

The Effect of Feeding Dried Tomato Pomace and Concentrate on Nutritional and Growth Parameters of Hararghe Highland Sheep, Eastern Ethiopia

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Abstract

Most tropical feed resources particularly crop residues and hay are mostly deficient in protein content. Thus, maximization of livestock productivity in the tropical regions largely depends on the efficiency of utilization of locally available protein sources. This study was aimed to evaluate the effect of supplementation of dried tomato pomace, concentrate mix and their mixture on intake, apparent digestibility, and live weight of Hararghe highland sheep fed a basal diet of natural pasture hay. The study was conducted using 24 yearling intact Hararghe highland male sheep with mean initial body weight (BW) of 16.7±2 (Mean ± SD). The experiment consisted 90 days feeding and 7 days digestibility trials. The experimental sheep were blocked into 6 blocks of 4 animals based on their initial BW and randomly assigned to one of the four treatments within a block. Treatments were ad libitum feeding of hay alone (T1), hay supplemented with 359.61 g dried tomato pomace (DTP; T2), hay supplemented with 300 g concentrate mix (CM=33% Noug seed cake (NSC) +67% Wheat Bran (WB); T3), and hay with 1:1 ratio of DTP and CM (T4). The crude protein (CP) content of hay, DTP, NSC and WB used in this study were 9.1, 17.8, 29.6 and 17.2%, respectively. Apparent digestibility of dry matter (DM) was 63, 61, 70 and 67% and that of CP was 66, 74, 81 and 77% for T1, T2, T3 and T4, respectively. Digestibility of DM was higher for T3 as compared to T1 and T2, while values for T4 were similar with T1 and T3. Digestibility of CP was highest for T3, lowest for T1 and intermediate for the other two treatments. Average daily gain (ADG) was lowest for T1 (30 g/day), and among the supplemented treatments values for T4 (65 g/day) was numerically higher than that for T3 (58 g/day) and T2 (57 g/day). Feed conversion efficiency also showed more or less a similar trend to ADG. Taken as a whole, the present finding evidenced that dried tomato pomace can replace concentrate mixture 100% as a supplement to sheep fed a basal diet of natural pasture hay.

Keywords: Dried tomato pomace; Feed intake; Digestibility; Sheep

Background

Sheep production systems in Ethiopia are predominantly traditional. The prevailing sheep production systems have evolved in relation to the total availability of land, the type of crop production practiced and the frequency or intensity of cropping, and the area of uncultivated waste land [1]. Despite the relatively huge livestock population with high potential for meat and milk production, a number of factors hindered the development of livestock sector in Ethiopia. Among the factors affecting sheep productivity like in other livestock species is feed shortage both in quality and quantity. In Ethiopia, sheep are kept mostly on natural pastures, crop residues and stubble grazing in which the quality and quantity are subjected to great seasonal variation [2,3]. Natural pasture covers about 61.92% of the total feed of livestock in the country, which is augmented by crop residues, hay and agro-industrial by products that covers 27.01, 6.55 and 0.78% of the total livestock feed, respectively [3]. However, most of these tropical feed resources particularly crop residues and hay are mostly deficient in protein content. Thus, maximization of livestock productivity in the tropical regions largely depends on the efficiency of utilization of locally available protein sources [4]. One option for improving performance of animals fed low quality diets is

supplementation with food processing agro-industrial by-products. Using agro-industrial by-products in ruminant nutrition is one of the important strategies to improve feed supply especially in developing countries [5]. Tomato pomaces increasingly have been used as valuable feedstuff in ruminants and poultry nutrition in developing countries [6,7]. Tomato Pomace is the mixture of tomato peels, crushed seeds and small amounts of pulp that remains after the processing of tomato for juice, paste and ketchup [8]. The total area of tomato cultivation in Ethiopia is 833 hectare by the year 1993 and later on the cultivation spread towards other parts of the country. Since 1994 up to present, tomato acreage increased to 5338 hectare with a total production of 55,635 Metric ton [9]. In Ethiopia there are two tomato processing factories that are Melgi-Wondo and Upper Awash Agro industry. The objectives of this study was to evaluate the effect of supplementation of dried tomato pomace, concentrate mix and their mixture on intake, apparent digestibility, and live weight of Hararghe highland sheep fed a basal diet of Natural pasture hay.

