Preparation of Densified Complete Feed Blocks with Condensed Tannins: Impact on Performance of Parasites in Goats

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ABSTRACT

Present study was planned to screen locally available tanniferous tree leaves for their chemical composition, presence of condensed tannins (CT), potential source of CT and suitable leaf meal mixture (LMM) was formulated for incorporation in the densified complete feed blocks (DCF). Two types of blocks (with and without CT; CT-DCF and DCF, respectively) were formulated and prepared. Twelve adult male goats of similar age and body weight (27.51 ± 0.86) were divided in 3 groups (4 in each) in completely randomized block design (CRD) for feeding of 75 days. Goats of T_1 (no infection) and T_2 (*H. contortus* infection @ 1500 L_3 /goat) were offered DCF blocks while the goats of T_3 (*H. contortus* infection @ 1500 L_3 /goat) offered CT-DCF. Initial body weights (kg) of goats did not differ significantly ($P<0.05$) irrespective of groups, however, final body weight at the end of feeding trial were significantly lower in T_2 compared to T_1 and T_3. Daily feed intake was significantly ($P<0.05$) lower in T_2 as compared to T_1 and T_3. Intakes of dry matter, organic matter, crude protein, digestible crude protein, digestible organic matter and total digestible nutrients (Kg/100 Kg bwt.) were significantly ($P<0.05$) higher in T_1 and T_3 as compared to T_2. The faecal egg counts (FECs) per gram faeces were significantly lower ($P<0.05$) in T_3 than that of T_2. It may be concluded that CT-DCF serve a promising complementary alternative feeding strategy to control *H. contortus* infection in goats as socio-economic, farmers and environmental friendly sustainable approach.

***Keywords*: **Densified complete feed blocks, Goats, *H. contortus* infection, Performance

Small ruminant production plays an important role in the traditional farming system of Jammu and Kashmir but fodder production from natural grasslands and fallow vegetation is distinctly seasonal. The deficiency of good quality feeds and fodders round the year, malnutrition and high prevalence of gastrointestinal parasitic infections are the main bottle neck. Among small ruminants, goats are the best animal for meat industry due to their hardiness, disease resistance, prolificacy and no socio-religious barrier for meat consumption. They act as insurance agents against crop failure and provides alternative source of livelihood to the farmers all round the year. They mostly thrive on grazing of natural grass as well as browsing on shrubs and tree leaves. The grazing lands are fast dwindling due to the ever growing human population and urbanization.

Among the gastrointestinal nematode infections (GINs), *Haemonchus ontortus* is one of the major problems of sheep and goat production throughout the world, particularly in tropical and subtropical areas (Pathak and Tiwari, 2012). For control of these parasites has solely relied on the repeated use of chemical anthelmintics. However, the emergence of anthelmintic resistant and the increasing concern of consumers for drug residues in animal products have provided a strong momentum towards the development of alternative strategies to control GINs (Pathak *et al*., 2013). Moreover, CT containing tree leaves and/ or LMM has been reported to reduce worm burden and increase animal performance (Pathak, 2013; Pathak *et al*., 2013; Singh *et al*., 2015). For proper utilization of locally available poor quality as well as unconventional feed resources in animals diet can be improved either by supplementing or incorporating costlier concentrate and other feed ingredients, which increases the utilization of nutrients (Pathak and Tiwari, 2013) through stimulating rumen fermentation (Samanta *et al*., 2003).

Supplementation of costly concentrate increases the pressure on supplemental feed resources and extra burden on animal keepers. Therefore, there is need for efficient utilization of these poor quality roughage resources to improve the nutritional status, health and performance in long-term sustenance; the other natural alternatives are required. One way of overcoming this problem is by feeding of CT enriched LMM containing densified complete feed blocks (CT-DCF). It is an alternative to utilize these locally available low quality roughages, forest waste/ tree leaves/ LMM and other cheaper locally available feed ingredients in a balanced proportion to improve animal performance and reduced parasitic infection (Pathak *et al*., 2013; Singh *et al*., 2015). Awareness towards use of densified complete feed block feeding in ruminants is increasingly spreading all over the world including in our country especially in the Agriculture, Animal and Veterinary Sciences Universities and Research Institutes, and being adopted by the progressive farmers. Most of the Universities and Institutes work on the beneficial effects of densified complete feed.

