RESEARCH ARTICLE Asian Journal of Dairy and Food Research, Volume 41 Issue 1: 106-110 (March 2022)

Various Effects of Concentrate Feed Supplementation at Different Physiological Stages in Madras Red Sheep

P. Suresh Kumar, K. Suresh Kumar, Karu Pasupathy, V. Ramesh Sarvana Kumar,
K. Viswanathan, S. Panneerselvam, D. Chandrasekaran

10.18805/ajdfr.DR-1616

ABSTRACT

Background: Majority of the sheep farmers in our country (semi arid region) do not supplement with concentrate feed even in critical physiological stages. It was observed that concentrate supplementation in addition to free grazing substantially improved production performance of ewes and lambs.

Methods: In this study the parameters such as conception rate, birth weight of lambs, fortnightly body weight changes, rumen fermentation pattern and blood parameters were recorded.

Result: Out of twenty sheep in each group 16, 18 and 19 were exhibited oestrous symptoms and the percentage of heat observed were 80, 90 and 95 in the G1, G2 and G3, respectively. The numbers of animals conceived were 12, 14 and 17 and the conception percentage was 75, 77 and 89. The concentrate supplemented group showed higher conception rate. The numbers of lambs born were 12, 14 and 17 and the lambing percentages were 75, 78 and 89 for the G1, G2 and G3, respectively. The rumen pH was found to be decreasing in G3 group followed by G2 group when compared to G1 group whereas, the production of VFA was found to be higher in G3 group followed by G2 group when compared to G1 group. There were increased levels of total nitrogen, TCA nitrogen and NP nitrogen in sheep at 4 hours after feeding of concentrate feed in G3 group followed by G2 group when compared to G1 group. The results indicated that the higher levels of blood glucose, triglycerides, cholesterol and BUN were observed in G3 group followed by G2 group when compared to G1 group.

Key words: Concentrate feed, Madras red sheep, Rumen fermentation pattern, Serum biochemical changes, Supplementation.

INTRODUCTION

The natural pastures could not support the nutrient needs of the animals in most parts of our country (Chaturvedi *et al.,* 2002). Sheep grazing on such lands are underfed for most part of the year. Hence, the productive and reproductive performances of the animals are low (Chaturvedi *et al.,* 2003). Biomass yield of the community rangeland is low and livestock stocking density is high in India (Sankhyan *et al.,* 1999). Majority of the sheep farmers in our country (semi arid region) do not supplement concentrate feed even in critical physiological stages (Chaturvedi *et al.,* 2002). It was observed that limited concentrate supplementation in addition to free grazing on community rangeland substantially improved production performance of ewes (Chaturvedi *et al.,* 2003) and growth performance of lambs (Shinde *et al.,* 1995; Chaturvedi *et al.,* 2000; Santra and Karim, 2002). Chaturvedi *et al*. (2010a) reported that the information on the effect of supplementary feeding on nutrient utilization and production performance of lambs, under field conditions is scanty. Therefore, the present study was undertaken to study the effect of concentrate supplementation on performance of Madras Red breed of sheep at different physiological stages.

MATERIALS AND METHODS

The study was conducted at Postgraduate Research Institute in Animal Sciences, during the year 2011 to 2014 at Kattupakkam, Kancheepuram district of Tamil Nadu. In this, sixty ewes were selected in the age group of 3 to 5 years and divided into three groups with twenty in each group. The first group was allowed for grazing for seven hours daily from 9.00 AM to 4.00 PM and served as control group (G1). The second and third group (G2 and G3) of animals were supplemented with concentrate feed @ 10% and 20% of their daily dry matter requirement, respectively such as prior to breeding (14 days), late gestation (last 42 days) and early lactation (first 60 days) and compounded feed for growing lambs up to 120 days of age. The parameters such as body weight changes during different physiological stages, conception rate, birth weight of lambs, fortnightly body weight changes, rumen fermentation pattern and blood parameters were

Livestock Farm Complex, Veterinary College and Research Institute, Tamil Nadu Veterinary and Animal Sciences University, Theni, Devadhanapatti-625 602, Tamil Nadu, India.

