animal Research 45*(1), 538-542.

Agarwal, N., Kamra, D.N., Chaudhary, L.C., Agarwal, I., Sahoo, A., & Pathak, N.N. (2002). Microbial status and rumen enzyme profile of crossbred calves fed on different microbial feed additives. *Letters in Applied Microbiology 34*(5), 329-336.

Allen, H.K., Levine, U.Y., Looft, T., Bandrick, M., & Casey, T.A. (2013). Treatment, promotion, commotion: Antibiotic alternatives in food-producing animals. *Trends in Microbiology 21*(3), 114-119.

Babazadeh, D., Vahdatpour, T., Nikpiran, H., Jafargholipour, M.A., & Vahdatpour, S. (2011). Effects of probiotic, prebiotic and synbiotic intake on blood enzymes and performance of Japanese quails (*Coturnix japonica*). *Indian Journal of Animal Sciences, 81*(8), 870.

Carvalho, S., Dias, F.D., Pires, C.C., Brutti, D.D., Lopes, J.F., Santos, D., & Griebler, L. (2014). Comportamento ingestivo de cordeiros Texel e Ideal alimentados com casca de soja. *Archivos de Zootecnia 63*(241), 55-64.

Chand, N., Muhammad, S., Khan, R.U., Alhidary, I. A., & Rehman, Z.U. (2016). Ameliorative effect of synthetic γ-aminobutyric acid (GABA) on performance traits, antioxidant status and immune response in broiler exposed to cyclic heat stress. *Environmental Science and Pollution Research International, 23*(23), 23930-23935.

Chaucheyras-Durand, F., & Fonty, G. (2001). Establishment of cellulolytic bacteria and development of fermentative activities in the rumen of gnotobiotically-reared lambs receiving the microbial additive *Saccharomyces cerevisiae* CNCM I-1077. *Reproduction Nutrition Development, 41*(1), 57-68.

Di Francia, A., Masucci, F., De Rosa, G., Varricchio, M.L., & Proto, V. (2008). Effects of *Aspergillus oryzae* extract and a *Saccharomyces cerevisiae* fermentation product on intake, body weight gain and digestibility in buffalo calves. *Animal Feed Science and Technology, 140* (1-2), 67-77.

Dias, A.L.G., Freitas, J.A., Micai, B., Azevedo, R.A., Greco, L.F., & Santos, J.E.P. (2018). Effects of supplementing yeast culture to diets differing in starch content on performance and feeding behaviour of dairy cows. *Journal of Dairy Science, 101*(1), 186-200.

Dirandeh, E. (2018). The effect of probiotic and prebiotic supplements on performance and health of Baluchi growing lambs. *Research on Animal production, 9*(21), 36-45.

Ebrahimi, R., Ahmadi, H.R., Zamiri, M.J., & Rowghani, E. (2007). Effect of energy and protein levels on feedlot performance and carcass characteristics of Mehraban ram lambs. *Pakistan Journal of Biological Sciences, 10*(10), 1679-1684.

Elliethy, M.A., Fattah, A., & Marwan, A.A. (2022). Influence of prebiotic, probiotic and synbiotic supplementation on digestibility, haemato-biochemical profile and productive performance in Barki lambs. *Egyptian Journal of Nutrition and Feeds, 25*(2), 199-210.

El-Mehanna, S.F., Abdelsalam, M.M., Hashem, N.M., El-Azrak, K.E.M., Mansour, M.M., & Zeitoun, M.M. (2017). Relevance of probiotic, prebiotic and synbiotic supplementations on haemato-biochemical parameters, metabolic hormones, biometric measurements and carcass characteristics of sub-tropical Noemi lambs *International Journal* of *Advanced Research, 1*, 1-10.

El-Waziry, A.M., Kamel, H.E.M., & Yacout, M.H.M. (2000). Effect of bakers' yeast (*Saccharomyces cerevisiae*) supplementation to berseem (*Trifolium Alexandrinum*) hay diet on protein digestion and rumen fermentation of sheep. *Egyptian Journal of Nutrition and Feeds, 3*, 71-82.

Galvani, D.B., Pires, C.C., Wommer, T.P., Oliveira, F., & Santos, M.F. (2010). Chewing patterns and digestion in sheep submitted to feed restriction *Journal of Animal Physiology and Animal Nutrition, 94*, e366-e373

Gaylean M.L. & Rivera, J.D. (2003) Nutritionally related disorders affecting feed-lot cattle. *Canadian Journal of Animal Sciences, 83,* 13-20 .