Materials and Methods

Description of the study area

The experiment was conducted at Haramaya University which is located 515 km East of Addis Ababa. The site is located at an altitude

of 1950 meter above sea level at 9°26' N latitude and 42°3' E longitude. The mean annual rainfall and temperature of the study area is 790 mm and 16°C, respectively [10].

Experimental animals and management

Twenty four yearling intact Hararghe highland male sheep with mean initial body weight of 16.7 ± 2.5 (Mean ± SD) were purchased from local market to conduct the experiment. The sheep were quarantined for 21 days in the experimental area. During this quarantine period, they were de-wormed (using Albendazole) and sprayed (using acarimic) against internal and external parasites, respectively, and vaccinated for pasteurellosis and anthrax with 1 ml ovine vaccine and ½ ml vaccine per sheep, respectively.

Feeds and feed preparation

Natural grass hay (predominantly Rhodes grass or *Chloris gayana*) was harvested from Haramaya University campus, kept under hay shade to maintain its quality and used as basal diet throughout the experimental period. Processed fresh tomato pomace was collected from Merti fruit and vegetable Processing Industry (*Upper Awash Agro-Industry*), it was dried by spread on plastic sheet and sun dried under shade until it was crispy, packed in sacks and transported to Haramaya University. Then coarsely ground at Haramaya University feed processing mill and then kept in clean sacks.

Experimental design and treatments

A randomized complete block design (RCBD) was used for the experiment. At the end of the quarantine period the sheep was fasted overnight and initial body weigh was measured. Animals were blocked into six blocks of four animals each on the basis of their initial body weight. Animals within a block were randomly assigned to the four treatments. Treatments were: natural grass hay *ad libitum* alone (T1), hay *ad libitum* supplemented with dried tomato pomace (T2), hay *ad libitum* supplemented with concentrate mixture of Wheat Bran (WB) and Noug Seed Cake (NSC) at a ratio of 67:33%, respectively (T3), and hay *ad libitum* supplemented with a 1:1 mixture of tomato pomace and concentrate mix (T4). The animals were fed concentrate at a rate of 300 gram per day on dry matter basis. The supplement for the other treatments was on iso-nitrogenous basis. From the laboratory analysis of the experimental feed, dried tomato pomace (DTP), NSC and WB had 17.75, 29.56 and 17.2% CP on DM basis, respectively. Considering the mentioned levels of CP, the 300 gram concentrate mixture was provided 63.83 CP. To supply the same amount of CP from tomato pomace about 359.61 g of DM tomato pomace need to be offered to animals in the treatment that receive only dried tomato pomace supplementation. The other supplemental treatment was received half of each of the supplements. In this experiment, samples of the supplement that used were analyzed for CP contents before the start of the experiment and the result of the analysis was used to make the supplemental diet iso-nitrogenous. The layout of the experimental treatments for the study is shown in Table 1.

Supplements (g/day/animal) on DM basis			
Treatments	Hay	Dried Tomato pomace	Concentrate mix
T1	Ad libitum	0	0
T2	Ad libitum	359.6 g	0

T3	Ad libitum	0	300 g
T4	Ad libitum	179.6 g	150 g

Table 1: Experimental treatments; Concentrate mix =33% noug seed cake and 67% wheat bran; DM=dry matter.

Measurements and Laboratory Analysis

Feed intake and body weight gain

The amount of feed provided and refusal from each experimental animal were recorded daily throughout the experimental period to determine daily feed intake of the experimental animals as the difference between feed offered and refusal. Samples of feed offered per batch of feed was taken and pooled and sub sampled at the end of the experiment for chemical analysis. Samples of feed refusals were taken per animal and pooled by treatment and sub sampled for chemical analysis at the end of the experiment. Body weight (BW) measurements were taken every 10 days after overnight fasting and daily BW gain was determined as a difference between final and initial BW divided over the feeding days. Feed conversion ratio (FCR) was calculated as the proportion feed intake to BW gain.

