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# Supplementation Effect of *Acacia tortilis* pod on Growth Performances and Carcass Characteristics of Woyto-Guji Goats Fed a Basal Diet of Desho Grass Hay

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## Abstract

This study aimed to evaluate supplementation effect of *Acacia tortilis* pod meal on the feed intake, nutrient digestibility, and weight gain and carcass characteristics of yearling male Woyto-Guji goats. Twenty yearling male Woyto-Guji goats with initial weight of 18.40 ± 1.23 kg (mean ± SD) were arranged in a completely randomized block design to four experimental diets. The experimental diets comprised of 20% of *Acacia tortilis* pod+78% of wheat bran (T1); 38% of *Acacia toritlis* pod+ 60% of wheat bran (T2); 58% of *Acacia tortilis* pod+40% of wheat bran (T3); and 20% of noug cake +78% of wheat bran(T4). In addition, all experimental diets contained 1% of table salts or mineral mixture. Five goats were randomly assigned to one of the experimental diets and the actual feeding of experimental goats was lasted for 90 days and followed by 7 days of a digestibility trial. The results indicated that goats supplemented with T2 diet consumed significantly higher (p<0.001) total dry matter and nutrients as compared to T1, T3 and T4 and though the total dry matter intake did not vary in goats received diet 1 or 2. Conversely, the result on nutrient digestibility coefficient indicated that goats supplemented with T2 digested the highest total dry matter, crude protein and fibers in compared to T1, T3 and T4. Likewise, goats supplemented with T2 attained heavier (p<0.001) daily weight gain, hot carcass weight and rib eye area muscle when compared to those goats supplemented with T1, T3 and T4. In conclusion, protein supplementary diets containing 38% of *Acacia toritlis* pod (T2) is promising in terms as it provided superior feeding value to goats fed on poor quality roughages followed by diet containing 20% of *Acacia tortilis* pod (T1) under pastoral management conditions of South Omo.

**Keywords:** *Acacia tortilis*, Feed intake, Nutrient digestibility, Weight gain, Woyto-Guji

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## Introduction

Ethiopia, excluding some none sedentary pastoral areas of Afar and Somali regions, has approximately 32.74 million goats [1]. Goats have been played tremendous roles for the poor communities through providing milk, meat, skins, manure and cash income [2,3]. Despite of these momentous roles to rural communities, the present production and reproduction performances have been generated from goats is generally low in Ethiopia [4]. This is due to either socio-economic or technical limitations [1]. The report [4] revealed that shortfall of feeds in quantity and supply is one of the major impediments that have been affecting goat production in Ethiopia. Woyto-Guji goats are one of the eight indigenous goat breeds that are distributed widely in the South Western arid and semiarid areas of the regions [1,5]. In to study region, goats suffer from nutritional constraints which are aggravated by seasonal variability of range forages due to recurrent and prolonged drought [6,7]. This have been resulted slow growth rate, poor body condition and increased susceptibility to diseases and parasites and contributing to lower production and reproductive performances of goats. Moreover, the protein is one of the critical elements in goat's diet in to study area, as pastoralists communities have not been to supplement goats with commercial concentrate supplements because of commercial concentrates are too expensive or not accessible to them [8,9]. In this regards, pursuing an alternate locally available proteinase feed resources is one of the appropriate strategies to alleviate protein deficiencies. Amongst the locally existing protein enrich feed resources, tree legume forages such as acacia species have indispensable role as protein supplements [10,11]. *Acacia toritlis* is one of the dominant acacia species distributed in vast areas of South Omo, Afar and Borana rangelands and it is one of the important sources of fodder for ruminants [11-13]. *Acacia toritlis* browse yields about 4-6 kg dry leaf and 10-12 kg pods per year per plant [14]. The previous study reported by Abdulrazak et al. [15] indicated that the CP content and DM digestibility of *Acacia tortilis* pods is about 18% and 46% respectively. Moreover, the feed intake, average daily gain and nutrient digestibility increased when Tigray highland sheep fed a basal diet of grass hay supplemented with concentrate diet contained 33% of *Acacia tortilis* pod as compared to control groups [16]. However, the growth performances and carcass characteristics of yearling male Woyto-Guji goats has not been studied and documented when goats are supplemented with diets having different level of *Acacia tortilis* pod for further utilization. Additionally, there is insufficient information on inclusion level of *Acacia tortilis* pod for optimal productivity of Woyto-Guji goats. Therefore, this study was designed to determine effects of *Acacia tortilis* pod meal supplementation on feed intake, digestibility, weight gain and carcass characteristics of male Woyto-Guji goats fed desho grass hay as a based diet.