Corresponding Author: P. Suresh Kumar, Livestock Farm Complex, Veterinary College and Research Institute, Tamil Nadu Veterinary and Animal Sciences University, Theni, Devadhanapatti-625 602, Tamil Nadu, India. Email: sureshkumarpalanimuthu@yahoo.com

How to cite this article: Kumar, P.S., Kumar, K.S., Pasupathy, K., Kumar, V.R.S., Viswanathan, K., Panneerselvam, S. and Chandrasekaran, D. (2022). Various Effects of Concentrate Feed Supplementation at Different Physiological Stages in Madras Red Sheep. Asian Journal of Dairy and Food Research. 41(1): 106-110. DOI: 10.18805/ajdfr.DR-1616.

Submitted: 28-12-2020 **Accepted:** 17-12-2021 **Online:** 28-01-2022

recorded. The collection of rumen liquor (RL) was done at0 and 4 hours post-feeding at different physiological stages (7th day after supplementation for prior to breeding, 21st day after supplementation during late pregnancy, 30th day after supplementation during early lactation and 120th day for growing lambs) from the animals using plastic stomach tube and syringe by suction. For estimation of TVFA, about 20 ml of the RL was preserved with two drops of saturated solution of mercuric chloride and for determination of nitrogen fractions about 20 ml of RL was preserved with two drops of 1 N sulphuric acid. The pH of the RL was observed immediately after collection with an electronic digital pH meter. The TVFA content, total nitrogen, non protein nitrogen of the RL were estimated as per the procedure of Barnett and Reid (1956) Kjeldahl method (AOAC) and Pearson and Smith (1943) respectively. TCA precipitable nitrogen (Protein nitrogen) was calculated as the difference between total nitrogen and non protein nitrogen. Blood samples were collected from jugular vein of each animal. The collection of blood was done on 7th day after supplementation for prior to breeding, 21st day after supplementation during late pregnancy, 30th day after supplementation during early lactation and 120th day for growing lamb. Blood was allowed to clot and centrifuged at 2000 rpm for 10 minutes and the obtained serum was stored at 50°C in the refrigerator. The blood samples collected from 20 animals in each group at the stage of prior to breeding and for other physiological stages (late pregnancy, early lactation and lambs the samples were collected from 12, 14 and 17 animals for the first, second and third groups, respectively). The blood glucose, triglycerides, cholesterol and BUN were determined by the method of (Tietz,1976) Fossati and Prencipe (1982), Wybenga *et al*. (1970), Henry (1964) using commercial kits (Biosystems, Chennai) and automatic spectrophotometer respectively. The data were statistically analyzed using one way ANOVA method as per Snedecor and Cochran (1989).

RESULTS AND DISCUSSION

Reproductive performances

Out of twenty sheep (Table 1) in each group 16, 18 and 19 were exhibited oestrous symptoms and the percentage of heat observed were 80, 90 and 95 in the G1, G2 and G3,

Table 1: Reproductive performance of ewes fed concentrate feed.

Parameters	G1 (0%)	G2 (10%)	G3 (20%)
No. of animals showed estrous symptoms	16	18	19
No. of animals conceived	12	14	17
Conception rate (per cent)	75	78	89
No. of lambs born	12	14	17
Single birth (No.)	12	14	17
Lambing percentage	75	78	89

Table 2: Rumen parameters during different physiological stages of ewes and growing lambs.