Digestibility trial

Immediately after the completion of the ninety days feeding trial, twenty animals were fitted with feces collection bags. After allowing adjustment period of three days to the harness, daily total feces excretion per animal was collected for seven days. Each day's fecal output of each animal was weighed and 20% was sub-sampled and stored frozen at -20 °C. Sample of feed offered and refused for individual animals during digestibility trial were separately collected for chemical analysis.

Chemical analyses

All samples of feed and feces were analyzed for dry matter (DM), ash, and CP, according to the procedures of [11]. The crude protein (CP) content was calculated by multiplying N content with a factor of 6.25. Neutral detergent fiber (NDF), acid detergent fiber (ADF) and acid detergent lignin (ADL) was analyzed as per the procedure of Van Soest and Robertson [12].

Statistical analysis

Data on feed intake, digestibility, and weight gain analysis's were subjected to analysis of variance (ANOVA) using the general linear model procedure of SAS software package. The difference between treatments means were separated by using least significant difference (LSD) tests. The model for data analysis was; $Y_{ij} = \mu + t_i + b_j + e_{ij}$ Where: y_{ij} =response variable, μ =overall mean, t_i =treatment effect, b_j =block effect, e_{ij} =random error.

Results

Chemical composition of the feed

The crude protein (CP) content of the supplements feeds ranges between 17.2 and 29.56% DM, and the grass hay consists 9.12% DM CP which was good quality. The relative Organic Matter (OM) of hay

in the present study was lower than in the supplemented feed, but hay's fiber contents were much higher than what was contained in the supplementary feeds. NDF and ADF were highest in DTP among the supplementary feed stuffs but lowest level NDF is recorded in NSC and ADF in the WB (Table 2).

Chemical compositions (% DM)						
Treatments feed	DM	CP	NDF	ADF	Ash	ADL
Hay	92	9.1	65.5	39.9	11.4	6.6
NSC	92.3	29.6	28.3	23.7	8.5	6.4
WB	92	17.2	48.4	14.5	7.7	3.8
DTP	91	17.8	48.9	42.3	7.8	10.2

Table 2: Chemical composition of treatment diets and hay refusal.

Dry matter and nutrient intake

The daily mean DM intake from native hay (basal diet) was higher in the un-supplemented sheep as compared to supplemented ones, while values among supplemented sheep were similar. The higher intake of the basal diet by the control group is expected, as sheep in T1 consumed more of the basal diet in an attempt to fulfil their nutrient requirement. The total daily DM and OM intake was significantly higher for supplemented treatments than control. The CP intake was higher for the supplemented sheep as compared to those fed hay alone. Daily CP intake varied between 50.35 and 102.75 g/day (Table 3).

Treatments						
Intake (g/d)	T1	T2	T3	T4	SEM	SL
Hay DM	536.2 ^a	332.2 ^b	360.8 ^b	321.8 ^b	17.9	***
Supplement DM	0.0 ^c	395.2 ^a	300.0 ^b	347.6 ^a	12.5	***
Total DM	536.2 ^b	727.4 ^a	660.8 ^a	727.4 ^a	22.2	***
OM	429.8 ^b	595.5 ^a	550.6 ^a	569.5 ^a	17.3	***
CP	50.4 ^b	101.8 ^a	97.8 ^a	102.8 ^a	3.1	***
NDF	347.1 ^b	407.3 ^a	357.9 ^b	375.7 ^{ab}	13.3	*
ADF	214.3 ^c	300.4 ^a	195.4 ^c	243.2 ^b	7.5	***

Table 3: Daily dry matter and nutrients intake of Hararghe highland sheep fed natural pasture grass hay basal diet supplemented with DTP and concentrate.

^{a-c}Means with different superscripts in a row are significantly different at ***P<0.001; *P<0.05.

Dry matter and nutrient digestibility

Apparent digestibility of DM and OM was higher for T3 than T1 and T2, while values for T4 were similar with T1 and T3 (Table 4). Generally, in this study dried tomato pomace when supplemented to grass hay failed to impart improvement in DM and OM digestibility despite its relatively high CP content, but supplementation with dried tomato pomace, concentrate mix or their mixture improved (P<0.001) the digestibility of CP of the total diet.