# Materials and Methods

## Description of study area

The study was conducted at the Key Afer goat research sub-station of Jinka Agricultural Research Center which is situated between 5°01' and 5°73' North latitude & 36°38' and 37°07' East longitude. The climate of the district varies from warm to hot semi-arid with altitudinal variation ranges between 500 and 1800 meters above sea level. Rainfall in the district is bimodal, heavy rain season from March to May and light rain season from September to October. The mean annual rainfall of the district was 1400 mm and the average annual temperature ranges from 15.6°C to 26°C with vegetation that dominated by varying densities of Acacia species and over 35 herbaceous species of grasses and legumes [6,8].

### *Acacia toritlis* pod collection and basal diet

*Acacia toritilis pod* was collected from Shaba Argemenda Kebele of Bena-Tsemay Woreda by mobilizing pastoral communities. Then the collected pods were crushed into 3 cm size using electrically milling machine and separated seeds from the pods. Desho grass hay was used as a basal diet, planted at Jinka Agricultural Research Center and harvested at 50% of flowering stages and transported to the experimental site. The grass was chopped into small pieces by using a hammering mill to reduce selection and enhance intake by the experimental goats. The goats were fed *ad- libitum* allowing them a 15% refusal of each diet, as suggested by Kaitho et al. [17].

## Experimental design and trial goats

A total of twenty intact yearlings male Woyto-Guji goats with an average initial body weight of 18.40 ± 1.23 kg (Means+SD) were used for this study. All goats were ear tagged and housed in individual pens with an area of 1.5 m by 2 m, which was made from locally available woody material. The experimental goats were dewormed against internal, external diseases and parasite and randomly assigned to one of the four experimental diets. There was adaptation period of 14 days to familiarize the goats with the experimental diet and the pens. The experimental diet was offered twice a day (10:00 AM morning and 4:00 PM afternoon) and all goats had free access to clean water. The goats were blocked into four groups which comprised five goats per group based on their initial body weight and penned in individual cage using randomized complete block design. The experimental diets formulation was adjusted to meet the daily protein and energy requirement of goats [18].

## Experimental diets

The experimental diets used in this study were comprised of desho grass hay ad-libitum+20% of *Acacia tortilis* pod+78% of wheat bran+1% of table salt+1% of mineral mixture (T1); desho grass hay *ad-libitum*+38% of *Acacia tortilis* pod+60 % of wheat bran+1% of salt+1% of mineral mixture (T2); desho grass hay *ad-libitum* +58% of *Acacia tortilis* pod+40% of wheat bran+1% table salt+1% of mineral mixture (T3) and desho grass hay *ad-libitum*+20% of noug cake+78% of wheat bran+1% of table salt+1% of mineral mixture(T4).

# Data Sources and Management

## Feed intake

The amount of diets offered to the experimental animals and the corresponding refusals was recorded daily for 90 days by using weight balance. The daily feed intake was calculated as a difference between the amount of feed offered and the total amount of feed refused.

## Body weight gain

Body weights of the experimental goats were recorded at the beginning of the trial, every 15 days during the 90 days of feeding period and final weights. All goats were weighed in the morning hours after overnight fasting using suspended weighing balance. Daily body weight gain (ADG) was calculated as the difference between final body weight and initial body weight divided by the number of feeding days (90 days). Feed conversion efficiency (FCE) was calculated by dividing ADG by daily total dry matter intake of each experimental goat.

## Digestibility trial

After adaptation, all goats were transferred to metabolic crates and each animal was fitted with a fecal bag for digestibility. The goats were adapted for three days to the carrying of fecal collection bag, which was followed by total fecal collection for a period of seven consequent days. Feces were collected from each experimental goat at 08:00 h before feeding was weighed daily and sub-samples (10% of total weight) were frozen at -20°C for chemical analysis. From the feed consumed and fecal matter secreted, apparent digestibility of the nutrients was calculated according to procedures of [19].