	Group-I	Group-II	Group-III	SEM
pH (0-hours)				
Before breeding	7.05^a (n=20)	6.94^b (n=20)	6.81^b (n=20)	0.04
Late pregnancy	7.08 (n=12)	7.00 (n=14)	6.94 (n=17)	0.06
Early lactation	7.04 (n=12)	6.97 (n=14)	6.90 (n=17)	0.05
Lambs (at 4th month of age)	7.16^a (n=12)	6.97^a (n=14)	6.95^b (n=17)	0.05
pH (4-hours after feeding of concentrate feed)				
Before preeding	7.01^a (n=20)	6.76^a (n=20)	6.66^b n=20)	0.04
Late pregnancy	7.00^a (n=12)	6.81^a (n=14)	6.68^b (n=17)	0.05
Early lactation	6.99^a (n=12)	6.87^b (n=14)	6.65^b (n=17)	0.05
Lambs (at 4th month of age)	7.03^a (n=12)	6.84^b (n=14)	6.64^c (n=17)	0.05
TVFA (meq / l) - 0 hours				
Before breeding	78.26^a (n=20)	90.26^b (n=20)	99.82^c±2.12 (n=20)	1.57
Late pregnancy	79.67^a (n=12)	96.71^b (n=14)	105.7^c±2.64 (n=17)	2.41
Early lactation	74.8^a (n=12)	84.31^b (n=14)	98.43^c±1.72 (n=17)	1.56
Lambs (at 4th month of age)	74.46^a (n=12)	83.18^b (n=14)	101.45^c (n=17)	1.48
TVFA (meq / l) - (4 hours after feeding of concentrate feed)				
Before breeding	88.04^a (n=20)	109.79^b (n=20)	120.26^c (n=20)	1.69
Late pregnancy	95.2^a (n=12)	114.64^b (n=14)	125.67^c (n=17)	1.45
Early lactation	97.77^a (n=12)	115.29^b (n=14)	126.54^c (n=17)	1.50
Lambs (at 4th month of age)	92.98^a (n=12)	112.91^b (n=14)	124.34^c (n=17)	1.48

Mean bearing different superscript within the row differ significantly ($P<0.05$).

respectively. The numbers of animals conceived were 12, 14 and 17 and the conception percentage was 75, 77 and 89. The concentrate supplemented group showed higher conception rate. The numbers of lambs born were 12, 14 and 17 and the lambing percentages were 75, 78 and 89 for the G1, G2 and G3, respectively. Chaturvedi *et al.* (2006) also reported that concentrate supplementation at the rate of 1.5% of body weight to ewes during critical stage increased plane of nutrition, conception rate, body condition and birth weight of lambs. The lambing rate of 80.33 to 90.56% in the breeding tract (Balasubramanyam *et al.,* 2011) and 76.83 to 85.56% in farmers flock was reported (Balasubramanyam *et al.,* 2010 and 2012). During early lactation (60 days before and after supplementation) the loss of body weight (kg) in G1 and G2 were 3.9±0.64, 0.76±0.29 whereas the G3 group gained 0.52±0.33 which was statistically significant (P<0.05). The present findings indicate that the ewes in G1 and G2 mobilized their body reserves to meet the additional nutrient requirements of lactation, leading to reduction in their body weight (Idris *et al.,* 2010). Significantly (P<0.05) higher birth weight of lambs were recorded in G2 and G3 (2.77±0.07, 2.83±0.04) than G1 (2.6±0.08). Improvement in birth weight of lambs due to supplementation of concentrate feed during late gestation period have been reported by Shinde *et al.* (1996); Chaturvedi *et al.* (2003; 2010a). The birth weight (kg) of lambs recorded by various authors (Sivakumar *et al*., 2009; Balasubramanyam *et al*., 2011 and 2012) in Madras Red sheep under field condition ranged from 2.69±0.01 to 2.9±0.01 with mean value of 2.76±0.01.