Treatments						
Digestibility (%)	T1	T2	T3	T4	SEM	SL
DM	62.9 ^{bc}	60.8 ^c	69.7 ^a	67.4 ^{ab}	0.019	*
OM	64.2 ^{bc}	59.8 ^c	71.2 ^a	68.5 ^{ab}	0.019	**
CP	66.3 ^c	74.4 ^b	80.7 ^a	76.9 ^b	0.012	***
ADF	63.6 ^a	48.7 ^b	61.3 ^a	60.5 ^a	0.025	*
NDF	62.8 ^a	52.7 ^b	63.9 ^a	61.1 ^a	0.034	*

Table 4: Apparent dry matter and nutrient digestibility of Hararghe highland sheep fed natural pasture grass hay basal diet and supplemented with DTP and concentrate.

^{a-c}Means with different superscripts in a row are significantly different at ***P<0.001; **P<0.01; *P<0.05.

Body weight change and feed conversion efficiency

The current study revealed that final BW, BWC, ADG and FCE were positively affected by supplementation (Table 5), and was lowest for T1 as compare to supplemented groups.

Treatments						
Parameters	T1	T2	T3	T4	SEM	SL
Initial BW (kg)	16.2	17.4	16.6	16.8	0.537	Ns
Final BW (kg)	18.8 ^b	22.6 ^a	21.8 ^a	22.6 ^a	0.788	**
BWC (kg)	2.7 ^b	5.1 ^a	5.3 ^a	5.8 ^a	0.427	***
ADG (g/day)	29.6 ^b	57.4 ^a	58.3 ^a	64.8 ^a	4.75	***
FCE (g ADG/g DMI)	0.053 ^b	0.083 ^a	0.090 ^a	0.095 ^a	0.0067	**

Table 5: Body weight change of Hararghe highland sheep fed natural pasture grass hay basal diet and supplemented with dried tomato pomace, and concentrate.

^{a-c}Means with different superscripts in a row are significantly different at ***P<0.001; **P<0.01; *P<0.05; Ns= non-significant

Among the supplemented treatments sheep in T4 and T3 had numerically better performance in ADG and BWC compared to T2. The highest daily body weight gain (64.8 g/d) was recorded in sheep supplemented with concentrate Mix and DTP (T2), followed by sheep in T3 (58.3 g/d).

Discussion

Chemical composition of treatment feeds

The high (9.12%) CP content of hay in this experiment is an indication that the hay was of good quality and is above the 7% CP required for microbial protein synthesis in the rumen that can support at least the maintenance requirement of ruminants, which is in line with the results of [13]. Differences in the nutritive value of hay used in different studies may be due to different factors, such as species composition of the hay, stage of maturity at harvest, and differences in the growing environment [14]. The CP content of dried tomato

pomace (DTP) used in this study is lower than the 22% reported by [7]. The chemical composition of DTP indicates that it can be a good supplement to poor quality hay.

Daily dry matter and nutrients intake

The total daily DM and OM intake was significantly higher ($P < 0.001$) for supplemented treatments than for T1. The reason for low intake of DM in T1 may be due to the quality of the hay and its low digestibility as well as the significantly lower crude protein intake by this group.

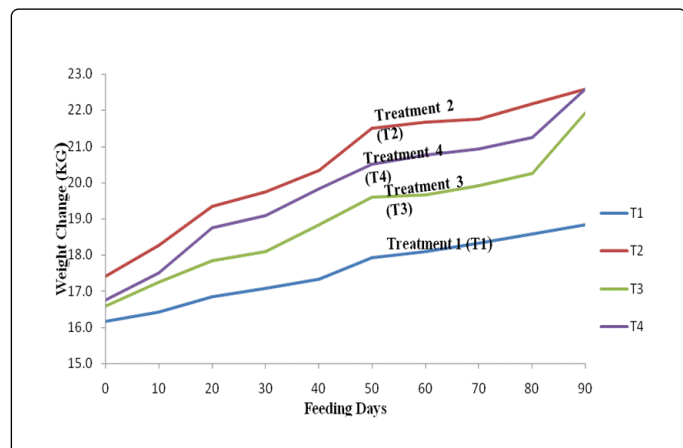


Figure 1: BW during the feeding trial for Hararghe highland sheep fed natural pasture grass hay basal diet supplemented with dried tomato pomace and concentrate.