## Carcass and yield measurement

All goats were slaughtered at the end of feeding trial and the final live weights were taken immediately after fastened overnight. Directly after slaughter, the blood was immediately collected and measured. The hot carcass weight was estimated according to procedures of [20] and the entire gastrointestinal tract except esophagus was removed with its contents and weighed with and without its contents and the weight of the gut fill was measured by the estimating the difference. The total edible and non-edible carcass components were calculated as the sum of all edible and none edible carcass components [20]. The empty body weight (EBW) was determined by deducting the weight of gut contents from slaughter weight. Dressing percentage in slaughter body weight (SBW) and EBW basis of the carcass calculated as carcass weight divided by slaughter live weight and multiplied by 100. Cross-sectional area of the eye rib muscle was measured between the 12$^{th}$ and 13$^{th}$ ribs [20]. The cross section area placed in deep freeze properly for two week and dissected in two equal parts by using knife and removed carefully all none muscle part from the rib eye area until clearly observed accumulated muscle look like eye [21]. The rib eye muscle area was traced first on transparency paper and measured by rotating the plani-meter device. Fat thickness over rib eye muscle area per each experimental goat was measured by using ruler after cutting into right and left two equal places and the average of two was considered as fat thickness.

## Laboratory analysis

Samples of partially dried feed offered, refusals and fecal samples were grounded by using a Willey Mill UK to pass through a 1 mm sieve size. DM, OM, CP and ash were analyzed according to procedures of [22]. The NDF value was calculated according to [23] and whereas, the ADF values was analyzed procedures of [24].

## Statistical analysis

Data on dry matter and nutrient intake, body weight gain, nutrient digestibility; and carcass characteristics were subjected to analysis of variances in the General Linear Model procedure of SAS. Differences between treatments means were separated using Duncan's Multiple Range Tests. The statistical model used in this study was: $Y_{ijk}=\mu+a_i+b_{ij}+e_{ik}$; where; $Y_{ijk}$=individual values of the independent variables; μ=Overall mean of response variables; $a_i$ = effect of treatment diets, $b_{ij}$=effect of block factor and $e_{ik}$= Random error.

# Results and Discussion

## Chemical composition of experimental diet and refusals

The chemical composition of experimental diet offered and refusals are presented in **Table 1**. The results from this study revealed that *Acacia tortilis* pod had higher Ash, Neutral detergent fiber (NDF) and Acid detergent fiber (ADF) and lower crude protein (CP) than wheat bran and noug cake mixture diets. Likewise, the desho grass hay used as basal diet in this study had lower CP and higher fibers contents compared to *Acacia toritilis* pod, wheat bran and noug cake. The feed refused by the experimental goats had higher NDF and ADF contents but lower CP contents compared with offered diets.

**Table 1** Chemical composition (% DM) of experimental diets and refusals. DM%=Dry matter percentage; CP=Crude protein; NDF=Neutral detergent fiber; ADF=Acid detergent fiber

| Feed ingredients | DM% | Ash | CP | NDF | ADF |
|---|---|---|---|---|---|
| *Acacia tortilis* pod | 87 | 12.62 | 12.6 | 45.5 | 24 |
| Wheat bran | 85 | 3.53 | 16.18 | 37.5 | 12 |
| Noug cake | 86 | 10.46 | 37 | 22.6 | 16.66 |
| Desho grass hay | 87 | 11.36 | 5.35 | 73.36 | 52.27 |
| **Treatments** | | | | | |
| T1 | 87 | 8.43 | 15.61 | 30.54 | 16.8 |
| T2 | 81 | 6.17 | 15.65 | 31.5 | 12.1 |
| T3 | 82 | 6.09 | 14.9 | 33.6 | 22 |
| T4 | 87 | 5.95 | 16.55 | 30.22 | 23.53 |
| **Refusals of experimental diets** | | | | | |
| T1 | 83 | 7.79 | 13 | 50 | 31.16 |
| T2 | 83 | 4.8 | 11.5 | 41.3 | 21.68 |
| T3 | 85 | 4.7 | 12.5 | 42.34 | 19.45 |
| T4 | 85 | 5.88 | 17.5 | 22.6 | 11.76 |
| Desho grass hay | 88 | 6.55 | 3.55 | 88.34 | 62.45 |