Rumen parameters

The influence of concentrate feed supplementation was assessed in terms of rumen pH, total VFA produced and nitrogen fractions (Table 2 and 3). The rumen pH was found to be decreasing in G3 group followed by G2 group when compared to G1 group at 4 hours after feeding of concentrate feed in sheep during various physiological stages whereas, the production of VFA was found to be higher in G3 group followed by G2 group when compared to G1 group. Similar observations have been made by Hatfield *et al*. (1998), Bhatta *et al*. (2005a) and Askar *et al*. (2014) in sheep. A reduction in pH and increase in total VFA at 4 h post feeding in G2 and G3 compared to G1 may be attributed to the supply of fermentable carbohydrates through concentrate feed

Table 3: Nitrogen metabolism in rumen during different physiological stages of ewes and growing lambs.

	Group-I	Group-II	Group-III	SEM
Total - N (mg/100 ml) - 0 hours				
Before breeding	68.54^a (n=20)	77.7^b (n=20)	84.98^c (n=20)	1.38
Late pregnancy	70.68^a (n=12)	82.44^b (n=14)	92.14^c (n=17)	1.20
Early lactation	69.55^a (n=12)	80.66^b (n=14)	88.02^c (n=17)	1.13
Lambs (at 4th month of age)	70.13^a (n=12)	81.56^b (n=14)	90.09^c (n=17)	1.07
Total - N (mg/100 ml) - 4 hours				
Before breeding	73.54^a (n=20)	95.58^b (n=20)	103.89^c (n=20)	1.86
Late pregnancy	77.23^a (n=12)	101.43^b (n=14)	112.65^c (n=17)	1.83
Early lactation	75.33^a (n=12)	97.42^b (n=14)	114.61^c (n=17)	1.47
Lambs (at 4th month of age)	81.96^a (n=12)	100.45^b (n=14)	113.56^c (n=17)	1.71
TCA - N (mg/100 ml) - 0 hours				
Before breeding	28.22^a (n=20)	35.61^b (n=20)	43.18^c (n=20)	0.88
Late pregnancy	32.4^a (n=12)	41.26^b (n=14)	45.04^c (n=17)	0.99
Early lactation	30.43^a (n=12)	38.43^b (n=14)	43.38^c (n=17)	0.83
Lambs (at 4th month of age)	26.40^a (n=12)	32.26^b (n=14)	40.13^c (n=17)	1.05
TCA - N (mg/100 ml) - 4 hours				
Before breeding	35.73^a (n=20)	47.61^b (n=20)	45.73^b (n=20)	0.95
Late pregnancy	38.25^a (n=12)	53.25^b (n=14)	48.25^b (n=17)	0.76
Early lactation	37.25^a (n=12)	51.26^b (n=14)	47.25^b (n=17)	1.10
Lambs (at 4th month of age)	34.05^a (n=12)	42.57^b (n=14)	44.05^b (n=17)	1.02
NP - N (mg/100 ml) - 0 hours				
Before breeding	40.32 (n=20)	42.09 (n=20)	41.80 (n=20)	1.69
Late pregnancy	38.28^a (n=12)	41.19^a (n=14)	47.09^b (n=17)	1.40
Early lactation	39.12^a (n=12)	42.23^a (n=14)	44.65^b (n=17)	1.66
Lambs (at 4th month of age)	43.73^a (n=12)	49.31^b (n=14)	49.96^b (n=17)	1.41
NP - N (mg/100 ml) - 4 hours				
Before breeding	37.81^a (n=20)	47.97^b (n=20)	45.71^b (n=20)	1.94
Late pregnancy	38.98^a (n=12)	48.17^b (n=14)	50.51^b (n=17)	1.98
Early lactation	38.08^a (n=12)	46.17^b (n=14)	51.48^c (n=17)	1.65
Lambs (at 4th month of age)	47.91^a (n=12)	57.89^b (n=14)	60.18^b (n=17)	2.21

Mean bearing different superscript within the row differ significantly (P<0.05).

Table 4: Blood parameters as influenced by concentrate supplementation during different physiological stages of ewes.