The result was in agreement with [15] who reported the total daily DM intake of 447.7 g/head/day for non-supplemented sheep and 613.6-749.6 g/head/day for the supplemented treatments. One of the factors that affect forage and concentrate intake and digestibility is its NDF content because it is the major component limiting rumen fill and has high correlation with rumination time, and also dietary deficiency of nutrients, especially of CP for rumen microbes will reduce voluntary intake [16].

The CP intake was higher ($P < 0.001$) for the supplemented sheep as compared to those fed hay alone. Similarly, [17] reported that the control treatment had a lower CP intake than the supplemented ones, horro sheep fed on grass hay and supplementation of different levels of dried 'girawa' (vernonia amygdalina) foliage and crushed maize grain mixtures. This is further supported by the report of [18], which stated that dietary protein supplementation increased the supply of nitrogen to the rumen microbes, which has positive effect in increasing microbe population and efficiency enabling them to increase the rate of breakdown of the digesta. The NDF and ADF intakes appear to be higher for the dried tomato pomace containing treatments as compared to T1 and T3. This may be associated with the higher level of fiber in dried tomato pomace as compared to the concentrate mixture.

Dry matter and nutrient digestibility

Supplementation significantly improved the apparent digestibility of DM, OM and NDF in sheep supplemented with cowpea or commercial concentrate at 150 or 300 g DM/day to maize stover [19]. However, in this study dried tomato pomace when supplemented to

grass hay failed to impart improvement in DM and OM digestibility despite its relatively high CP content. This may be associated with the relative greater fiber content of dried tomato pomace as fiber content may affect DM digestibility of feeds [16]. Moreover, the digestibility of CP was higher for T3 as compared to the other supplemented groups. This could be associated with the reduced OM digestibility of dried tomato pomace supplemented treatments possibly due to the higher fiber content of the pomace. The higher digestibility of CP in supplemented sheep as compared to non-supplemented may be due to high CP content of supplement, which is in line with the results of [20].

The digestibility of NDF and ADF were significantly different ($P < 0.05$) among treatments, and was lower for T2 as compared to the other treatments that had a similar value. This difference appears to be consistent with the difference in NDF and ADF intake among treatments observed in this study. This effect might have also negatively impacted the digestibility of DM and other nutrients, since NDF and ADF are the primary chemical components of feed that determine the rate of digestion [21].

Body weight change and feed conversion efficiency

The trend of weight changes across the feeding weeks (Figure 1) revealed that the live weight of the experimental animals in all the supplemented treatments increased through time with more prominent increase in animals supplemented with dried tomato pomace and concentrate group. Initial body weight was similar ($P > 0.05$) among treatments. The hay used in current study was of good quality in terms of CP and digestibility which could have been a reason for the positive and good ADG observed for T1 in this study. Sheep fed hay alone showed lower ADG which could be due to lower DM and CP intake. Values for FCE for T1 was with the in range of 0.042-0.079 obtained by Niguse [22] in sheep fed natural hay basal diet. The enhanced FCE in the supplemented group in the current study seems to be related to higher nutrient concentration of the supplements and the consequent increase in live weight gain. In agreement to the result of this study, [23,24] also reported supplemented sheep to have higher FCE than the non-supplemented ones. In conclusion, the results of this study suggested that dried tomato pomace can replace concentrate mixture 100% as a supplement to sheep fed a basal diet of hay with better biological performance but further study needs on dried tomato pomace by making silage to explore the possibility of enhancing the digestibility of dried tomato pomace.

Conclusion

The chemical composition of DTP indicates that it can be a good supplement to poor quality hay. However, in this study dried tomato pomace when supplemented to grass hay failed to impart improvement in DM and OM digestibility despite its relatively high CP content but better in CP digestibility. Final body weight, ADG and FCE were significantly affected by the supplementation. The results of this study show that dried tomato pomace have potential to replace concentrate mixture 100% as a supplement to sheep fed a basal diet of hay.

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