The Pharma Innovation Journal 2018; 7(4): 674-678

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277- 7695
ISSN (P): 2349-8242
NAAS Rating: 5.03
TPI 2018; 7(4): 674-678

www.thepharmajournal.com
Received: 23-02-2018
Accepted: 25-03-2018

Raju J
PhD Scholar & ICAR-SRF, Department of Animal Nutrition, PVNR TVU, Rajendranagar, Hyderabad, Telangana, India

Narasimha J
Department of Animal Nutrition, PVNR TVU, Rajendranagar, Hyderabad, Telangana, India

Nalini kumari N
Department of Animal Nutrition, PVNR TVU, Rajendranagar, Hyderabad, Telangana, India

Raghunanadan T
Associate Dean, CVSC, Korutla, PVNR TVU, Rajendranagar, Hyderabad, Telangana, India

Chinni Preetam V
Department of Poultry Science, PVNR TVU, Rajendranagar, Hyderabad, Telangana, India

Ashok kumar A
Department of Poultry Science, PVNR TVU, Rajendranagar, Hyderabad, Telangana, India

Parthasarathi T
Department of LPM, PVNR TVU, Rajendranagar, Hyderabad, Telangana, India

Correspondence
Raju J
PhD Scholar & ICAR-SRF, Department of Animal Nutrition, PVNR TVU, Rajendranagar, Hyderabad, Telangana, India

Effect of feeding differently processed complete rations on carcass characteristics in growing ram lambs

Raju J, Narasimha J, Nalini kumari N, Raghunanadan T, Chinni preetam V, Ashok kumar A and Parthasarathi T

Abstract
The present study was carried out to evaluate the effect of feeding differently processed (chaff, mash, expander extruder pellet and block) sorghum stover based complete rations on carcass characteristics and meat quality in growing ram lambs. Twenty four growing Nellore x Deccani cross ram lambs of 3-4 months old (14.50±0.41 kg b.wt.) were randomly distributed into four experimental groups of six animals each in a complete randomized design (CRD). The sorghum stover (SS) was incorporated in complete diets with roughage to concentrate ratio of 50:50 and were processed in to mash (SSM), expander extruder pellets (SSP) and blocks (SSB) and compared with chaffed SS (SSC) mixed with concentrate mixture (50 SS: 50 concentrate) in a growth trial for a period of 120 days in Nellore x Deccani cross ram lambs. The pre slaughter weight was significantly higher (P>0.05) in SSP ration compared to other three rations. However, the empty body weight and carcass weights were similar (P>0.05) among the rations. No significant differences were observed among the treatment groups for the carcass weight, dressing percentage, proportions of whole sale cuts, edible and inedible portions, yield of visceral organs, and per cent yield of bone, meat and fat and bone, meat ratio in different wholesale cuts as well as carcass and meat quality. Thus, it can be concluded that, processing of complete rations into mash, pellet and block could not influence the carcass characteristics and meat quality in growing ram lambs.

Keywords: sorghum stover, sheep, mash, pellet, block, carcass, meat quality

1. Introduction
Demand for livestock sourced foods like meat and milk is going to increase globally by 70 and 58%, respectively by 2050 compared to 2010 due to increase in human population and growing incomes (FAO, 2011). A recent study analyzing the demand versus supply of animal sourced food in India by Gandhi and Zhou (2010) [5] suggests that India's rapid rise in the demand for livestock products may far outpace its domestic supply, intensification of livestock systems appears to be imminent in India in order to meet the expected demands. But constraints for intensification of livestock systems include shortage of feed and fodder resources, poor quality of basal diets and imbalanced feeding. Hence, intensification of livestock systems depends on improving the quality and quantity of crop residues (CR) besides value addition in the form of fortification and densification.

The cereal CR are generally have poor digestibility mostly due to highly lignified cell walls. It can represent a large potential source of energy for ruminants provided their nutrients are fully explored with suitable processing technology. Various processing methods like grinding (Reddy *et al.,* 1992) [21], pelleting (Reddy, 1990) [20] and block making (Karimizadeh *et al.,* 2017) [7] improved the dry matter intake and nutrient digestibility of various CR. The feeding of complete feed block stabilizes rumen fermentation, minimizes fermentation loss, and ensures better ammonia utilization (Prasad *et al.,* 2001) [14]. Now-a-days expanders are being used in feed industry as an alternative for pelleting because of its high production efficiency, attaining high temperatures, complete gelatinization, simplicity in operation, inactivation of antinutritional factors, increased molasses addition and higher pellet durability (Prasad, 2003) [15]. Keeping in view of the above, the present study was conducted to study the effect of feeding differently processed (chaff, mash, expander extruder pellet and block) sorghum stover based complete rations on carcass characteristics in growing ram lambs.