	Group-I	Group-II	Group-III	SEM
Glucose (mg/dl)				
Before breeding	53.47[a] (n=20)	57.01[b] (n=20)	61.15[c] (n=20)	0.67
Late pregnancy	58.56[a] (n=12)	63.99[b] (n=14)	69.48[c] (n=17)	0.43
Early lactation	56.76[a] (n=12)	63.42[b] (n=14)	69.61[c] (n=17)	0.48
Triglycerides (mg/dl)				
Before breeding	13.35[a] (n=20)	15.29[b] (n=20)	16.44[c] (n=20)	0.16
Late pregnancy	14.37[a] (n=12)	15.91[b] (n=14)	16.98[c] (n=17)	0.19
Early lactation	14.38[a] (n=12)	15.90[b] (n=14)	18.05[c] (n=17)	0.14
Blood urea nitrogen (mg/dl)				
Before breeding	21.38[a] (n=20)	24.60[b] (n=20)	32.33[c] (n=20)	0.29
Late pregnancy	12.21[a] (n=12)	14.68[b] (n=14)	21.70[c] (n=17)	0.18
Early lactation	14.01[a] (n=12)	17.68[b] (n=14)	18.86[c] (n=17)	0.10
Cholesterol (mg/dl)				
Before breeding	65.49[a] (n=20)	71.11[b] (n=20)	74.92[c] (n=20)	0.21
Late pregnancy	65.31[a] (n=12)	70.81[b] (n=14)	73.84[c] (n=17)	0.23
Early lactation	65.57[a] (n=12)	69.06[b] (n=14)	74.04[c] (n=17)	0.39

Mean bearing different superscript within the row differ significantly (P<0.05).

Group-I - Maintained on grazing for 7 hours.

Group-II - Supplementation of concentrate @10% of DM requirement along with grazing.

Group-III - Supplementation of concentrate @ 20% of DM requirement along with grazing.

Chaturvedi *et al.,* 2013). The results related to nitrogen metabolism in the rumen of sheep observed during different physiological stages of sheep and growing lambs is presented in Table 2. There were increased levels of total nitrogen, TCA nitrogen and NP nitrogen in sheep at 4 hours after feeding of concentrate feed. The results of this study was in agreement with the observations of Bhatta *et al.* (2005b) and Singh and Kundu (2010) who also observed improvement in nitrogen metabolism in the rumen due to supplementation of either concentrate or tree leaves. The increase in total N could be correlated to higher concentration of nitrogen supplied in the concentrate feed. Supply of fermentable carbohydrate in the rumen might have improved utilization of ammonia by microbes and ensured better supply of protein and energy for production (Chaturvedi *et al.* 2003). It is concluded that supplementing concentrate feed in grazing animals for seven hours beneficially influences rumen fermentation pattern.

Blood parameters

The results (Table 4) indicated that the higher levels of blood glucose were observed in G3 group followed by G2 group when compared to G1 group. These results were in line with the observation of Mohamed and Abdalla, (2013) who recorded increased blood glucose due to concentrate supplementation. The increased levels of blood glucose observed in this study might be due to production of more propionic acid in concentrate supplemented groups (McDonald, 1996). The triglyceride levels were significantly (P<0.05) high in G3 group followed by G2 group when compared to G1 group. These results were in concordance with the findings of Sarwar *et al.* (2010) who reported that the triglycerides levels were significantly (P<0.05) higher in concentrate supplemented group than animals fed with fodder only. Significantly (P<0.05) increased cholesterol levels were observed in concentrate supplemented groups (G2 and G3) as compared to un-supplemented group. These results were in agreement with findings of Sarwar *et al*., (2010) (*loc. cit*) who reported that the cholesterol levels were significantly (P<0.05) higher in concentrate supplemented group than those fed with fodder only. Muralidharan *et al.* (2012) also reported that the cholesterol level was significantly (P<0.05) higher in concentrate supplemented group than the group allowed only for grazing. Better plane of nutrition of these groups might have resulted in more cholesterol synthesis in these groups. The level of BUN among various treatment groups was significantly (P<0.05) different. The BUN level was more during breeding and growing age than during pregnancy and lactation. Moreover, the BUN level was more in G3 group followed by G2 group when compared to G1 group. The increased levels of BUN could be due to supply of more nitrogen to these groups. This result is similar to the findings of Sarwar *et al*. (*loc. cit*) who reported that there was linear increase in BUN level when the CP of feed increased. The additional protein apart from grazing supplied through concentrate feed might have increased the BUN values through metabolism. It is concluded that supplementing concentrate feed in critical periods of grazing sheep beneficially changes the serum biochemical parameters. However, the level of BUN observed in this study was higher than the normal level of sheep.