Certainly in the near future animal keeper may get specific answers to increase animal productivity, control worm burden and to reduce production and reproduction related problems. Though the bio-mass resources in the country are limited, these are to be used efficiently with the help of recently available scientific outcomes and technical principles (Pathak and Zombade, 2004). Moreover, the information regarding formulation, preparation and production CT enriched LMM containing densified complete feed blocks feeding and utilization in *H. contortus* infected goats are scanty. Therefore, the present study was planned to access the palatability, nutritional as well as mechanical quality of densified complete feed blocks with and without CT enriched LMM containing densified complete feed blocks (CT-DCF and DCF) in *H. contortus* infected goats.

MATERIALS AND METHODS

Study was carried out in the Division of Animal Nutrition, Faculty of Veterinary Sciences & AH, Sher-e-Kashmir, University of Agricultural Sciences and Technology, Jammu, R. S. Pura, Jammu-181 102. Locally available tree leaves viz. *Eugenia jambolana*, *Ficus bengalensis*, *Leucaena leucocephala*, *Morus alba* and *Psidium guajava* were collected from College premises and transported to the Divisional shed in fresh state. They were shed dried and then they were screened for their chemical composition (Table 1) and presence of condensed tannins (CT). Subsequently they were processed for preparation and formulation of suitable leaf meal mixture (LMM) of *E. jambolana*, *P. guajava* and *M. alba* in the ratio of

50: 30: 20, respectively, so that it provide CT source as well as maintaining isonitrogenous and isocaloric experimental densified complete feed blocks.

Table 1: Chemical composition of tree leaves (g/kg) on DM basis

Attributes	*P. guajava*	*E. jambolana*	*F. bengalensis*	*L. leucocephala*	*M. alba*
Organic matter	916.6	919.0	867.4	915.9	919.2
Crude protein	89.4	88.6	97.3	223.7	179.6
Crude fibre	126.6	132.1	130.8	110.8	89.8
Ether extract	40.3	43.1	26.8	49.3	32.4
Neutral detergent fibre	306.6	327.1	463.5	332.6	221.8
Acid detergent fibre	258.3	282.2	380.1	210.9	209.6
Condensed tannins	94.7	62.9	46.3	46.4	1.1

Procurement and processing of feed ingredients

A variety of heaper feed ingredients were explored that could be incorporated in both type of densified complete feed blocks with and without CT (CT-DCF and DCF). They were processed like cereal grains must be ground through fine grinder. Oil cake and other feed ingredients are ground through the coarse grinder, using sieve of size 5-8 mm. Minerals, vitamins, other feed supplements and other feed ingredients are mixed separately and stored for mixing in the premix at the time of preparation. A suitable concentrate mixture (crushed maize: 33, Mustard oil cake: 40; wheat bran: 24; mineral mixture1.5 and common salt: 1.5) was formulated for the preparation of DCF and CT-DCF blocks. Wheat straw was procured from local market having particle size of 0.5 to 4 cm.

Preparation of feed blocks

Both type of blocks were prepared by pressing mixed material in a double chambered manually operated screw type densified complete feed block making machine, which was designed and developed by the Scientists of our Division. The required quantity of feed ingredients were weighed and mixed uniformly to prepare CT-DCF and DCF blocks, respectively (Table 2). Weighed amount of wheat straw was spread over the smooth surface of the cemented floor and required quantity of molasses mixed with urea solution in water was sprinkled on the wheat straw and thoroughly mixed in it to increase the adhesive characteristics of wheat straw. The molasses mixed wheat straw was blended with concentrate mixture in proper roughage: concentrate ratio. However, the required amounts of conventional concentrate mixture and wheat straw were replaced by LMM as CT source and alternative feed resource for preparation of CT-DCF. Whole mixture was hand mixed and kept for 4-5 hours as such on smooth surface of cemented floor so that each particle of feed ingredients absorbs moisture and get homogenized.

Thereafter, it was transferred to the upper chamber of manually operated block making machine and manual pressure was applied by handle rotation which was fitted on the pressure plate with a provision plate fixing and screw type rotation handle which provide desired pressure for preparation of feed blocks. For removing the prepared blocks pressure was released slightly (Fig. 1) and then packed those feed blocks in polythine bag. They were properly stored in a moisture free airy place before use.