Materials and methods
The SS was incorporated in complete diets with roughage to concentrate ratio of 50:50 and were processed in to mash (SSM), expander extruder pellets (SSP) and blocks (SSB) and

compared with chaffed SS (SSC) mixed with concentrate mixture (50 SS: 50 concentrate) in a growth trial in Nellore x Deccani cross ram lambs. Complete diet was first processed to mash form by grinding through 8 mm sieve in a hammer mill. Then one third of the mash was subjected to expander extruder pelleting and another one third to compact feed block making. These three processed SS based complete diets were evaluated through growth trial for a period of 120 days in comparison to a conventional control ration containing 50% concentrates and 50% chopped sorghum (*Sorghum bicolor*) stover. The per cent ingredient and chemical composition of experimental complete rations are shown in Table 1 and 2, respectively. The DCP and TDN requirements of the experimental animals were computed as per the recommendations of ICAR (2013).

The *in vivo* experiment was conducted at Department of Animal Nutrition, College of Veterinary Science, Rajendranagar, Hyderabad. Twenty four growing Nellore x Deccani cross ram lambs of 3-4 months old (14.50±0.41 kg b.wt.) were randomly distributed into four experimental groups of six animals each in a complete randomized design (CRD).

All the four groups were offered respective experimental rations *ad- libitum* twice daily at 9:00 and 15:00 h by weighing in electronic balance and residue if any left was weighed after 24 h for a period of 120 days. Fortnightly body weights for two consecutive days in the morning before feeding and watering were recorded. All the experimental animals were offered clean and fresh drinking water round the clock. The study was approved by the animal care and use committee. Quantity of concentrate to the control group was adjusted fortnightly according to body weight to meet the protein requirements. All the lambs were de wormed and vaccinated against enterotoxaemia prior to initiation of the study and housed in well ventilated individual pens with facilities for feeding and watering.

After growth trial, three animals from each group were randomly selected, starved overnight and slaughtered by "Halal method" to study the carcass characteristics. The sticking, legging, dressing and evisceration were performed as per the procedure of Gerrard (1964) [6]. Weight of hot carcass, different wholesale cuts, edible (liver, heart, testes, diaphragm, kidney and spleen) and non-edible (blood, lungs, trachea, stomach and intestines) offals were recorded. The weight of fat, muscle and bone of each trimmed cut were recorded separately from left side of the carcass. Feed samples were analysed for proximate principles by AOAC (1997) [1] method. Calcium was estimated as per the method described by Talapatra *et al.* (1940) [24]. Phosphorous was determined colourimetrically as per the method of Ward and Johnston (1962) [25]. The results obtained were subjected to analysis through software (version 17.0; SPSS, 2005) by applying one- way analysis of variance through generalized linear model and the treatment means were ranked using Duncan's multiple range test with a significance at P<0.05. All the statistical procedures were done as per Snedecor and Cochran (1994) [23].

Results and Discussion

Chemical Composition of Experimental Rations

The chemical composition of differently processed complete rations is presented in Table 2. Perusal of data revealed that, the chemical composition and fiber fractions of all the four differently processed sorghum stover based complete rations were comparable. The non-significant difference in chemical composition of the experimental diets was obvious, as it had similar ingredient composition. Processing has no effect on the chemical composition of experimental complete diets, since roughage to concentrate ratio is constant in a particular crop residue based complete diet (Khan *et al*., 2016) [8]. Similar to our findings, Nalini Kumari *et al*. (2014) [12] observed that, the processing could not affect the chemical composition of the diets and pelleting of mash diet with expander extruder had no effect on chemical composition. Samanta *et al*. (2003) [22] also observed no significant difference in chemical composition of complete diet in mash form and in complete feed block. In contrast to our results, Anandan *et al*. (2012) [3] observed that protein content, and NDF of differently processed sweet sorghum bagasse with leaf residues (SSBLR) based complete rations were similar for mash and pellets form but lower (P<0.05) in feed block than in the two afore mentioned feed forms. Anandan *et al*. (2013) [2] further reported that, despite been mixed from the same ingredients and in the same proportion, laboratory quality traits (ADF, ADL) slightly but significantly vary between complete feed block and feed mash. Feed blocks had consistently superior laboratory fodder quality traits compared to feed mash.

