# aJava

Asian Journal of Animal and Veterinary Advances

Academic
Journals Inc.

www.academicjournals.com

OPEN ACCESS Asian Journal of Animal and Veterinary Advances

ISSN 1683-9919
DOI: 10.3923/ajava.2020.50.59

# Research Article
# Effects of *Acacia tortilis* Pod Feeding in Improving Performance of Goats Fed Grass Hay

Denbela Hidosa and Sintayehu Kibiret

Livestock Research Directorate, Jinka Agricultural Research Center, P.O. Box 96, Jinka, Ethiopia

## Abstract

**Background and Objectives:** *Acacia* species are common in the drier areas of Ethiopian rangelands and are rich in protein and digestible nutrients. This study aimed to evaluate the effects of *Acacia tortilis* pod feeding on the performance of yearling male Woyto-Guji goats. **Materials and Methods:** Twenty yearling male Woyto-Guji goats with initial body weight of 18.40±1.23 kg (Means±SD) were assigned to one of the four experimental diets in a randomized complete block design. The experimental diets tested in this study were 20% of *Acacia tortilis* pod+78% of wheat bran (T1), 38% of *Acacia tortilis* pod+60% of wheat bran (T2), 58% of *Acacia tortilis* pod+40% of wheat bran (T3), 20% of noug cake+78% of wheat bran (T4) and 1% of table salts and mineral mixture added in all diets. **Results:** The total dry matter, crude protein and metabolizable energy intake and nutrient digestibility were higher ($p<0.001$) for goats supplemented with T2 diet than goats supplemented with T1, T3 and T4 diets. But, the total dry matter intake was insignificant ($p>0.001$) for goats supplemented with T2 and T1 diets. Likewise, goats supplemented with T2 diet attained heavier ($p<0.001$) daily weight gain, hot carcass weight and rib eye area muscle than goats supplemented with T1, T3 and T4 diets. **Conclusion:** These results suggested that feeding *Acacia tortilis* pod at 38% inclusion level in goats ration increased the growth performance and carcass yield of goats.

Key words: *Acacia tortilis*, feed intake, digestibility, weight gain, Woyto-Guji goats

Citation: Denbela Hidosa and Sintayehu Kibiret, 2020. Effects of *Acacia tortilis* pod feeding in improving performance of goats fed grass hay. Asian J. Anim. Vet. Adv., 15: 50-59.

Corresponding Author: Denbela Hidosa, Livestock Research Directorate, Jinka Agricultural Research Center, P.O. Box 96, Jinka, Ethiopia



Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

## INTRODUCTION

Ethiopia excluding some non-sedentary pastoral areas of Afar and Somali regions has approximately 32.74 million goats[1]. Goats have 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 performance have been obtained from goats is generally low in Ethiopia[4]. This is due to either socio-economic or technical limitations[1]. The poor feed quality and inadequate feed supply are one of the major impediments that have been affecting goat production in Ethiopia[4]. 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 Ethiopia[1,5]. In to study region, goats have suffered from nutritional shortfalls which are aggravated by seasonal variability of range forages due to climate change impact[6,8]. This is triggering to increase high slow growth rate, mortality, longer calving intervals and substantial weight loss and increase susceptibility to diseases and parasites to goats[7,9]. Moreover, the protein is one of the most critical elements in goat's diet in to study region, as pastoralists communities have not been in position to supplement goats with commercial concentrate because of commercial concentrates are too expensive or not accessible to them[7,8]. In this regards, supplementing goats with locally available forage could be one strategy to combat nutritional impediments. Amongst the locally existing protein enrich feed resources, tree legume forages such as acacia species have indispensable role as protein supplements[10,11]. *Acacia tortilis* 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 tortilis* 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] demonstrated that crude protein and dry matter digestibility of *Acacia tortilis pods* are 18 and 46%, respectively. In addition, the feed intake, weight gain and nutrient digestibility were improved when Tigray highland sheep fed a basal diet of grass hay supplemented with concentrate diet contained 33% of *Acacia tortilis* pod[16]. However, the feeding effects of *Acacia tortilis* pod to growth performances and carcass characteristics of yearling male Woyto-Guji goats have not been studied and documented when goats are feeding diets having different inclusion level of *Acacia tortilis* pod for further utilization by herders. Therefore, this study was designed to determine effects of *Acacia tortilis* pod feeding 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:** This study was conducted from June-September, 2018 at the Key Afer goat research sub-station of Jinka Agricultural Research. The study area is situated between 5°01' and 5°73' North latitude and 36°38' and 37°07' East longitude. The climate of the district varies from warm to hot semi-arid with altitudinal variation ranges between 500-1800 m above sea level. Rainfall in the district is bimodal and heavy rain season from March-May and light rain season from September-October. The mean annual rainfall of the district was 1400 mm and the average annual temperature ranges from 15.6-26°C and rangelands dominated by varying densities of *Acacia* species and over 35 herbaceous species of grasses and legumes[6,8].