Crude protein is used in ruminant diet due to rumen microbes can be converted nitrogen to microbial protein, which can be used by host animal [23]. Microbes themselves need protein precursors for their growth and energy to act up on roughage feeds. The CP content of *Acacia tortilis* pod obtained from our study is higher than the minimum level of CP (8%) required for normal microbial function in the rumen of ruminant animals [25,26]. However, the value obtained from our study is lower than the value of 180 g/kg, DM reported by Abdulrazak et al. [15]. The current results on CP content showed slightly higher than reported values of 116 and 117 g/kg, DM by Ondiek et al. and Fadul et al. [10,27]. Furthermore [11,12] reported values of 173 and 180 g/kg, DM of CP for *Acacia tortilis* leaf respectively which demonstrated that the CP content in the leaf of *Acacia tortilis* is higher than its pods. Generally the CP content of *Acacia tortilis* pod from our study is enough to satisfy ruminant's livestock required amounts of CP (130-140 g, $kg^{-1}$ DM) in order to get high growth performance animals [28,29]. On the other hand, the CP content of desho grass which used as basal diet in our study is below the minimum CP amount (70-80 g $kg^{-1}$ DM) for ruminal microbes to support acceptable ruminal microbial activity [30] which indicated that supplementation is required in order to improve the nutritive values of such poor quality feed in order to boost the performances from animals [31].

The neutral detergent fiber (NDF) and acid detergent fiber (ADF) are structural carbohydrate or insoluble dietary fiber influenced performances of animals through impairing the feed intake and digestibility respectively [23]. The NDF and ADF values of *Acacia tortilis* pod recorded from this study was lower than values of

560 g/kg, DM and 337 g/kg, DM reported by Weldegebriel B et al. [16] respectively, but higher than reported value of 360 g/kg, DM [32]. The high fibers and lower CP contents in the diet refused by goats than the offered one had demonstrated that goats had better ability of select more cell content than cell wall in order to attenuate their energy requirements. The previous studies reported by Nsahlai et al. and Baloyi et al. [33,34] had demonstrated that ruminants' animals could forage more on younger plant material than on mature ones due to a higher in fibers (Cell wall) and low protein contents.

## Dry matter and nutrient intake

The results in **Table 2** indicated that goats supplemented with T2 diets consumed significantly higher (P<0.001) dry matter than those supplemented with T3 and T4 but statistically insignificant (P>0.001) compared with T1. Likewise, goats supplemented with T2 consumed higher (P<0.001) CP and ME than those supplemented with T1, T3 and T4 diets. However, goats supplemented with T1 and T3 had similar (p>0.001) CP intake. Goats supplemented with T2 was significantly higher (P<0.001) total NDF than those supplemented with T1, T3 and T4 while the differences among T1, T3 and T4 was minimal. Likewise goats supplemented with T1 were higher in terms of ADF intake compared with T3 and T4. Nutrient intake is the amount of feed consumed during a specified period of time when there is free access to the feeds [35]. The higher total DM intake for those goats supplemented with T2 than goats supplemented with T1, T3 and T4 is due to higher nutrient digestibility in T2 diet than T1, T3 and T4. The higher digestibility of T2 diet could increase the supply of different nutrients to the rumen microbes which enhanced the rumen microbial efficiency thereby increase the rate of breakdown of the ingested diets. In agreement with the current results, the rate of breakdown of ingested material increased, the total feed intake also increased in turn [23]. Furthermore, when Tigray highland sheep were fed grass hay as basal diet and supplemented with diets that comprised 66.7% of *Acacia tortilis* pod shown lower (600.9 g/day) total DM intake than sheep that supplemented with 33% *Acacia tortilis* pod [16] which is similar to result from the our study for Woyto-Guji goats supplemented with diets comprised 38% of *Acacia tortilis* pod (T2). In contrast, an increase of the total DM intake by the experimental goat was notices with the increase in the amount of *A. tortilis* pods in diet up to 75% and then declined by increasing inclusion rate beyond 75% in experimental diet [36]. Moreover, the total DM intake by the Woyto-Guji and Red Sokoto goats increased as *Acacia nilotica* pod inclusion level in diet increased from 19 to 58% [37] and 25% to 50% [37] which is contradicted result from our study. Moreover, the higher CP, NDF and ADF for those goats supplemented with T2 than goats supplemented with T1, T3 and T4 are due to higher total DM intake. Generally, the total CP intake obtained from this study was within the recommended range by [18] for goats weighing 15 kg in order to attain 100 g/day of body weight gain under tropical conditions. However, it is higher than values of 65–70 g/day suggested by Kearl [38] for goats weighing 20-25 kg under tropical condition.