Carcass Characteristics and Meat Quality

The details of pre slaughter weight, empty body weight, and carcass weight are presented in Table 3. The pre slaughter weight was significantly higher (P>0.05) in SSP ration compared to other three rations. However, the empty body weight and carcass weights were not significantly different (P>0.05) among the rations, but numerically higher in lambs fed SSP ration. Similar results were obtained by Nalini Kumari (2011) [11] in lambs fed sweet sorghum bagasse based differently processed complete diets (chop, mash and pellet forms). Similarly, Madhavi *et al*. (2010) observed no difference in slaughter weight and carcass weight in lambs fed bajra straw based chopped, mash and expander extruded diets.

Dressing percentage

The mean dressing percentage on pre slaughter weight and empty body weight was 42.24 and 58.33, 42.67 and 59.04, 43.32 and 60.00, 42.48 and 57.66, respectively in ram lambs fed SSC, SSM, SSP, and SSB rations (Table 3). The differences in dressing percentage either on slaughter weight or empty body weight basis among the rations were statistically not significant. No uniform trend could be noticed in the dressing percentage on empty body weight among the rations. Similarly, no significant differences were observed among treatment groups for dressing percentage on preslaughter and empty body weight basis in lambs fed sweet sorghum bagasse based chop, mash and pellet form of rations (Nalini Kumari, 2011) [11]. The dressing percentage was comparable with the value reported by Reddy and Linga Reddy (2003) [16] in native lambs fed pelleted cotton stalks (40%) based complete diet. Madhavi *et al*. (2010) and Reddy *et al*. (2005) [19] reported comparable dressing percentage on processed 38.5 per cent bajra straw based diets in lambs.

Proportions of wholesale cuts and edible and non edible portion

The per cent proportions of wholesale cuts for the experimental animals are presented in Table 4. Processing of sorghum straw based rations did not significantly influence the wholesale cuts of lambs of different groups. The edible

and non-edible portions percentage of slaughtered lambs fed SSC, SSM, SSP, and SSB rations were 53.63 and 22.64, 54.04 and 22.48, 54.67 and 21.97, 53.57 and 22.35, respectively. The edible and inedible percentage and its ratio did not vary significantly among the lambs fed differently processed sorghum stover based complete rations, but the edible portion percentage was numerically higher in lambs fed SSP rations. The lower dressing percentage of mash and chopped form was reflection of higher percentage of non edible portion than expander extruded diet. The proportion of edible portion of SSP fed lambs was 1.94, 1.17 and 2.05 per cent higher than SSC, SSM and SSB fed lambs, respectively.

The per cent of fore shank and brisket, shoulder and neck, rack, loin and leg in carcasses of SSP fed lambs were comparable to the values recorded by Reddy and Linga Reddy (2003) [16] in native lambs fed cotton stalks (40%) based expander extruded pellets and Nalini Kumari (2011) [11] in sheep feed sweet sorghum bagasse based pellets. Reddy and Reddy (2001) [17, 18] reported proportion of different wholesale cuts of native brown lambs under intensive system and the values were 35.2, 16.6, 12.7, 22.5 and 13.0 per cent for leg, loin, rack, shoulder and neck, fore shank and brisket, respectively. The proportion of wholesale cuts and edible and non edible portions were within the normal range on all processed diets in lambs fed 38.5 per cent bajra straw based complete diets (Madhavi *et al*., 2010).

Yield of visceral organs

The yield of visceral organs, pluck, liver, kidney, heart, testes, gastrointestinal tract (GIT) full, GIT empty, spleen, lungs with trachea and leaf fat, as percentage of pre slaughter weight of slaughtered lambs fed SSC, SSM, SSP and SSB were presented in Table 5. Processing did not affect the yield of pluck, liver, kidney, heart, testes, gastrointestinal tract (GIT), spleen, lungs with trachea and leaf fat, as percentage of preslaughter weight (Table 5). The skin, head and blood in kg of experimental lambs were not significantly different among the rations. No trend was observed in the visceral organ values among all the treatments. The proportion of wholesale cuts and edible and non edible portions were comparable on all the processed diets in lambs fed 38.5 per cent bajra straw based complete diets (Madhavi *et al.*, 2010).

Proportion of meat, bone and fat in carcass.

