International Scholars Journals

International Journal of Histology and Cytology ISSN 2447-9535 Vol. 6 (3), pp. 001-007, March, 2019. Available online at www.internationalscholarsjournals.org © International Scholars Journals

Full Length Research Paper

Effect of level of substitution of sweet potato (*Ipomoea Batatas. L*) vines for concentrate on body weight gain and carcass characteristics of browsing Arsi-Bale goats

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Accepted 07 January, 2019

The study was conducted for 132 days on forty growing Arsi-Bale male goats of 16.78±0.61kg initial body weight to evaluate the use of fresh sweet potato vines (SPV) and concentrate given as sole or mixtures and also to determine the optimum level of substitution. Browsing goats were supplemented with SPV and concentrate, which was gradually replaced with fresh sweet potato vines at five levels: 0% SPV (T1), 25% SPV (T2), 50% SPV (T3), 75% SPV (T4) and 100% SPV (T5). There were no significant differences between T1, T2 and T3 in average daily gain (ADG) . T1, T2 and T3 had significantly (P<0.05) higher ADG (g) (60.13 ± 0.004, 59.52 ± 0.002 and 56.34 ± 0.003 vs. 33.01 ± 0.003 and 20.83 ± 0.001) than T4 and T5, respectively. T5 had significantly (P<0.05) lower ADG (20.83 ± 0.001 g) than other treatments. There were no significant differences among treatments in carcass traits except in fat thickness (mm) which was highest (P<0.05) for T1 (1.67 ± 0.33) followed by T3 (1.33 ± 0.33), T2 (1.17 ± 0.44), T4 (1.17 ± 0.17) and lowest for T5 (1.23 ± 0.15). In general, there was no significant difference among treatments in primal cut (kg) except for T5 which had lowest (P<0.05) leg, loin and shoulder and neck than T1. Similarly, there were no significant differences among T1, T2 and T3 in muscle, fat and bone tissue. Therefore, from this study it can be concluded that 25 and 50% sweet potato vines substitution for concentrate can be used for growing Arsi-Bale male goats finishing with acceptable weight gain, carcass traits and compositions.

Key words: Arsi-Bale goats, carcass characteristics, sweet potato vines, weight gain.

INTRODUCTION

Goats are the predominant small ruminant species in the middle rift valley of Ethiopia, where most of them are kept under extensive management system and depend almost exclusively on natural pasture. During the dry season, the nutritive value of natural pastures deteriorates and become deficient in many nutrients, especially proteins. As a result, animals depend on those pastures progressively loss weight until the wet season comes. Alternatively, animals can be supplemented to minimize or to prevent weight losses (Abule et al., 1998) . Supplementing basal feeds that are deficient in major nutrients with either grain concentrate or forage legumes can improve the digestive and metabolic condition of ruminants. However, under smallholder farmers' condition supplementing livestock feed that are poor in nutrient contents and digestibility with grain concentrate is unaffordable and expensive. One way of improving the utilization of available crop residues is by proper supplementation with leguminous forages (Lagasse et al., 1990)

In developing countries, there is a shortage of both energy sources and feedstuffs with acceptable protein content for animal production. In view of the worldwide demand for additional feed sources, the exploitation of traditional crops, which often are grown with low inputs, and are largely adapted to the climatic conditions of the developing countries, would be a step towards better resource utilization (An, 2004). One traditional crop in tropical countries is sweet potato (*Ipomoea batatas. L*), which originated from Central America. Sweet potato is extensively grown in many countries, especially in China and Southeast Asia. In Ethiopia, sweet potato is culti-

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Table 1. Chemical composition of experimental diets

Feed type	DM%	CP%	NDF%	ADF%	ADL%	Ash%	GE (kcal/g DM)
Sweet potato vines	92.14	19.38	35.58	29.74	6.10	17.76	3.72
Wheat bran	92.46	17.01	52.17	17.25	-	7.64	4.85
Noug seed cake	95.73	35.5	32.01	28.16	-	9.02	5.09

vated in most high land areas and now days its cultivation is expanding towards the low land part of the country.

Sweet potato (*I. batatas. L*) is a creeping plant with perennial vines and adventitious roots, which can be easily cultivated and is relatively drought resistant. Nutritionally, sweet potato tuber is a rich source of energy while the vines are a rich source of protein and vitamins. The feeding value of vine is close to that of alfalfa (Dominguez, 1992). The young leaves of sweet potatoes are highly relished by livestock and are a valuable source of protein, vitamins, and minerals. The foliage last through out the dry season and is a valuable source of fodder (FAO, 1975).

Both the tubers and vines of sweet potato are used as a feed for cattle, pigs, chickens and small ruminants (Woolfe, 1992). Karachi and Dzowela (1988) reported that sweet potato vines could be used as an alternative dry season supplementary feed for calves. It is traditionally grown to provide the tubers for human consumption and the vines can be used as useful supplementary feed for goats in areas where the crop is grown (Adugna et al., 2000). Getachew et al. (2000) reported that sweet potato vines are one of the major feed sources for goats in the Harar high lands. However, in Ethiopia information on sweet potato vines supplementation as livestock feed was scanty. Therefore, the current study was designed with the objectives to evaluate the effect of substituting concentrate by sweet potato vines on growth and carcass traits and to determine the optimum level of concentrate substitution with sweet potato vines for Arsi-Bale goats.