***Acacia tortilis* pod collection and basal diet:** *Acacia tortilis* 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 was 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 and allowed goats to fed basal diet *ad-libitum* by considering 15% refusal of each diet as suggested[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 pen which was made from locally available woody material with an area of 1.5 by 2 m. The experimental goats were dewormed against internal and external diseases and parasite. The groups of goats were randomly assigned to 1 of the 4 experimental diets. There was adaptation period for 15 days (1st-15th June, 2018) to familiarize the goats with the experimental diet and the pens. The experimental diets were offered twice a day (10:00 am in morning and 4:00 pm afternoon) and all goats had free access to clean water. The goats were grouped into four groups which comprised five goats per group based on their initial body weight and penned in individual cage in 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 and the corresponding refusals were measured in daily base for 90 consecutive days by using weight balance. The daily feed intake was calculated as difference between the total amount of feed offered and the total amount of feed refused by goats.

**Body weight gain:** Body weights of the goats were taken at the beginning of the trial for every 15 days of feeding periods in the morning after overnight fasting by using suspended weighing balance. The average 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 (g) by daily total dry matter intake by each experimental goat.

**Digestibility trial:** After adaptation periods, all goats were transferred to metabolic crates and each goat was fitted with a fecal collection bag for digestibility trial. The goats were adapted for three days to carry fecal collection bag and then followed seven consecutive days for actual fecal collection. Feces were collected from each goat at 08:00 h before feeding and measured daily base and sub-samples (10% of total weight) were frozen at -20°C for further chemical analysis. From the feed consumed and fecal matter secreted the apparent digestibility of the nutrients was calculated[19].

**Carcass yield measurement:** All goats were slaughtered at the end of feeding trial and the final live weights goats were taken immediately after fastened overnight. Directly after slaughter the blood was immediately collected and measured by using suspended spring weight balance. The hot carcass weight was estimated[20] and the entire gastrointestinal tract except esophagus was removed with its contents and weighed with and without its contents. Then the weight of the gut fill was measured by the estimating their differences. The total edible and non-edible carcass components were calculated as the sum of all edible and non-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. The cross-sectional area of the eye rib muscle was measured between the 12 and 13th 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 non-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 by using the planimeter device. Fat thickness over rib eye muscle area per each 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 1 mm sieve size. The DM, OM, CP and Ash contents were analyzed[22]. The NDF value was calculated[23] and the ADF values was analyzed[24].

**Statistical analysis:** Data on nutrients intake, body weight gain and nutrient digestibility and carcass characteristics were subjected to analysis of variances (ANOVA) in General Linear Model (GLM) procedure of SAS. Differences between treatments means were separated using Duncan's Multiple Range Test (DMRT). The statistical model used in this study was:

$$Yijk = \mu + A_i + B_{ij} + e_{ik}$$

Where:

Yijk = Individual values of the independent variables
$\mu$ = Overall mean of dependent variables
$A_i$ = Effect of treatment diets (T1, T2, T3 and T4)
$B_{ij}$ = Effect of block factor (initial age)
$e_{ik}$ = Random error

## RESULTS AND DISCUSSION

**Chemical composition of experimental diet and refusals:** The chemical composition of offered diets and refusals were presented in Table 1. The *Acacia tortilis* pod had higher ash, Neutral Detergent Fiber (NDF) and Acid Detergent Fiber

Table 1: Chemical compositions (%DM) of experimental diets and refusals

| Feed ingredients | DM (%) | Ash (g kg$^{-1}$) | CP (g kg$^{-1}$) | NDF (g kg$^{-1}$) | ADF (g kg$^{-1}$) |
|---|---|---|---|---|---|
| *Acacia tortilis* pod | 87 | 120.62 | 126.0 | 455.0 | 240.0 |
| Wheat bran | 85 | 35.30 | 161.8 | 375.0 | 120.0 |
| Noug cake | 86 | 100.46 | 370.0 | 226.0 | 166.6 |
| Desho grass hay | 87 | 110.36 | 053.5 | 733.6 | 522.7 |
| **Treatments** | | | | | |
| T1 | 87 | 80.43 | 156.1 | 305.4 | 168.0 |
| T2 | 81 | 60.17 | 156.5 | 315.0 | 121.0 |
| T3 | 82 | 60.09 | 149.0 | 336.0 | 220.0 |
| T4 | 87 | 50.95 | 165.5 | 302.2 | 235.3 |
| **Refusals of experimental diets** | | | | | |
| T1 | 83 | 70.79 | 130.0 | 500.0 | 311.6 |
| T2 | 83 | 40.80 | 115.0 | 413.0 | 216.8 |
| T3 | 85 | 40.70 | 125.0 | 423.4 | 194.5 |
| T4 | 85 | 50.88 | 175.0 | 226.0 | 117.6 |
| Desho grass hay | 88 | 60.55 | 35.5 | 883.4 | 624.5 |