The per cent yield of bone, meat and fat and bone, meat ratio in different wholesale cuts and in total carcass are given in Table 6. No significant variation could be seen in bone and meat yield (%) and their ratios in various wholesale cuts among rations. Similarly, Madhavi *et al.* (2010) reported that processing could not affect the percentage of lean and bone in the lambs fed bajra straw based (38.5%) complete diets. The reported value of meat, bone ratio was lower than the values reported by Reddy and Linga Reddy (2003) [16] in native lambs fed cotton stalks (40%) based pelleted complete diet, whereas pelleted diets recorded increased trend in lean proportions in lambs fed 38.5 per cent bajra straw based complete diets in lambs (Reddy *et al*., 2005) [19].

Chemical composition of meat

The chemical composition of Longissimus dorsi muscle is presented in Table 7. The moisture, protein, fat and ash contents of meat were not affected by the processing of complete rations. No significant difference in per cent of fat content in Longissimus dorsi muscle of lambs fed different experimental diets indicated that fat had uniformly intermixed with muscle fibre irrespective of nature of the diet. Similar results were obtained by Nalini Kumari (2011) [11] and Madhavi (2003) [10] in lambs fed differently processed sweet sorghum bagasse and bajra straw based complete rations, respectively

Table 1: Ingredient composition (%) of differently processed SS based complete rations for growth study in growing Nellore x Deccani cross ram lambs

Ingredient	SSC	SSM	SSP	SSB
Sorghum stover	50	50	50	50
Maize	10	10	10	10
Cotton seed cake	8	8	8	8
Groundnut cake	4	4	4	4
Deoiled rice bran	16	16	16	16
Red gram chunni	5	5	5	5
Molasses	5	5	5	5
Urea	0.5	0.5	0.5	0.5
Mineral mixture[#]	1	1	1	1
Salt	0.5	0.5	0.5	0.5
Total	100	100	100	100

[#]Ranmix 1 kg contains Cu-2 g, Co-100 mg, Fe-6 g, Zn-2.2 g, Ca-220 g, P-100 g, Mg-40 g, Co-100 mg, Iodine-200 mg, B1-1300 mg, B6-130 mg, B12-3000 mg, Vit E-975 IU, Vit A-750000 IU, Vit D3-150000 IU.

Table 2: Chemical composition (% DM basis) of differently processed sorghum stover based complete rations

Attribute	SSC	SSM	SSP	SSB
OM	90.46	90.22	90.16	90.29
CP	11.84	11.94	12.04	11.99
EE	2.94	2.80	2.71	2.74
TCHO	75.68	75.48	75.41	75.56
NDF	54.10	53.89	53.10	52.96
ADF	36.94	36.67	35.97	36.18
Cellulose	26.15	26.06	25.45	26.01
Hemicellulose	17.16	17.22	17.13	16.78
Ash	9.52	9.79	9.86	9.68
Lignin	4.23	4.15	4.21	4.10
Ca	1.12	1.08	1.09	1.07
P	0.63	0.60	0.63	0.59

Each value is the average of three observations

OM, Organic matter; CP, Crude protein; EE, Ether extract; TCHO, Total carbohydrates; NDF, Neutral detergent fiber; ADF, Acid detergent fiber; Ca, Calcium; P, Phosphorus

Sorghum stover (SS) based complete rations processed into mash (SSM), expander extruded pellets (SSP), block (SSB) and chopped SS mixed with concentrate (SSC)

Table 3: Effect of differently processed sorghum stover based complete rations on carcass characteristics and dressing percentage in growing Nellore x Deccani cross ram lambs

Parameter	SSC	SSM	SSP	SSB	SEM	P
Pre slaughter weight (kg)	22.76[a]	23.08[a]	24.93[b]	23.42[a]	0.45	0.05
Empty body weight (kg)	16.62	16.57	18.01	17.00	0.51	0.82
Carcass weight (kg)	9.65	10.04	11.00	9.67	0.29	0.34
Dressing %						
On slaughter weight	42.24	42.67	43.32	42.48	0.51	0.92
On empty body weight	58.33	59.04	60.02	57.66	0.82	0.83

Each value is the average of three observations

SEM, Standard error of mean

Table 4: Effect of feeding differently processed sorghum stover based complete rations on yield of whole sale cuts, edible and non edible portions (% carcass weight) in growing Nellore x Deccani cross ram lambs