## Dry matter and nutrient digestibility

The dry matter and nutrient digestibility coefficient (%DM) of Woyto-Guji goats fed on a basal diet of desho grass hay and supplemented with different level of *Acacia tortilis* pod

**Table 2** The dry matter and nutrient intake of Woyto-Guji goats supplemented with *Acacia tortilis* pod. Mean values in a row having different superscripts differ significantly each other; ***= (P<0.001); SEM=Standard error mean; DM=Dry matter; OM=Organic matter; CP=Crude protein; NDF = Neutral detergent fiber; ADF = Acid detergent fiber; SL= significance level.

| | Treatments | | | | | |
|---|---|---|---|---|---|---|
| **Intake** | **T1** | **T2** | **T3** | **T4** | **SEM** | **P-Value** |
| **DM intake (g/day)** | | | | | | |
| Supplements | 434.70$^{b}$ | 432.69$^{b}$ | 475$^{a}$ | 409.69$^{c}$ | 9.64 | 0.001 |
| Basal diet | 281.21$^{c}$ | 351.44$^{a}$ | 293.18$^{bc}$ | 304.89$^{b}$ | 9.79 | 0.001 |
| Total | 715.90$^{b}$ | 784.14$^{a}$ | 767$^{a}$ | 714.66$^{b}$ | 11.53 | 0.001 |
| **OM intake(g/day)** | | | | | | |
| Supplements | 405.99$^{c}$ | 497.84a | 398.70$^{a}$ | 458.79$^{b}$ | 9.96 | 0.001 |
| Basal diet | 358.06$^{a}$ | 286.50$^{c}$ | 298.71$^{bc}$ | 310.64$^{b}$ | 9.84 | 0.001 |
| Total | 764. 06$^{c}$ | 784.44$^{a}$ | 695.41$^{b}$ | 769.44$^{bc}$ | 11.70 | 0.001 |
| **CP intake(g/day)** | | | | | | |
| Supplements | 64.77$^{b}$ | 67.72$^{a}$ | 64.34$^{b}$ | 67.82$^{a}$ | 3.74 | 0.001 |
| Basal diet | 15.55$^{bc}$ | 18.8$^{a}$ | 15.68$^{bc}$ | 16.32$^{b}$ | 2.23 | 0.001 |
| Total | 80.32$^{c}$ | 86.52$^{a}$ | 80.03$^{c}$ | 84.13$^{b}$ | 3.87 | 0.001 |
| ME intake(MJ/day) | 10.08$^{c}$ | 14.69$^{a}$ | 6.08$^{d}$ | 12.57$^{b}$ | 2.43 | 0.001 |
| **NDF intake (g/day)** | | | | | | |
| Supplements | 144.30$^{b}$ | 136.30$^{c}$ | 144.30$^{b}$ | 137.68$^{b}$ | 5.56 | 0.001 |
| Basal diet | 206.29$^{c}$ | 257.82$^{a}$ | 215.08$^{bc}$ | 223.67$^{b}$ | 8.36 | 0.001 |
| Total | 366.39$^{b}$ | 394.12$^{a}$ | 359.78$^{b}$ | 361.35$^{b}$ | 8.72 | 0.001 |
| **ADF intake(g/day)** | | | | | | |
| Supplements | 78.51$^{a}$ | 74.77$^{b}$ | 63.08$^{c}$ | 49.95$^{d}$ | 3.74 | 0.001 |
| Basal diet | 153.25$^{bc}$ | 183.69$^{a}$ | 146.98$^{c}$ | 159.36$^{b}$ | 7.07 | 0.001 |
| Total | 231.47$^{b}$ | 258.47$^{a}$ | 210.07$^{c}$ | 209.32$^{c}$ | 7 | 0.001 |

meal are presented in **Table 3**. The DM, OM, CP, NDF and ADF apparent digestibility was significantly higher (P<0.001) for goats supplemented with T2 than those goats supplemented with T1, T3 and T4 while the apparent digestibility was not significant (P>0.001) for goats supplemented with diet T1 and T3 for DM, OM, CP and NDF.