Fig. 1: Showing storage of CT-DCF and DCF blocks for feeding of experimental goats

Table 2: Effect on nutrient intake and faecal egg counts in *H. contortus* infected goats fed DCF and CT-DCF blocks

Attributes	Group*			SEM	P values
	T_1	T_2	T_3		
Body weight (kg)	$28.08^b \pm 1.91$	$20.58^a \pm 1.63$	$26.33^b \pm 1.09$	1.27	0.020
Nutrient intake					
Densified Complete feed blocks (DCF/ CT-DCF)					
% Body weight	2.28 ± 0.14	2.42 ± 0.05	2.62 ± 0.19	0.09	0.288
Kg/100kg Body weight	$6.33^b \pm 0.31$	$4.96^a \pm 0.34$	$6.87^b \pm 0.50$	0.32	0.020
Dry matter					
% Body weight	2.00 ± 0.13	2.13 ± 0.04	2.21 ± 0.13	0.06	0.430
Kg/100kg Body weight	$5.56^b \pm 0.27$	$4.36^a \pm 0.30$	$5.79^b \pm 0.37$	0.25	0.023
Organic matter					
% Body weight	1.80 ± 0.12	1.92 ± 0.04	1.98 ± 0.11	0.05	0.456
Kg/100kg Body weight	$5.01^b \pm 0.25$	$3.93^a \pm 0.27$	$5.21^b \pm 0.33$	0.22	0.023
Crude Protein					
% Body weight	0.22 ± 0.01	0.23 ± 0.00	0.24 ± 0.01	0.01	0.462
Kg/100kg Body weight	$0.61^b \pm 0.03$	$0.48^a \pm 0.03$	$0.63^b \pm 0.04$	0.03	0.026
Digestible crude protein					
% Body weight	$0.15^{ab} \pm 0.01$	$0.13^a \pm 0.00$	$0.16^b \pm 0.01$	0.00	0.048
Kg/100kg Body weight	$0.42^b \pm 0.02$	$0.27^a \pm 0.03$	$0.41^b \pm 0.02$	0.02	0.003
Digestible organic matter					
% Body weight	1.12 ± 0.07	1.06 ± 0.01	1.15 ± 0.05	0.03	0.419
Kg/100kg Body weight	$3.13^b \pm 0.17$	$2.18^a \pm 0.15$	$3.03^b \pm 0.17$	0.15	0.005
Total digestible nutrient					
% Body weight	1.18 ± 0.07	1.12 ± 0.02	1.21 ± 0.05	0.03	0.443
Kg/100kg Body weight	$3.29^b \pm 0.18$	$2.29^a \pm 0.16$	$3.18^b \pm 0.18$	0.16	0.005
Condensed tannins					
% of Dry matter intake	$0.00^a \pm 0.00$	$0.00^a \pm 0.00$	$1.61^b \pm 0.00$	0.23	0.000
Faecal egg counts	-	$845.83^b \pm 161$	$97.92^a \pm 20$	96.93	0.001

[ab] Means with different superscripts within a row differ significantly

*T_1: Negative control; T_2: Infected Control; T_3: Infected Treatment

Animals, feeding and experimental design

Twelve local adult male goats (27.51 ± 0.86 kg average body weight) were divided randomly into three equal groups each having four goats in a completely randomized block design (CRD) as mentioned below:

T1 (Negative control)	:	No infection + DCF feeding
T2 (Infected control)	:	*H. contortus* infection + DCF feeding
T3 (Infected treatment)	:	*H. contortus* infection + CT-DCF feeding

Feeding trial was lasted for 75 days excluding 21 days of adaptation on feed blocks in all three groups (T_1, T_2 and T_3) before the start of experiment. During feeding trial goats of T_1 and T_2 groups were fed with DCF, however the goats of T_3 group were fed with CT-DCF *ad libitum*. All goats were provided drinking water twice daily in the morning and evening. Both type blocks were formulated in such a way to supply nutrients in a balanced proportion to fulfill the nutrient requirements for maintenance as per NRC (2007). They were kept in a well-ventilated goat shed having concrete floor throughout the experiment. All goats were dewormed as per standard protocol before the start of experiment. Hygienic and sanitary conditions were provided in the shed by routinely using disinfectant and detergent.

Experimental *H. contortus* infection

Abomasums of goats were collected from nearest meat shop and brought to the laboratory. They were excise in the tray and adult female *Haemonchus contortus* parasites were obtained. Parasitic eggs were retrieved from gravid uterus as per requirement. The infective 3rd stage larvae (L_3) were produced by standard petridish method of faecal culture technique. The infective doses of the 3rd stage larvae of *H. contortus* were prepared and administered orally @ 1500 larvae per goat of T_2 and T_3 groups.