Gonzalez, L.A., Ferret, A., Manteca, X., & Calsamiglia, S. (2008). Increasing sodium bicarbonate level in high-concentrate diets for heifers. II. Efects on chewing and feeding behaviours *Animal, 2*, 713-722.

Hady, M.M., EL-Banna, R.A., Teleb, H. ., & Shimaa, R.A. (2012). Evaluation of mannan oligosaccharide (Bio-Mos®) and esterified glucomannan (MTB-100®) dietary supplementation on growth performance, serum parameters and rumen ecology of Barki lambs under Egyptian environment *APCBEE Procedia, 4*, 158-162.

Hashemi, S.R., & Davoodi, H. (2011). Herbal plants and their derivatives as growth and health promoters in animal nutrition. *Veterinary Research Communications, 35*, 169-180.

Kowalski, Z.M., Gorka, P., & Schlagheck, A. (2009). Performance of Holstein calves fed milk replacer and starter mixture supplemented with probiotic feed additive. *Journal of Animal Feed Science, 18*, 335-347.

Lean, I.J., Golder, H.M., Hall, M.B. (2014). Feeding, evaluating, and controlling rumen function. *Veterinary Clinics of North America Food Animal Practice.*;*30*(3):539-575.

Lesmeister, K.E., Heinrichs, A.J., & Gabler, M.T. (2004) Effects of supplemental yeast (*Saccharomyces cerevisiae*) culture on rumen development, growth characteristics, and blood parameters in neonatal dairy calves. *Journal of Dairy Science, 87*(6), 1832-1839.

Masters, D.G., Rintoul, A.J., Dynes, R.A., Pearce, K.L., & Norman, H.C. (2005). Feed intake and production in sheep fed diets high in sodium and potassium. *Australian Journal of Agricultural Research, 56*, 427.

Marden, J.P., Julien, C., Monteils, V., Auclair, E., Moncoulon, R., & Bayouthre, C. (2008). *Journal of Dairy Science. 91*, 3528-3535.

Munir, I.M., & Kardiyanto, E. (2015). Body weight gain of local sheep in banten with rice bran and grass addition. In: Proceedings seminar Nasional Teknologi Peternakan dan Veteriner, edited by I.M. Munir *et al.* (Puslitbangnak, Jakarta), pp. 390-396.

Nagaraja, T.G., & Chengappa, M.M. (1998). Liver abscesses in feedlot cattle: a review. *Journal of Animal Science 76,* 287

NRC (2007). *Nutrient Requirements of Small Ruminants*: Sheep, Goats, Cervids, and New World Camelids. National Academy Press, Washington DC, USA.

Riddell, J.B., Gallegos, A.J., Harmon, D.L., & Mcleod, K.R. (2010) Addition of a Bacillus based probitic to the diet of preruminant calves: Influence on growth, health, and blood parameters. *International* Journal of Applied Research Veterinary Medicine, 8, 78-85.

Saeed, M., Yatao, X., Rehman, Z.U., Arain, M.A., Soom, R.N., Abd El-Hac, M.E., Bhutto, Z.A., Abbasi, B., Dhama, K., Sarwar, M., & Chao, S. (2017). Nutritional and ethical aspects of Yacon (*Smallanthusson chifolius*) for human, animals and poultry. *International Journal of Pharmacology, 13,* 361-369.

Santra, A., Chaturvedi, O., Tripathi, M.., Kumar, R. & Karim, S. (2003). Effect of dietary sodium bicarbonate supplementation on fermentation characteristics and ciliate protozoal population in rumen of lambs. *Small Ruminant Research, 47*, 203-212.

Shoukry, M.M., El-Nomeary, Y.A.A.E.F., Salman, F.M., & Shakweer, W.M.E.S. (2023). Improving the productive performance of growing lambs using prebiotic and probiotic as growth promoters. *Tropical Animal Health and Production*, *55*(6), 375.

Sultan, A., Ullah, I., Khan, S., & Khan, R.U. (2015). Effect of organic acid supplementation on the performance and ileal microflora of broiler during finishing period. *Pakistan Journal of Zoology, 47,* 635-639.

Tripathi, M.., Santra, A., Chaturvedi, O., & Karim, S. (2004). Effect of sodium bicarbonate supplementation on ruminal fluid pH, feed intake, nutrient utilization and growth of lambs fed high concentrate diets. *Animal Feed Science and Technology, 111*, 27-39.

Zapata, O., Cervantes, A., Barreras, A., Monge-Navarro, F., González-Vizcarra, V.M., Estrada-Angulo, A., & Plascencia, A. (2021). Effects of single or combined supplementation of probiotics and prebiotics on ruminal fermentation, ruminal bacteria and total tract digestion in lambs. *Small Ruminant Research, 204,* 106538.