Parameter	SSC	SSM	SSP	SSB	SEM	P
Fore shank and brisket	17.00	18.25	18.10	19.04	0.24	0.07
Neck and shoulder	23.59	23.37	23.51	22.86	0.17	0.49
Rack	11.51	11.16	11.03	11.34	0.07	0.07
Loin	12.00	11.32	11.44	11.41	0.13	0.25
Leg	35.90	35.90	35.92	35.35	0.25	0.86
Edible portion (% slaughter wt.)	53.63	54.04	54.67	53.57	0.52	0.91
Non edible portion (% slaughter wt.)	22.64	22.48	21.97	22.35	0.17	0.59
Edible: Non edible portions	2.37	2.40	2.49	2.40	0.03	0.71

Each value is the average of three observations

Table 5: Effect of feeding differently processed sorghum stover based complete rations on yield of visceral organs (% pre slaughter weight) in growing Nellore x Deccani cross ram lambs

Parameter	SSC	SSM	SSP	SSB	SEM	P
Liver	3.10	3.13	3.10	3.09	0.03	0.98
Kidney	1.31	1.30	1.32	1.37	0.02	0.52
Heart	0.30	0.30	0.31	0.30	0.01	0.98
Testis	0.41	0.42	0.42	0.41	0.01	0.32
GIT full	27.34	27.64	26.91	27.12	0.58	0.98
GIT empty	6.84	7.04	6.85	7.07	0.18	0.96
Spleen	0.34	0.33	0.34	0.33	0.01	0.99
Lungs with trachea	1.38	1.41	1.36	1.31	0.03	0.72
Pluck	0.58	0.55	0.53	0.57	0.01	0.16
Skin (kg)	2.51	2.37	2.52	2.36	0.06	0.79
Head (kg)	1.40	1.39	1.45	1.36	0.03	0.73
Blood (kg)	0.72	0.81	0.84	0.78	0.02	0.40

Each value is the average of three observations
Mean values in a row do not differ significantly
SEM, Standard error of mean

Table 6: Effect of feeding differently processed sorghum stover based complete rations on proportion of lean, bone and fat in the carcasses of growing Nellore x Deccani cross ram lambs

Parameter	SSC	SSM	SSP	SSB	SEM	P
Bone (%)	33.40	33.20	32.30	34.07	0.30	0.23
Meat (%)	59.23	59.17	60.30	58.17	0.33	0.16
Fat (%)	7.37	7.63	7.40	7.77	0.07	0.07
M-B Ratio (%)	1.80	1.77	1.87	1.73	0.26	0.34

Each value is the average of three observations
Mean values in a row do not differ significantly
SEM, Standard error of mean

Table 7: Chemical composition of Longissimus dorsi muscle on fresh basis (%) in growing Nellore x Deccani cross ram lambs fed differently processed sorghum stover based complete rations

Parameter	SSC	SSM	SSP	SSB	SEM	P
Moisture (%)	74.19	75.50	76.02	75.71	0.31	0.17
Protein (%)	20.95	21.45	21.58	21.35	0.09	0.09
Fat (%)	1.74	2.03	2.01	1.85	0.06	0.29
Ash (%)	1.91	1.82	1.80	2.06	0.04	0.12

Each value is the average of three observations
Mean values in a row do not differ significantly (P>0.05)
SEM, Standard error of mean

Conclusions

The results of present study indicated that, processing could not influence the carcass weight, dressing percentage, proportions of whole sale cuts, edible and inedible portions, yield of visceral organs, and per cent yield of bone, meat and fat and bone, meat ratio in different wholesale cuts as well as carcass and meat quality.

References

1. AOAC. (Association of Official Analytical Chemists, Official Methods of Analysis). 16th edition, Washington, D C, 1997.
2. Anandan S, Khan AA, Ravi D, Rao MSB, Ramana Reddy Y, Blümmel M. Identification of a superior dual purpose maize hybrid among widely grown hybrids in South Asia and value addition to its stover through feed supplementation and feed processing. Field crops research. 2013; 153:52-57.
3. Anandan S, Zoltan H, Khan AA, Ravi D, Blümmel M. Feeding value of sweet sorghum bagasse and leaf residues after juice extraction for bio-ethanol production fed to sheep as complete rations in diverse physical forms. Animal feed science and technology. 2012; 175(3):131-136.