Digestibility is determined as the difference between the amount of feed consumed and the amount excreted as feces by an animal. It is strongly linked to the fibers (NDF and ADL) contents [19]. The goats that supplemented with diet 38% *Acacia toritlis* pod demonstrated higher digestibility of nutrients (DM, CP, NDF and ADF), and it is attributed to higher intake of CP and ME from the total diets, which donated more available CP and ME that enhanced the rumen microbial efficiency thereby degradation of nutrients. According to report [19] feed with higher crude protein content could promote higher microbial populations and growth thereby facilitation of rumen fermentation. Moreover, it was observed from this study that higher amount of fibers (NDF and ADF) intake by goats supplemented with T2. However, the digestibility of nutrients was not influenced by the increased intake of fibers. Conversely [38] recorded that increased fibers, especially ADF contents, impaired digestibility of the nutrients. The nutrients digestibility (DM, CP, NDF and ADF) for goats supplemented with T2 from the current study is higher than values of 59.75%, 59.71%, 56.87% and 43.35% respectively, for DM, CP, NDF and ADF that was reported by Weldegebriel et al. [16] for Tigray highland sheep fed basal diet grass hay and supplemented with experimental diet contained 33% of *Acacia tortilis* pod. Moreover, higher apparent digestibility coefficient of DM, CP, NDF and ADF were reported by Uguru et al. [37] for yearling male Woyto-Guji goats fed basal diet of desho grass and supplemented with experimental diets contained 59% of *Acacia nilotica* pod which confirms of findings from our study.

## Body weight change and nutrient conversion efficiency

The final body weight change, daily weight gain and feed conversion efficiency of Woyto-Guji goats fed a basal diet of desho grass hay and supplemented with *Acacia tortilis* pod meal are presented in **Table 4**. The findings from this study on daily weight gain (g/day) performance revealed that those goats supplemented with T2 had higher (P<0.001) ADG than those goats supplemented with T1 and T4 but similar (P>0.01) to those goats fed on diet T3. However, those goats supplemented with diet T1 and T4 had attained similar (P>0.01) ADG. Goats supplemented with T2 had higher (P<0.01) ADG than those supplemented with T1 and T4 which is due to higher total DM intake and nutrient digestibility which made goats efficiently converted consumed feed in to flesh. Similar to results from our study [31] suggested that animal that consumed diet with more crude protein could be promoted higher microbial populations and faster digestion and thereby better growth performances. Furthermore, the similarity in ADG between goats supplemented with T2 and T1 in the current study could be attributed to similarly in supplement intake between them.

## Carcass characteristics of Wotyo-Guji goats

Carcass characteristics of Woyto-Guji goat that fed a basal diet of desho grass hay supplemented with *Acacia tortilis* pod is presented in **Table 5**. Similarly, those goats supplemented with T2 diets attained the heaviest (P<0.05) rib eye muscle area (REMA), HCW and fat thickness than those goats fed on diet T1, T3 and T4. However, findings from this study on DP, SBW, REMA, fat thickness and EBW revealed that there was no significant difference(P>0.05) among goats fed on T1, T3 and T4. The experimental goats supplemented with T2 diets attained heaviest (P<0.05) HCW, REMA and fat thickness is due to fact that higher intake of total DM, ME intake and digestibility of nutrients. Pralomkarn et al. [39] found that dressing percentage of animals increased as total DM and nutrient intake increased, which is in line with the findings from our study. Moreover, Liméa et al. [40] suggested that if animal have been ingested energy above the requirement, it could be deposited more fat which might be induced higher fat thickness which is similar to findings

**Table 3** Dry matter and nutrient apparent digestibility coefficient (% DM) of Woyto-Guji goats supplemented with *Acacia tortilis* pod. Means with different superscripts (a, b, c) within row are significant at P<0.001.

| Apparent Digestibility | Treatments | | | | | |
|---|---|---|---|---|---|---|
| (%) | T1 | T2 | T3 | T4 | SEM | P-Value |
| DM | 58.23$^{b}$ | 79.84$^{a}$ | 52.50$^{b}$ | 64.09$^{b}$ | 3.62 | 0.001 |
| OM | 61.20$^{b}$ | 79.47$^{a}$ | 54.53$^{b}$ | 63.52$^{b}$ | 3.55 | 0.001 |
| CP | 57.48$^{c}$ | 89.04$^{a}$ | 54.57$^{c}$ | 70.79$^{b}$ | 3.40 | 0.001 |
| NDF | 55.29$^{c}$ | 77.20$^{a}$ | 50.01$^{c}$ | 75.40$^{a}$ | 3.01 | 0.001 |
| ADF | 50.52$^{b}$ | 58.89$^{a}$ | 40.32$^{c}$ | 55.39$^{a}$ | 1.32 | 0.001 |

**Table 4** Body weight change, ADG and feed FCE of Woyto-Guji goats supplemented with *Acacia tortilis* pod. Mean values in a row having different superscripts differ significantly each other * = P<0.05; FCE = Feed conversion efficiency; SEM = Standard error of mean and NS = Not significant.