CP: Crude protein, NDF: Neutral detergent fiber, ADF: Acid detergent fiber, T1: Desho grass hay *ad-libitum*+20% of *Acacia tortilis* pod+78% of wheat bran+1% of table salt+1% of mineral mixture, T2: Desho grass hay *ad-libitum*+38% of *Acacia tortilis* pod+60% of wheat bran+1% of salt+1% of mineral mixture, T3: Desho grass hay *ad-libitum*+58% of *Acacia tortilis* pod+40% of wheat bran+1% table salt+1% of mineral mixture, T4: Desho grass hay *ad-libitum*+20% of noug cake+78% of wheat bran+1% of table salt+1% of mineral mixture

(ADF) and lower Crude Protein (CP) than wheat bran and noug cake. Likewise, the Desho grass hay used as basal diet in this study had lower CP and higher fibers contents as compared to *Acacia tortilis* 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. The CP content of *Acacia tortilis* pod obtained from this study is higher than the minimum level of CP (8%) required for normal microbial function in the rumen of ruminant animals[23,25].

Moreover, CP had obtained from this study was lower than the value of 180 g kg$^{-1}$, DM reported[15] in pervious study and slightly higher than reported values of 116-117 g kg$^{-1}$, DM[10,26], respectively. Generally the CP content of *Acacia tortilis* pod from this 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[27,28]. On the other hand, the CP content of Desho grass which used as basal diet in this study is below the minimum CP amount (70-80 g kg$^{-1}$, DM) for normal ruminal microbes to support acceptable ruminal microbial activity[29]. The lower CP content of Desho grass from this is 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[30].

The NDF and ADF values of *Acacia tortilis* pod recorded from this study was lower than reported values (560, DM and 337 g kg$^{-1}$, DM)[16], respectively but higher than reported value of 360 g kg$^{-1}$, DM[31]. The high fibers and lower CP contents in the diet refused by goats than the offered, which 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 confirmed that animals could forage more on younger plant material than on mature ones due to a higher in fibers and low protein contents[32,33].

**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 ($p>0.001$) when 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 diet was significantly higher ($p<0.001$) for total NDF than those supplemented with T1, T3 and T4, while the differences among T1, T3 and T4 were minimal. Likewise, goats supplemented with T1 were higher in terms of ADF intake when compared goats supplemented with T3 and T4 diets. The higher total dry matter intake for those goats supplemented with T2 than goats supplemented with T1, T3 and T4 from this study 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 and as consequences, increased the rate of breakdown of the ingested diets. In agreement with the current result, the rate of breakdown of ingested material increased, the total feed intake by animal also increased in turn[34]. The study indicated that the total dry matter intake by Tigray highland sheep supplemented with diets comprised of 33% *Acacia tortilis* pod was higher than those sheep supplemented with diet comprised 66.7% of *Acacia tortilis* which is in agreement to result from this study[16]. In contradicted to result from this study, a previous study[35] had demonstrated that an increase of the total dry matter intake by the goat was noticed with the increase in the amount of *Acacia tortilis* pods in diet up to 75% and then declined by increasing inclusion rate beyond 75%. Conversely, the total dry matter intake by the Woyto-Guji and Red Sokoto goats was increased as *Acacia nilotica* pod inclusion level in diet increased from 19-58 and 25-50%, respectively[36,37] which is contradicted results from this study.

The higher CP, NDF and ADF for those goats supplemented with diet T2 than goats supplemented with T1, T3 and T4 are due to higher total dry matter intake. Generally, the total CP intake obtained from this study was within the

Table 2: Dry matter and nutrient intake of Woyto-Guji goats supplemented with *Acacia tortilis* pod

| | Treatments | | | | | |
|---|---|---|---|---|---|---|
| Intake | T1 | T2 | T3 | T4 | SEM | p-value |
| **DM intake (g/day)** | | | | | | |
| Supplements | 434.70$^{b}$ | 432.69$^{b}$ | 475.00$^{a}$ | 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$^{a}$ | 767.00$^{a}$ | 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$^{a}$ | 06.08$^{d}$ | 12.57$^{b}$ | 2.43 | 0.001 |
| **NDF intake (g/day)** | | | | | | |
| Supplements | 160.09$^{a}$ | 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$^{c}$ | 7.00 | 0.001 |

Mean values (a, b, c, d) in a row having different superscripts differ significantly each other, SEM: Standard error of mean, DM: Dry matter, OM: Organic matter, CP: Crude protein, NDF: Neutral detergent fiber, ADF: Acid detergent fiber, ME: Metabolisable energy, MJ: Megajoule, T1: Desho grass hay *ad-libitum*+20% of *Acacia tortilis* pod+78% of wheat bran+1% of table salt+1% of mineral mixture, T2: Desho grass hay *ad-libitum*+38% of *Acacia tortilis* pod+60% of wheat bran+1% of salt+1% of mineral mixture, T3: Desho grass hay *ad-libitum*+58% of *Acacia tortilis* pod+40% of wheat bran+1% table salt+1% of mineral mixture, T4: Desho grass hay *ad-libitum*+20% of noug cake+78% of wheat bran+1% of table salt+1% of mineral mixture