CONCLUSION

It was concluded that supplementation of concentrate feed to sheep @ 20% of dry matter requirement (G_3 group) during critical stages of reproduction such as prior to breeding (14 days), late gestation (last 42 days) and early lactation (first 60 days) significantly ($p<0.05$) improved rumen fermentation pattern, blood parameters and reproduction performance of sheep in terms of body weight gain during late pregnancy and early lactation, conception rate, lambing percentage and birth weight of lambs when compared to concentrate feed supplementation @ 10% of dry matter requirement (G_2) or non-supplemented groups.

REFERENCES

Askar, A.R., Salama, R., El-Shaer, H.M., Safwat, M.A., Poraei, M., Nassar, M.S., Badawy, H.S. and Raef, O. (2014). Evaluation of the use of arid-area rangelands by grazing sheep: Effect of season and supplementary feeding. Small Ruminant Research. 121: 262-270.

Balasubramanyam, D., Jaishankar, S. and Sivaselvam, S.N. (2010). Production performance of Madras Red sheep. Indian Vet. Journal. 87(12): 1231-1233.

Balasubramanyam, D., Jaishankar, S., Kathiravan, P. and Sivaselvam, S.N. (2011). Sex ratio and reproductive performance of Madras Red sheep under field conditions. Indian J. Field Vet. 6(3): 63-65.

Balasubramanyam, D., Raja, T.V., Kumarasamy, P. and Sivaselvam, S.N. (2012). Estimation of genetic parameters and trends for body weight traits in Madras Red sheep. Indian J. of Small Rumin. 18(2): 173-179.

Barnett, A.J. and Reid, R.L. (1956). Studies on the production of volatile fatty acids from grass by rumen liquor in an artificial rumen. I. Volatile fatty acid production from grass. J. Agric. Sci. 48: 315-321.

Bhatta, R., Vaithiyanathan, S., Singh, N.P. Shinde, A.K. and Verma, D.L. (2005a). Effect of feeding tree leaves as supplements on the nutrient digestion and rumen fermentation pattern in sheep grazing on semi-arid range of India. Small Rum. Res. 60: 273-280.

Bhatta, R., Vaithiyanathan, S. Singh, N.P. Shinde A.K. and Verma, D.L. (2005b). Effect of tree leaf as supplementation on nutrient digestion and rumen fermentation pattern in sheep grazing semi-arid range of India. Small Rum. Res. 60: 281-288.

Chadurvedi, O.H., Mishra, A.S., Karim, S.A. and Jakhmola, R.C. (2000). Effect of supplementary feeding during late gestation on growth performance of lambs under field condition. Indian J. of Small Rumin. 6: 110-112.

Chadurvedi, O.H., Mishra, A.S., Karim, S.A. and Jakhmola, R.C. (2003). Effect of supplementary feeding during late gestation on productive performance of ewes grazing on community rangeland. Indian J. Anim. Sci. 71: 714-717.

Chadurvedi, O.H., Tripathi, M.K., Mishra, A.S., Verma, D.L., Rawat, P.S. and Jakhmola, R.C. (2002). Land as well as livestock holding pattern and feeding practices of livestock in Malpura taluk of semiarid eastern Rajasthan. Indian J. Small Rum. 8: 143-146.