| Growth indices | Treatments | | | | | |
|---|---|---|---|---|---|---|
| | T1 | T2 | T3 | T4 | SEM | P-Value |
| IBW(kg) | 18.4 | 17.8 | 18.6 | 18.8 | 1.23 | **NS** |
| FBW(kg) | 25.8 | 26.5 | 25.5 | 25.1 | 1.27 | NS |
| BWC(kg) | 7.40$^{ab}$ | 8.75$^{a}$ | 6.5$^{b}$ | 6.30$^{b}$ | 1.05 | 0.05 |
| ADG(g) | 82.22$^{a}$ | 96.67$^{a}$ | 71.22$^{bc}$ | 70$^{bc}$ | 3.45 | 0.05 |
| FCE | 11.75$^{c}$ | 13.13$^{a}$ | 9.63$^{b}$ | 10.13$^{d}$ | 0.17 | 0.05 |

**Table 5** Carcass characteristics of Woyto-Guji goats fed desho grass hay and supplemented with *Acacia tortilis* pod. Mean values in a row having different superscripts (a, b) differ significantly at P<0.05. NS = Non-significant; SEM= Standard error of mean; SW = Slaughter weight; EBW = Empty body weight; HCW = Hot carcass weight; REMA = Rib-eye muscle area; $cm^2$ = Square of centimetre.

| Parameters | Treatments | | | | | |
|---|---|---|---|---|---|---|
| | T1 | T2 | T3 | T4 | SEM | P-value |
| SBW (kg) | 27.4 | 27.2 | 26.8 | 24.8 | 1.41 | NS |
| EBW (kg) | 23.16 | 23.56 | 22.68 | 22.36 | 1.48 | NS |
| HCW (kg) | $12.40^b$ | $13.28^a$ | $12^b$ | $11.36^b$ | 1.18 | 0.05 |
| **Dressing percentage:** | | | | | | |
| SW basis (%) | 50.75 | 51.75 | 45.5 | 46.75 | 1.48 | NS |
| EBW basis (%) | 57 | 60.25 | 54.75 | 58.75 | 1.45 | NS |
| Fat thickness ($cm^2$) | $0.50^b$ | $0.67^a$ | $0.51^b$ | $0.51^b$ | 0.02 | 0.05 |
| REMA ($cm^2$) | $12.44^b$ | $14.22^a$ | $12.38^b$ | $11.49^b$ | 1.69 | 0.05 |

from this study. Furthermore, Das et al. [41] study had shown that the carcasses that have wider rib eye area had higher carcass components (Meat yield) which corroborated findings from our study for goats supplemented with T2 diet. However, similarity in DP, SBW, REMA, fat thickness and EBW among goats fed on T1 and T3 due to similarity in total DM intake, digestibility of nutrients and partitioning of the body weight gain obtained as a result of supplementation into carcass and non-carcass components. Kumar et al. [42] observed similar DP among the Gaddi goats at different planes of nutrition which demonstrated that the plane of nutrition did not significantly affect DP which is corresponding to findings from our study on carcass characteristics. Generally, the DP values in EBW base obtained from the current study for goats supplemented with *Acacia tortis* pod were higher than the values of 41.34% and 41.79% reported by Legesse [43] respectively for Somali and Mid-Rift Valley goats raised on concentrate-based diets. Conversely, Abera [44] reported values of 45.5, 43.5, 45.4 and 45.2% DP for grazing Afar, Long eared Somali, Arsi-Bale and Woyto-Guji goats, respectively which is lower than observed values from our study. However the DP values from this study were found within range values of 55.2-62.9% reported by Abebe [45] for local Somali goats under high planed nutrition.

## Edible non carcass component

The edible non carcass components of Woyto-Guji goat fed a basal diet of desho grass hay supplemented with *Acacia tortilis* pod meal were presented in **Table 6** below. The heart weight was the lowest (p>0.001) in those goats consumed diet T3 and but it was higher for goats fed T2. Head and tongue for goats fed on diet T1, T3 and T4 diets were greater (p<0.001) than those fed T2 but not significantly differed among goats fed on T3, T2 and T4. The weight of Liver and bile, Kidneys and total fat were the similar (p>0.001) among the experimental goats. Goats supplemented with T3 diet attained heavier (p>0.001) total non -edible offal than T1, T2 and T4. Goats supplemented with T2 had attained lower (p<0.001) total non-edible offal than T3.