Table 3: Dry matter and nutrient apparent digestibility coefficient (%DM) of Woyto-Guji goats supplemented with *Acacia tortilis* pod

| | Treatments | | | | | |
|---|---|---|---|---|---|---|
| Apparent digestibility (%) | 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 |

Means with different superscripts (a, b, c) within row are significant at p<0.001, DM: Dry matter, OM: Organic matter, CP: Crude protein, NDF: Neutral detergent fiber, ADF: Acid detergent fiber, T1: Desho grass hay *ad-libitum*+20% of *Acacia tortilis* pod+78% of wheat bran+1% of table salt+1% of mineral mixture, T2: Desho grass hay *ad-libitum*+38% of *Acacia tortilis* pod+60% of wheat bran+1% of salt+1% of mineral mixture, T3: Desho grass hay *ad-libitum*+58% of *Acacia tortilis* pod+40% of wheat bran+1% table salt+1% of mineral mixture, T4: Desho grass hay *ad-libitum*+20% of noug cake+78% of wheat bran+1% of table salt+1% of mineral mixture

recommended range by Mandal *et al.*[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 other results[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 meal were presented in Table 3. The apparent digestibility of DM, OM, CP, NDF and ADF were 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.

The goats that supplemented with diet T2 were demonstrated higher digestibility of nutrients (DM, CP, NDF and ADF), due to higher intake of CP and ME from the total diet which donated more available CP and ME that enhanced the rumen microbial efficiency thereby degradation of nutrients. The feed with higher crude protein content could promote higher microbial populations growth and thereby facilitation of rumen fermentation[19]. The nutrients digestibility (DM, CP, NDF and ADF) for goats supplemented with T2 from this study is higher than values of 59.75, 59.71, 56.87 and

Table 4: Body weight change, ADG and feed FCE of Woyto-Guji goats supplemented with *Acacia tortilis* pod

| | Treatments | | | | | |
|---|---|---|---|---|---|---|
| Growth indices | T1 | T2 | T3 | T4 | SEM | p-value |
| IBW (kg) | 18.40 | 17.80 | 18.60 | 18.80 | 1.23 | NS |
| FBW (kg) | 25.80 | 26.50 | 25.50 | 25.10 | 1.27 | NS |
| BWC (kg) | 07.40$^{ab}$ | 08.75$^{a}$ | 06.05$^{b}$ | 06.30$^{b}$ | 1.05 | 0.05 |
| ADG (g) | 82.22$^{a}$ | 96.67$^{a}$ | 71.22$^{bc}$ | 00.70$^{bc}$ | 3.45 | 0.05 |
| FCE | 11.75$^{c}$ | 13.13$^{a}$ | 09.63$^{b}$ | 10.13$^{d}$ | 0.17 | 0.05 |

Mean values in a row having different superscripts (a, b, c, d) differ significantly each other, *p<0.05 SEM: Standard error of mean and NS: Not significant, IBW: Initial body weight, FBW: Final body weight, BWC: Body weight change, ADG: Average daily gain, FCE: Feed conversion efficiency, T1: Desho grass hay *ad-libitum*+20% of *Acacia tortilis* pod+78% of wheat bran+1% of table salt+1% of mineral mixture, T2: Desho grass hay *ad-libitum*+38% of *Acacia tortilis* pod+60% of wheat bran+1% of salt+1% of mineral mixture, T3: Desho grass hay *ad-libitum*+58% of *Acacia tortilis* pod+40% of wheat bran+1% table salt+1% of mineral mixture, T4: Desho grass hay *ad-libitum*+20% of noug cake+78% of wheat bran+1% of table salt+1% of mineral mixture

Table 5: Carcass characteristics of Woyto-Guji goats fed Desho grass hay and supplemented with *Acacia tortilis* pod

| | Treatments | | | | | |
|---|---|---|---|---|---|---|
| Parameters | T1 | T2 | T3 | T4 | SEM | p-value |
| SBW (kg) | 27.40 | 27.20 | 26.80 | 24.80 | 1.41 | NS |
| EBW (kg) | 23.16 | 23.56 | 22.68 | 22.36 | 1.48 | NS |
| HCW (kg) | 12.40$^{b}$ | 13.28$^{a}$ | 12.00$^{b}$ | 11.36$^{b}$ | 1.18 | 0.05 |
| **Dressing (%)** | | | | | | |
| SW basis (%) | 50.75 | 51.75 | 45.50 | 46.75 | 1.48 | NS |
| EBW basis (%) | 57.00 | 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 |

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 centimeter, T1: Desho grass hay *ad-libitum*+20% of *Acacia tortilis* pod+78% of wheat bran+1% of table salt+1% of mineral mixture, T2: Desho grass hay *ad-libitum*+38% of *Acacia tortilis* pod+60% of wheat bran+1% of salt+1% of mineral mixture, T3: Desho grass hay *ad-libitum*+58% of *Acacia tortilis* pod+40% of wheat bran+1% table salt+1% of mineral mixture, T4: Desho grass hay *ad-libitum*+20% of noug cake+78% of wheat bran+1% of table salt+1% of mineral mixture

43.35%, respectively, for DM, CP, NDF and ADF that was reported[16] but similar to previously reported value[37] for yearling male Woyto-Guji goats fed basal diet of desho grass and supplemented with experimental diets contained 59% of *Acacia nilotica* pod.