Chaturvedi, O.H., Bhatta, R., Verma, D.L. and Singh, N.P. (2006). Effect of flushing on nutrient utilization and reproductive performance of ewes grazing on community range land. Asian-Australasian J Anim. Sci. 19: 521-525.

Chaturvedi, O.H., Mann, J.S. and Karim, S.A. (2010a). Effect of concentrate supplementation to ewes grazing on community rangeland during late gestation and early lactation. Indian J. Small Rum. 16(1): 97-100.

Fossati, P. and Principe, L. (1982). Serum triglycerides determined colorimetrically with an enzyme that produces hydrogen peroxide. Clin. Chem. 28: 2077-2080.

Hatfield Patrick G., Julie, A. Hopkins, W. Shawn Ramsey and Alan Gilmore. (1998). Effects of level of protein and type of molasses on digestakinetics and blood metabolites in sheep. Small Rum. Res. 28: 161-170.

Henry, R.J. (1964). Clinical Chemistry: Principles and Techniques, Hoeber, Newyork, N.Y. 651.

McDonald, P., Edward, R.A., Greenhalgh, J.F. and Morgan,C.A. (1996). Animal Nutrition. Logman Scientific and Techn Harlow, UK. p.159.

Muralidharan, J., Jayachandran, S., Selvaraj, P., Visha, P. and Ramesh Saravanakumar, V. (2012). Effect of concentrate and Urea molasses mineral block supplementation on blood biochemical profi le of Mecheri lambs. Indian J.Small Rum.18(1): 75-79.

Pearson, R.M. and Smith J.A. (1943). The utilization of urea in the bovine rumen.1. Methods of analysis of rumen ingesta and preliminary experiments *in vivo*. Biochem. J. 37(1): 142-148.

Sankhyan, S.K., Shinde, A.K. and Karim, S.A. (1999). Seasonal changes in biomass yield, nutrient intake and its utilization by sheep maintained on community grazing land. Indian J. Anim. Sci. 69: 617-620.

Santra, A. and Karim, S.A. (2002). Nutrient utilization and growth performance of defaunated and faunated lambs maintained on complete diets containing varying proportion of roughage and concentrate. Animal Feed Sci. Tech. 101: 87-99.

Sarwar, M., Mukhtar, N., Shahzad, M.A., Nisa, M. (2010). Traditional versus high input feeding system: Impact on nutrient intake, blood dynamics, hormonal profile weight gain and economics in growing lambs. Eg. J. of Sh. and G. Sci. 5(1): 127-145.

Shinde, A.K., Karim, S.A., Mann, J.S. and Patnayak, B.C. (1996). Performance of sheep under different silvipastoral systems. Indian J. Anim. Prod. Management. 12: 30-33.

Shinde, A.K., S.A.Karim and B.C, Patnayak. (1995). Growth performance of weaner lambs and kids under intensive and semi intensive feeding management. Indian J. Anim. Sci. 65: 830-833.

Singh S. and Kundu, S.S. (2010). Intake, nutrient digestibility, rumen fermentation and water kinetics of sheep fed *Dichanthium annulatum* grass hay-tree leaves diets. Livestock Res. Rural Develop. 22(8): 77-85.

Sivakumar, T., Balasubramanyam, D., Thilak, K., Pon. Jawahar, Gopi, H. and Jaishankar, S. (2009). Growth and reproductive performance of Madras Red sheep under field conditions. Indian J. Small Rum. 15(2): 248-252.

Snedecor, G.W. and Cochran, W.G. (1989). Statistical Methods, 6th Edition, The Iowa State University Press, Ames. USA.

Tietz, N.W. (1976). Fundamentals of Clinical Chemistry, 2nd edition, W.B. Sounders Company Limited, Philadelphia. pp. 248.

Wybenga, D.R., Pileggi, V.J., Dirstine, P.H. and John, Di Georgio. (1970). Direct manual determination of total serum cholesterolwith a single stable reagent. Clinical Chemistry. 16(12): 980-984.