4. FAO. World livestock-Livestock in food security. Food and Agriculture Organization, Rome, Italy, 2011.
5. Gandhi VP, Zhou ZY. Rising demand for livestock products in India: Nature, patterns and implications. Australasian Agribusiness Review. 2010; 18:7.
6. Gerrand F. Meat Technology. 3rd edition Leonard Hell Limited, London, 1964.
7. Karimizadeh E, Chaji M, Mohammadabadi T. Effects of physical form of diet on nutrient digestibility, rumen fermentation, rumination, growth performance and protozoa population of finishing lambs. Animal Nutrition. 2017; 3(2):139-144.
8. Khan AA, Sai M, Rao B, Ravi D, Prasad KVS, Anandan S *et al*. Effect of varying the crop residue, cultivar and physical form on intake and nutrient utilization in Deccani sheep fed complete diets. Animal Nutrition and Feed Technology. 2016; 16:197-208.
9. Madhavi K, Reddy TJ, Ramana Reddy Y, Reddy GVN. Effect of feeding differently processed detoxified neem (*Azadirachta indica*) seed cake based complete diet on growth, nutrient utilization and carcass characteristics in Nellore sheep. Livestock Research for Rural Development. 2006; 18(10)
10. Madhavi K. Effect of differently processed complete diet containing detoxified neem seed cake on growth and nutrient utilisation in sheep (Doctoral dissertation, Acharya NG Ranga Agricultural University Rajendranagar, Hyderabad), 2003.
11. Nalini Kumari N. Effect of feeding sweet sorghum bagasse (SSB) based diets on nutrient utilization and performance in native sheep. Ph.D. thesis submitted to SVVU, Tirupati, 2011.
12. Nalini Kumari N, Ramana Reddy Y, Blummel M, Monika T, Reddy BVS, Ravinder Reddy Ch. Effect of feeding differently processed sweet sorghum (Sorghum bicolor L. Moench) bagasse based complete diet on nutrient utilization and microbial N supply in growing ram lambs. Small Ruminant Research. 2014; 117:52-57.
13. Nalini Kumari N, Ramana Reddy Y, Blummel M, Nagalakshmi D, Monika T, Reddy BVS *et al*. Growth performance and carcass characteristics of growing ram lambs fed sweet sorghum bagasse-based complete rations varying in roughage-to-concentrate ratios. Tropical animal health and production. 2013; 45(2):649-655.
14. Prasad CS, Gowda NKS, Ramana JV. Feeding strategies to enhance animal productivity. In: Proceedings of the Xth animal nutrition conference, Karnal: NDRI, 2001, 23-45.
15. Prasad DA. Extrusion-Expansion applications in the feed industry. In: Short term course on feed processing technology. Acharya N. G. Ranga Agricultural University, Hyderabad, India. 2003, 102-108.
16. Reddy GVN, Reddy LJ. Effect of cotton stalks based complete diets on growth and carcass characteristics in sheep and goats in field conditions. Indian Journal of Animal Nutrition. 2003; 20(1):97-100.
17. Reddy GVN, Reddy MR. Meat production and carcass characteristics of native goats and sheep under intensive system of feeding utilizing urea treated sorghum straw based diet. Indian Journal of Animal Nutrition. 2001; 18:375-379.
18. Reddy GVN, Joji Reddy K, Nagalakshmi D. Effect of feeding Expander extruder Processed complete Diet containing Maize cobs on Production performance of Buffaloes. Indian Journal of Animal Nutrition. 2001; 18(1):8-14.
19. Reddy GVN, Reddy AR, Anjaneyulu Y, Ramana Reddy Y. Technologies for enhancing feed quality. Publication of results of Team of excellence on feed technology and quality assurance (NATP), ANGRAU, 2005.
20. Reddy MR. Complete diets based on fibrous residues for dairy cattle. Indian Dairyman. 1990; 42:180-184.
21. Reddy MR, Govindaiah T, Reddy GVN. Effect of physical processing on the nutritive value and nutrient utilization of cotton straw in goats. Proceedings of Vth International Conference on Goats, New Delhi, 1992, 194 (Abstr.)
22. Samanta AK, Singh KK, Das MM, Maity SB, Kundu SS. Effect of complete feed block on nutrient utilization and rumen fermentation in Barbari goats. Small Ruminant Research. 2003; 48:95-102.
23. Snedecor GW, Cochran WG. Statistical methods. 8th edn, Iowa State University Press, Ames, Iowa, USA-50010, 1994.
24. Talapatra SK, Roy SC, Sen KC. Estimation of phosphorus, chlorine, calcium, magnesium, sodium and potassium in food stuffs. Indian Journal of Veterinary Science and Animal Husbandry. 1940; 10:243-258.
25. Ward GM, Johnston FB. Chemical methods of plants analysis. Publ.1064. Research Branch, Canada, Department of Agriculture, 1962.