**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 were presented in Table 4. The findings from this study on daily weight gain (g/day) performance revealed that those goats supplemented with T2 diet had higher (p<0.001) Average Daily Gain (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 (g/day) than those supplemented with T1 and T4 diets. This is due to higher total dry matter intake and nutrient digestibility which made goats efficiently converted consumed feeds in to flesh. Similar to result from this study that animal that consumed diet with more crude protein could be promoted higher microbial populations and faster digestion and thereby better growth performances[30]. 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 goats.

**Carcass characteristics of Woyto-Guji goats:** Carcass characteristics of Woyto-Guji goat that fed a basal diet of desho grass hay supplemented with *Acacia tortilis* pod were 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 goats supplemented with T2 diet 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. The previous study[39,40] found that dressing percentage of animals increased as total dry matter and nutrient intake increased. Moreover, if animal have ingested energy above the

Table 6: Least-square means of edible non-carcass components of Woyto-Guji goats supplemented with *Acacia tortilis* pod

| | Experimental diets | | | | | |
|---|---|---|---|---|---|---|
| Edible non-carcass offal (g) | T1 | T2 | T3 | T4 | SEM | p-value |
| Head and tongue | 1920[a] | 1465[b] | 1840[a] | 1760[a] | 15.00 | 0.001 |
| Heart | 108 | 122 | 103 | 118.00 | 11.60 | NS |
| Kidney | 84.20 | 63.00 | 70.00 | 77.80 | 04.60 | NS |
| Testicles weight | 206.40[b] | 214[b] | 304.20[a] | 224.00[ab] | 03.87 | 0.001 |
| Liver and bile | 394.00 | 367.00 | 399.00 | 420.60 | 06.78 | NS |
| Total fat | 345.00 | 469.00 | 420.00 | 340.20 | 13.56 | NS |
| Weight of empty gut | 677[a] | 816[a] | 847[a] | 450[b] | 08.00 | 0.001 |
| Total edible offal | 3635[a] | 3518[a] | 4305[b] | 3309[c] | 24.00 | 0.001 |

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, T1: Desho grass hay *ad-libitum*+20% of *Acacia tortilis* pod+78% of wheat bran+1% of table salt+1% of mineral mixture, T2: Desho grass hay *ad-libitum*+38% of *Acacia tortilis* pod+60% of wheat bran+1% of salt+1% of mineral mixture, T3: Desho grass hay *ad-libitum*+ 58% of *Acacia tortilis* pod+40% of wheat bran+1% table salt+1% of mineral mixture, T4: Desho grass hay *ad-libitum*+20% of noug cake+78% of wheat bran+1% of table salt+1% of mineral mixture

requirement, it could be deposited fatter which might be induced higher fat thickness[41] which is similar to result from this study. Furthermore, the previous study[41] had shown that the carcasses that have wider rib eye area had higher carcass components (Meat yield). However, similarity in DP, SBW, REMA, fat thickness and EBW among goats fed on T1 and T3 diets due to similarity in total dry matter 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 affected DP which is corresponding to findings from our study on carcass characteristics. Generally, the DP values in EBW base obtained from the this study for goats supplemented with *Acacia tortilis* pod were higher than the values of 41.34 and 41.79%, respectively[43] for Somali and Mid-Rift Valley goats raised on concentrate-based diets. Conversely, the reported values[44] of 45.5, 43.5, 45.4 and 45.2% DP for grazing Afar, Long eared Somali, Arsi-Bale and Woyto-Guji goats lower than observed values from this study. However the DP values from this study were found within range values of 55.2-62.9% for local Somali goats under high planed nutrition[45].

**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. The heart weight was the lowest (p>0.001) in those goats consumed diet T3 and but it was higher for goats fed T2 diet. 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 T1, T3 and T4. The weight of liver, 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 diet had attained lower (p<0.001) total non-edible offal than T3 diet.

Goats supplemented with T3 diet attained heavier (p>0.001) total non-edible offal than goats supplemented with T1 and T2 diets. This is due to higher in gut content which has expected to lower rate of digestion and induced proportionally bigger gut content. The goats that were supplemented with T2 diet 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 diets. 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.

**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 goats fed on T1 and T3 diets were heavier (p<0.001) than those goats fed on 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, 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.