Analysis and measurement

A metabolism trial of six days duration was conducted at the end of feeding trial to determine the nutrient intake and utilization in *H. contortus* infected goats. Chemical composition viz. dry matter (DM), organic matter (OM), crude protein (CP) and ether extract (EE) of feed offered, residue left and faeces voided were analyzed by the method of AOAC (1995) and nitrogen content in urine and faeces were estimated by Kjeldahl method. Neutral detergent fibre (NDF) and acid detergent fibre (ADF) were determined as per the method of Van Soest *et al*. (1991). The CT content in various tree leaves, LMM and CT-DCF was determined as per butanol-Hcl method of Makkar (2000). Faecal egg counts (FECs) per gram of faeces were counted using Stoll's egg counting method of Anonymous (1986).

At the start of the experiment, goats were weighed for two consecutive days to get their average initial body weight. The weight of individual goat was recorded at fortnightly intervals in the morning before feeding and watering for whole experimental period in order to assess the changes in body weight, if any. Goats were individually offered weighed quantities of respective feed blocks (i.e. DCF in T_1 and T_2 and CT-DCF in T_3) in the morning and evening. Offered and refusals of feed from all goats were weighed daily and sampled at weekly intervals for subsequent analysis of DM to assess the average dry matter intake (DMI) throughout the experimental period.

Statistical Analysis

Results obtained were subjected to analysis of variance and treatment means were ranked using Duncan multiple range test (Snedecor and Cochran, 2004). The periodic alterations in body weight changes and DMI were determine using repeated measures design (General linear model; GLM, Multivariate) by SPSS version 10.0 for windows. Significance was declared at $P<0.05$ unless otherwise stated. The overall mean of FECs were compared between T_2 and T_3 groups whereas the goats of T_1 group showed zero egg count throughout the experiment, therefore they were not included in the statistical analysis.

RESULTS AND DISCUSSION

Chemical composition of tree leaves

Chemical composition (g/kg DM) of locally available tree leaves in the present study showed wide variation (Table 1). These variations could be a result of agro-climatic conditions, season, stage of maturity, genetic makeup, soil fertility, harvesting methodology, post harvest stages and processing conditions like drying and / or grinding before analysis (Dey *et al.,* 2006; Pathak *et al*., 2015; Singh *et al*., 2015; Sheikh *et al*., 2011). They were found to be rich source of protein, soluble carbohydrates, and CTs, and showed great potential as an alternate feed resource (Bakshi and Wadhwa, 2007; Pathak *et al*., 2013; Singh *et al*., 2015) or functional feed. Use of tree leaves in ruminant enhances microbial growth and digestion

(Bonsi *et al*., 1995). Moreover, fodder tree leaves are very relishing to small ruminants especially goats.

Acceptability, palatability, compactness and daily feed intake

The incorporation of LMM in CT-DCF provides more compactness and better binding ability compared to DCF blocks. The T_1 and T_2 groups offered DCF blocks while T_3 group offered CT fortified LMM incorporated CT-DCF blocks. All experimental goats of T_1, T_2 and T_3 groups were trained and well adopted for feeding of DCF and CT-DCF blocks, respectively for 21 days as preliminary feeding before the start of experimental study. After proper adaptation period, the acceptability and palatability of both types of feed blocks (DCF and CT-DCF) by experimental goats of all three groups (T_1, T_2 and T_3) was equally good.

Densified complete feed blocks

The ingredients and chemical composition of DCF and CT-DCF blocks have been presented in table 2. Suitable proportions of concentrate mixture, wheat straw, LSP and DCP were replaced with LMM. The LMM as CT source was only added in CT-DCF at 26.0 % level. Locally available feed stuffs were incorporated in varying proportion and mixed thoroughly to achieve the desired roughage and concentrate ratio. Feed ingredients and their chemical composition used for formulation of DCF and CT-DCF in the present study were comparable to those used by previous workers (Raghuvansi *et al*., 2007; Nagalakshami and Reddy, 2012). Molasses was used as feed binder @ 10% in the present study for preparation of DCF and CT-DCF blocks as used by previous workers (Sinha *et al*., 2011; Nagalakshami and Reddy, 2012). Among the feed blocks, CT-DCF blocks containing LMM showed more compactness and hardness as compared to DCF blocks. This may be due to LMM having good binding ability.