Goats supplemented with T3 diet attained heavier (p>0.001) total non-edible offal than T1 and T2. This is due to higher in gut content which has been expected to lower rate of digestion, which induced proportionally bigger gut content. The goats that were supplemented with T2 weighed lower gut contents than the goats supplemented with T1 and T3. This could be related to the diet goat were fed, which was highly digestible compared with T1 and T3 and took low retention time in the rumen. However, goats supplemented with T3 diet had considerably heavier gut content than goats fed on T2 and T1. This could be due to slower digestion of the feed consumed by the former group, which allowed the digesta to stay in the rumen for longer time than in the latter group of goats.

**Table 6** The Least -Square means of edible non carcass components of Woyto-Guji goats supplemented with *Acacia tortilis* pod. Mean values in a row having different superscripts (a, b, c) differ significantly at P<0.001. NS = Non-significant; SEM= Standard error of means .

| Edible non-carcass offal | Experimental Diets | | | | | |
|---|---|---|---|---|---|---|
| | T1 | T2 | T3 | T4 | SEM | P-value |
| Head and Tongue (g) | $1920^a$ | $1465^b$ | $1840^a$ | $1760^a$ | 15 | 0.001 |
| Heart(g) | 108 | 122 | 103 | 118 | 11.6 | NS |
| Kidney(g) | 84.2 | 63 | 70 | 77.8 | 4.6 | NS |
| Testicles weight(g) | $206.40^b$ | $214^b$ | $304.20^a$ | $224.00^{ab}$ | 3.87 | 0.001 |
| Liver and Bile(g) | 394 | 367 | 399 | 420.6 | 6.78 | NS |
| Total fat(g) | 345 | 469 | 420 | 340.2 | 13.56 | NS |
| Weight of empty gut (g) | $677^a$ | $816^a$ | $847^a$ | $450^b$ | 8 | 0.001 |
| Total edible offal(g) | $3635^a$ | $3518^a$ | $4305^b$ | $3309^c$ | 24 | 0.001 |

**Table 7** The least-square means of non-edible non carcass components of Woyto-Guji goat supplemented with *Acacia tortilis* pod. Mean values in a row having different superscripts (a, b) differ significantly at P<0.0101; NS=Non-significant; SEM=Standard error of mean

| Non edible non-carcass offal | Treatments | | | | | |
|---|---|---|---|---|---|---|
| | T1 | T2 | T3 | T4 | SEM | P-value |
| Skin weight (g) | $1510^a$ | $1225^b$ | $1475^a$ | $1325^b$ | 95.31 | 0.001 |
| Lung and Trachea(g) | 360 | 400 | 425 | 337.5 | 75.66 | NS |
| Spleen(g) | $200^a$ | $187^a$ | $200^a$ | $100^b$ | 14.61 | 0.001 |
| Gut content (g) | 2800 | 2562. 5 | 2975 | 3012.5 | 575.75 | NS |
| Feet weight (g) | $750^a$ | $550^b$ | $825^a$ | $537^b$ | 149.65 | 0.001 |
| Total non-edible offal(g) | 4375 | 5075 | 4870 | 4775 | 667.89 | NS |

## The non-edible non-carcass components

The non-edible non-carcass component of Woyto-Guji goats fed a basal diet of desho grass hay supplemented with *Acacia tortilis* pod was presented in **Table 7**. Skin and feet weight for T1 and T3 were heavier (p<0.001) than those goats fed T2 and T4 diets. The lowest (p<0.001) spleen weights were observed in goats fed T4 diets. The weights of total non-edible offal, gut content and lung and trachea were similar (p>0.001) among treatments. The similarity in total non-edible non carcass components among the experimental goats might be due to similarity in gut contents.

# Conclusion

The use of *Acacia tortilis* pod greatly improved the intake, digestibility, ADG and carcass characteristics of Woyto-Guji goat and used as crude protein supplements to replace commercial concentrate which is not easily accessible to pastoral areas. However, the goats supplemented with diet that consisted 39% of *Acacia tortilis* pod (T2) had attained higher ADG of 96.67 g/day, therefore, has better potential as a protein supplement to goats fed on poor quality feeds followed by diet contained 20% of *Acacia tortilis* pod (T1).

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## Authors' Contributions

Denbela Hidosa initiated proposal, prepared data collection sheet, gathering data, and wrote this whole manuscript and Mr. Asifaw Bisirate participated in carcass evaluation process.

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## Competing Interests

The authors declare that they have no competing interests.

## Ethical Approval

The experimental protocols used in the current study have been followed the national guidelines for the care and use of animals.

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