**Implications and limitations of the study:** Generally, the shortfall in goat feeds is a critical problem across pastoral areas of the regions due to overgrazing and climate change impact, thus supplementary feeding is a necessity to improve goat's

Table 7: Least-square means of non-edible non carcass components of Woyto-Guji goat supplemented with *Acacia tortilis* pod

| Non-edible non-carcass offal (g) | Treatments T1 | T2 | T3 | T4 | SEM | p-value |
|---|---|---|---|---|---|---|
| Skin weight | 1510[a] | 1225[b] | 1475[a] | 1325[b] | 95.31 | 0.001 |
| Lung and trachea | 360 | 400 | 425 | 337.50 | 75.66 | NS |
| Spleen | 200[a] | 187[a] | 200[a] | 100[b] | 14.61 | 0.001 |
| Gut content | 2800 | 2562. 5 | 2975 | 3012.5 | 575.75 | NS |
| Feet weight | 750[a] | 550[b] | 825[a] | 537[b] | 149.65 | 0.001 |
| Total non-edible offal | 4375 | 5075 | 4870 | 4775 | 667.89 | NS |

Mean values in a row having different superscripts (a, b) differ significantly at p<0.0101, NS: Non-significant, SEM: Standard error of mean, T1: Desho grass hay *ad-libitum*+20% of *Acacia tortilis* pod+78% of wheat bran+1% of table salt+1% of mineral mixture, T2: Desho grass hay *ad-libitum*+38% of *Acacia tortilis* pod+60 % of wheat bran+1% of salt+1% of mineral mixture, T3: Desho grass hay *ad-libitum*+58% of *Acacia tortilis* pod+40% of wheat bran+1% table salt+1% of mineral mixture, T4: Desho grass hay *ad-libitum*+20% of noug cake+78% of wheat bran+1% of table salt+1% of mineral mixture

production system. Thus, strategic supplementation of goats with range forage trees like *Acacia tortilis* pod that can easily be naturally established and available to communities is ideal in order to get increased production performance from goat production. Therefore, this study recommended to be fed to goat *Acacia tortilis* pod as supplements at 38% feeding level for optimal performance of goat as for most resources herders cannot afford commercial supplements. Based in results, this study suggested the following works for future in order to fill the limitation of this study.

- The information obtained from the current study on effects of *Acacia tortilis* pod feeding on biological performance of Woyto-Guji goats at on station level should be demonstrated and promoted in wider scale at on farm level through awareness creations

## 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 38% of *Acacia tortilis* pod (T2) had attained higher ADG of 96.67 g/day. Therefore, it has better potential as a protein supplement to goats fed on poor quality feeds followed by diet contained 20% of *Acacia tortilis* pod (T1).

## SIGNIFICANCE STATEMENT

This study discovered the effects of feeding *Acacia tortilis* pod to performances of Woyto-Guji goats. The findings from this study will be beneficial for goat produces to improve nutritional shortfall and hence, improve livelihood of producers. This study will be also helped the researchers to uncover the critical areas of goat nutrition that many researchers were not able to explore.

## ACKNOWLEDGMENT

This study was supported by the grant from the Southern Agricultural Research Institute, Livestock Feed and Feeding Improvement Program in South Omo Zone and National Food Security Improvement Program of Ethiopia (2018 financial year, grant code, JARC007-006). Therefore, we are extremely thankful the Southern Agricultural Research Institute for budget support and Jinka Agricultural Research Center at Jinka in South Omo for providing logistical support and monitoring this research activity. We also, grateful to acknowledge Mr Asfaw Bisrat from Debre Birhan Agricultural Research Center for carcass evaluation and Mr Shagnachew Hailu and Mr Yakoba Molisha from Jinka Agricultural Research Center for data collection, assistance and good coordination during feeding experimental goats. Finally, we thank Mr Ashenafi Kebede of Debre Birhan Agricultural Research Centre for on time feeds, refusals and fecal sample analysis.

The author would also like to thanks the Asian Journal of Animal and Veterinary Advances for publishing this article free of cost and to Karim Foundation for bearing the cost of article production, hosting as well as liaison with abstracting & indexing services, and customer services.

## REFERENCES

1. Central Statistical Agency, 2017. Federal democratic republic of Ethiopia: Agricultural sample survey. Volume-2: Report on livestock and livestock characteristics (private peasant holdings). Statistical Bulletin No. 585, April 2017, Addis Ababa, Ethiopia.