Nutrient intake

Daily feed intakes among both infected groups (T_2 and T_3), significantly higher intake was recorded in T_3 than that of T_2. Higher intake of CT-DCF that contained LMM as CT source having anthelmintic properties would diminish *H. contortus* load in T_3 as indicated by reduced FECs. Present findings are consistent with the previous results (Osoro *et al*. 2007; Lisonbee *et al*. 2009). They observed that parasitized goats and lambs ate more of a tannin containing supplement than non-parasitized animals. The depression of feed intake in T_2 group was probably due to severity of *H. contortus* infection and panic reaction caused by these parasites. The findings were in accordance to the earlier report (Pathak *et al*., 2013) in sheep and kids (Pathak and Tiwari, 2012) infected with *H. contortus*. Daily intakes of DM, OM, CP and feed blocks (Kg/100 Kg bwt.) were significantly (P<0.05) higher in T_1 and T_3 groups as compared to T_2 group. Present results are contradictory with the findings of many workers (Scharenberg *et al*., 2008), who reported non-significant difference in total intake of DM, OM in *H. contortus* infected lambs, sheep and goats fed on diets with and without tanniferous sainfoin, LMM incorporated composite diet and multi nutrient blocks, respectively.

Nutrient intake by goats (Table 3) was within the normal range (NRC, 2007) and this clearly indicates that both types of blocks (DCF and CT-DCF) were palatable. Present results are in concurrence with earlier reports, who reported that CTs are beneficial to ruminants at low concentration because they protect dietary proteins from degradation in the rumen (Day *et al*., 2008; Pathak *et al*., 2013). The intakes of DCP, DOM and TDN in kg per 100 Kg body weight were significantly (P<0.05) higher in T_1 and T_3 groups as compared to T_2 group, although, the intakes of DCP, DOM and TDN between T_1 and T_3 were statistically similar. However, intakes of DCP, DOM and TDN when expressed in percent of body weight did not differ significantly (P<0.05) irrespective of groups.

Body weight changes

The fortnightly body weight changes in *H. contortus* infected goats fed DCF and CT-DCF for experimental period of 75 days are depicted in the fig 5. The initial body weights (kg) of goats did not differ significantly (P<0.05) irrespective of all three groups, however, the mean body weight (kg) was significantly (P<0.020) lower in infected control (T_2) group as compared to negative control (T_1) and infected treatment (T_3) groups. Similar to present findings several workers (Swarnkar *et al.* 2007; Pathak *et al*. 2013; Singh *et al*., 2015) also reported that there was no marked variation in body weight in sheep and goats infected with *H. contortus* having tanniferous plant (*Prosopis cineraria*) or CT supplemented with in their diet in comparison to control.

Faecal egg counts

Effect of CT-DCF feeding on faecal egg counts in *H. contortus* infected goats observed after 21 days post administration of *H. contortus* (L_3) larvae @ 1500) in T_2 and T_3 groups and they showed passing parasitic eggs in their faeces. Though, FECs were zero in goats of T_1 group throughout the experimental period, so they were not included in the statistical analysis. Mean faecal egg counts were significantly ($P<0.001$) lower in CT-DCF fed infected treatment (T_3) group as compared to DCF fed infected control (T_2) group (Table 3). The CT-DCF feeding caused 88 percent FECs reduction in T_3 group as compared to DCF fed group (T_2). It clearly indicated that CT acts as natural anthelmintic to control *H. contortus* infection and improve goat performance. Infected goats of T_3 group increased intake of CT-DCF, which suggested that they self-medicated with CT against *H. contortus*. Present findings are consistent with findings of earlier workers (Osoro *et al*., 2007 and Lisonbee *et al*., 2009). They also observed that parasitized goats and lambs ate more tannin-containing supplement than that of non-parasitized counterparts. Parasitized goats of T_3 group modified their feed intake containing CT-DCF, likely as a consequence of experiencing relief from the parasitic burden induced by the anthelmintic properties of CT.

CONCLUSION

It may be concluded that CT-DCF blocks provide better binding ability and compactness and serve a promising alternative feeding strategy to control *H. contortus* infection in goats as socio-economic, farmers and environmental friendly sustainable approach. Higher intake of CT-DCF *vis-a-vis* DCF indicates self-medication behaviour of infected goats.

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