2. Zewdu, A. and C. Peacock, 2003. Improving access to and consumption of animal source foods in Rural households: The experiences of a women-focused goat development program in the highlands of Ethiopia. J. Nutr., 133: 3981S-3986S.
3. Peacock, C., 2005. Goats-A pathway out of poverty. Small Rumin. Res., 60: 179-186.
4. FAO., 2018. Ethiopia: Report on Feed Inventory and Feed Balance, 2018. Food and Agriculture Organization of the United Nations, Rome, Italy, ISBN: 978-92-5-131004-5, Pages: 160.
5. FARM-Africa, 1996. Goat Types of Ethiopia and Eritrea: Physical Description and Management Systems. FARM-Africa, London, UK.
6. Admasu, T., E. Abule and Z.K. Tessema, 2010. Livestock-rangeland management practices and community perceptions towards rangeland degradation in South Omo zone of Southern Ethiopia. Livest. Res. Rural Dev., Vol. 22, No. 1.
7. Hidosa, D., Y. Tesfaye and A. Feleke, 2017. Assessment on feed resource, feed production constraints and opportunities in Salamago Woreda in South Omo zone, in South Western Ethiopia. Acad. J. Nutr., 6: 34-42.
8. Berhanu, T., G. Abebe, J. Thingtham, S. Tusdri and S. Prasanpanich, 2017. Availability of feed resources for goats in pastoral and agro-pastoral districts of South Omo zone, Ethiopia. Int. J. Res.-Granthaalayah, 5: 154-160.
9. Hidosa, D., A. Tolera and A. Nurfeta, 2018. Effect of lablab and pigeon pea leaf meal supplementation on performance of goats fed a basal diet of haricot bean haulms. Trop. Anim. Health Prod., 50: 1271-1277.
10. Ondiek, J.O., P.B. Ogore, E.K. Shakala and G.M. Kaburu, 2013. Feed intake, digestibility and performance of growing small East African goats offered maize (*Zea mays*) stover supplemented with *Balanites aegyptiaca* and *Acacia tortilis* leaf forages. Basic Res. J. Agric. Sci. Rev., 2: 21-26.
11. Bayssa, M., T. Negesse and A. Tolera, 2016. Effect of supplementation with different proportion of concentrate mixture and untreated or calcium hydroxide treated *Acacia toritilis* Leaves on feed intake, digestibility, nutrient retention and rumen fermentation parameters of Arsi Bale goats fed Rhodes grass hay basal diet. Iran. J. Applied Anim. Sci., 6: 599-612.
12. Aster, A., 2010. Nutritional and anti-nutritional quality of range vegetation in Southern Ethiopia and supplementary values of selected browse leaves to goats. Ph.D. Thesis, Norwegian University of Life Sciences, Norway.
13. Dagnachew, S., A. Amamute and W. Temesgen, 2011. Epidemiology of gastrointestinal helminthiasis of small ruminants in selected sites of North Gondarzone, Northwest Ethiopia. Ethiop. Vet. J., 15: 57-68.
14. Bekele-Tesemma, A., 2007. Useful trees and shrubs of Ethiopia: Identification, propagation and management for 17 agroclimatic zones. RELMA in ICRAF Project, Nairobi, Nairobi, Pages: 552.
15. Abdulrazak, S.A., E.A. Orden, T. Ichinohe and T. Fujihara, 2000. Chemical composition, phenolic concentration and *in vitro* gas production characteristics of selected Acacia fruits and leaves. Asian-Aust. J. Anim. Sci., 13: 935-940.
16. Weldegebriel, B., K. Kefelegn and H. Mulata, 2014. Effect of feeding Acacia pods (*Acacia seyal*) with or without wheat bran on feed intake and digestibility of Tigray Highland sheep in hay based feed. J. Biol. Agric. Healthcare, 4: 26-33.
17. Kaitho, R.J., N.N. Umunna, I.V. Nsahlai, S. Tamminga, J. Van Bruchem, J. Hanson and M. Van De Wouw, 1996. Palatability of multipurpose tree species: Effect of species and length of study on intake and relative palatability by sheep. Agrofor. Syst., 33: 249-261.
18. Mandal, A.B., S.S. Paul, G.P. Mandal, A. Kannan and N.N. Pathak, 2005. Deriving nutrient requirements of growing Indian goats under tropical condition. Small Rumin. Res., 58: 201-217.
19. McDonald, P., R.A. Edwards, J.F.D. Greenhalgh and C.A. Morgan, 2002. Animal Nutrition. 6th Edn., Prentice Hall, UK., ISBN: 9780582419063, Pages: 693.
20. Gilmour, A.R., A.F. Luff, N.M. Fogarty and R. Banks, 1994. Genetic parameters for ultrasound fat depth and eye muscle measurements in live Poll Dorset sheep. Aust. J. Agric. Res., 45: 1281-1291.
21. Purchas, R.W., 1978. Some effects of nutrition and castration on meat production from male Suffolk cross (Border Leicester-Romney cross) lambs: I. Growth and carcass quality. N. Z. J. Agric. Res., 21: 367-376.
22. AOAC., 1990. Official Methods of Analysis. 15th Edn., Association of Official Analytical Chemists, Washington, DC., USA., Pages: 684.
23. Van Soest, P.J., J.B. Robertson and B.A. Lewis, 1991. Methods of dietary fiber, detergent fiber and non starch polysaccharide in relation to animal nutrition. J. Dairy Sci., 74: 3583-3597.
24. Van Soest, P.J. J.B. Robertson, 1985. Analysis of forage and fibrous feeds. A Laboratory Manual for Animal Science 613, Cornell University, Ithaca, New York, USA.
25. Norton, B.W., 2003. The Nutritive Value of Tree Legumes. In: Forage Tree Legumes in Tropical Agriculture, Gutteridge, R.C. H.M. Shelton (Eds.). CAB International, UK., pp: 1-10.
26. NRC., 1981. Effect of Environment on Nutrient Requirements of Domestic Animal. National Academy Press, Washington, DC., USA.
27. Fadul, B., F.M. El-Hag, A. Idris, S.A.E. Zareba and J. Jadaalla, 2014. The Effects of feeding *Acacia tortilis* pods and groundnut cake on lambs' performance under range conditions in North Kordofan state, Sudan. World Essays J., 1: 26-30.
28. Owens, F.N. R. Zinn, 1988. Protein Metabolism of Ruminant Animals. In: The Ruminant Animal Digestive Physiology and Nutrition, Church, D.C. (Eds.). Waveland Press, Illinois, pp: 227-249.

29. Meissner, H.H. D.V. Paulsmeier, 1995. Plant compositional constituents affecting between-plant and animal species prediction of forage intake. J. Anim. Sci., 73: 2447-2457.
30. McDonald, P., R.A. Edward, J.F.D. Greenhalgh, C.A. Morgan, L.A. Sinclair and R.G. Wilkinson, 2011. Animal Nutrition. 7th Edn., Prentice Hall/Pearson Education Ltd., Harlow, UK., ISBN-13: 9781408204238, Pages: 692.
31. Nurfeta, A., A. Churfo and A. Abebe, 2013. Substitution of pigeon pea leaves for noug (*Guizotia abyssinica*) seed cake as a protein supplement to sheep fed low quality tropical grass hay. Ethiopian J. Applied Sci. Technol., 4: 1-13.
32. Chaves, A.V., G.C. Waghorn, I.M. Brookes and D.R. Woodfield, 2006. Effect of maturation and initial harvest dates on the nutritive characteristics of ryegrass (*Lolium perenne* L.). Anim. Feed Sci. Technol., 127: 293-318.
33. Nsahlai, I.V., Z. Sileshi, S. Bediye and N.N. Umunna, 1996. Nutritional characteristics and strategies to enhance utilization of tropical feeds for low resource livestock producers. Proceedings of the 4th Conference of Ethiopian Society of Animal Production, April 18-19, 1996, Addis Ababa, Ethiopia, pp: 40-56.
34. Baloyi, J.J., N.T. Ngongoni and H. Hamudikuwanda, 2006. Voluntary intake, nitrogen metabolism and rumen fermentation patterns in sheep given cowpea, silverleaf desmodium and fine-stem stylo legume hays as supplementary feeds to natural pasture hay. Afr. J. Range Forage Sci., 23: 191-195.
35. Nastis, A., 2007. Feeding behaviour of goats and wisation of pasture and rangelands. Options Mediterraneenes, CIHEAM.
36. Araya, M.R., R.K. Ngugi, N.K. Musimba and D.M. Nyariki, 2003. Effect of *Acacia tortilis* pods on intake, digestibility and nutritive quality of goat diets in Southwestern Eritrea. Afr. J. Range Forage Sci., 20: 59-62.
37. Hidosa, D. D. Gemiyo, 2017. Replacement of commercial concentrate with *Acacia nilotica* Pod meal on feed intake, digestibility and weight gain of boer x woyto-guji crossbred goats. Am. J. Agric. Forest, 5: 192-197.
38. Uguru, C., C.A.M. Lakpini, G.N. Akpa and G.S. Bawa, 2014. Nutritional potential of acacia (*Acacia nilotica* (L.) Del.) pods for growing Red Sokoto goats. IOSR J. Agric. Vet. Sci., 7: 43-49.
39. Kearl, L.C., 1982. Nutrient Requirements of Ruminants in Developing Countries. 1st Edn., International Feedstuffs Institute, Utah State University, Logan, Utah, USA., ISBN: 9780874211160, Pages: 381.
40. Pralomkarn, W., S. Kochapakdee, S. Saithanoo and B.W. Norton, 1995. Energy and protein utilisation for maintenance and growth of Thai native and Anglo-Nubian x Thai native male weaner goats. Small Rumin. Res., 16: 13-20.
41. Das, A.K. V. Rajkumar, 2010. Comparative study on carcass characteristics and meat quality of three Indian goat breeds. Indian J. Anim. Sci., 80: 1014-1018.
42. Kumar, S., S.P. Tiwari and M.P. Narang, 1991. Effect of different planes of nutrition on carcass characteristics in Gaddi goats. Indian Vet. J., 68: 953-956.
43. Getahun, L., 2001. Growth pattern and carcass characteristics of Small and Mid-rift valley goats. M.Sc. Thesis, Alemaya Univesity, Ethiopia.
44. Ayele, A., 2001. A comparative study on slaughter components with emphasis on edible offal of some indigenous goat types. M.Sc. Thesis, Alemaya University, Alemaya, Ethiopia.
45. Abebe, G., 2000. Carcass characteristics of Somali goats slaughtered at different ages. Proceedings of the 7th International Conference on Goats, May 15-21, 2000, France, pp: 829.