MATERIALS AND METHODS

Study area description

The experiment was conducted at Adami Tulu Agricultural Research Center, which is located 167 km south of Addis Ababa at an altitude of 1650 m above sea level in mid rift valley. The agro-ecological zone of the area is semi arid and sub humid with acacia woodland vegetation type. The mean annual rain falls is 760 mm. The mean minimum and maximum temperature are 12.6 and 27^{o} C, respectively. The soil type is fine, sandy loam with sand: silt: clay in the ratio of 34: 38: 18, respectively. The pH is 7.88.

Experimental animals and treatments

Forty yearling male Arsi-Bale goats were purchased from the local market. They were treated for external and internal parasite with accarcide and albendazole, respectively. All experimental animals were assigned randomly to one of the five dietary treatments based animals. However, two kids from T2 and T4 died few weeks after the beginning of the experiment. The treatments were: browsing **+** 0% sweet potato vines + 100% concentrate (T1), browsing + 25% sweet potato vines + 75% concentrate (T2), browsing + 50% sweet potato vines + 50% concentrate (T3), browsing + 75% sweet potato vines + 25% concentrate (T4) and browsing + 100% sweet potato vines + 0% concentrate (T5). A preliminary period of 14 days was given to allow adjustment of the growing animals to diets and facilities and followed by 132 days of feeding period. The supplemental feeds were weighed every morning and the animals were fed 50% of their daily ration in the morning before they went for browsing and 50% in the afternoon up on their return from browsing/grazing. This is because the experiment was conducted during wet season when there were abundant green pastures. The quantity of feed offered at the start of the experiment was 2.5% of body weight in DM per day. The amount of feed offered during the experiment was adjusted to their body weight change.

Experimental feeds and its composition

Feed type and its chemical compositions are given in Table 1. One variety of sweet potatoes which is locally named Bellela was planted in the forage production experimental fields and all necessary agronomy practices such as land or seedbed preparation, planting, watering, and weeding were under taken. This variety was the most promising variety both in its tuber and biomass yield at either on-station or on-farm conditions in mid rift valley of Ethiopia. When the tuber become mature which was 90 days after transplanting, the vines was harvested and chopped approximately into 5cm length before providing it to animals. The sweet potato vines were harvested at equal days of intervals to get vines of the same age. The concentrate supplement was a mixture of 78.4% wheat bran, 20.6% noug seed cake, and 1% salt with estimated nutrient concentration of 20.5% CP and 2.16 MJ ME per kg DM. Refusals from each treatment group were collected and weighed daily in the morning before offering the today's ration.

Carcass evaluation

Three goats from each treatment group were randomly selected and slaughtered for carcass evaluation at the end of experimental period. The goats were slaughtered following the standard procedures of USDA (1982). The bodies were skinned; the heads and feet were removed. The carcasses were eviscerated and the internal organs and tissues were weighed. All body components such as head, four feet with hooves, skin, kidneys, and liver with bile, heart, lungs, empty gut, canal fat, heart fat, omental and mesenteric fat were weighed separately and not included in dressed carcass. Empty live weight, hot carcass weight, and hot dressing percentage were determined. Dressing percentage was calculated according to hot carcass weight and pre-slaughter live weight.

After hot carcass measurements, the carcass was split down at the vertebral column having the two sides as symmetrically as possible. One half of the carcass was placed in a chiller operating at -2^{0}C for 24 h. The chilled carcass was cut between 12 and 13th ribs to on their body weight. Each treatment group contained eight animals

Table 2. LSM ± SE for changes in live weight by Arsi-Bale male kids fed increasing proportions of sweet potato vines as replacement for concentrate.

Treatments	Iwt (kg)	Fwt (kg)	TG (kg)	ADG (g)	No. observation
T1	16.81±0.71^{a}	24.75±0.56^{a}	7.94±0.59^{a}	60.13±0.004^{a}	8
T2	16.79±0.63^{a}	24.64±0.70^{a}	7.86±0.30^{a}	59.52±0.002^{a}	7
T3	16.19±0.54^{a}	23.63±0.67^{ab}	7.44±0.37^{a}	56.34±0.003^{a}	8
T4	17.57±0.73^{a}	21.93±0.79^{b}	4.36±0.46^{b}	33.01±0.003^{b}	7
T5	16.56±0.45^{a}	19.31±0.52^{c}	2.75±0.19^{c}	20.83±0.001^{c}	8

Means in the same column with different letters are statistically significantly (P<0.05).

measure the rib eye area. The thickness of fat along the surface of longissimus dorsi was measured according to the methods described in Boggs and Merkel (1993). Then after, the carcass was separated in to five primal cuts (leg, lion, rack, breast and shank and shoulder and neck). Each primal cut was weighed separately. From each primal cut muscle and fat were trimmed from bone by knife and weighed separately. Finally, the amount of each tissue from each primal cut was added together with their respective to determine the proportion of muscle, bone and fat in the carcass.

Body weight change and all carcass or non carcass traits parameters were collected. All collected data were analyzed using analysis of variance procedures for a completely randomized design experiment using the General Linear Model procedures of SAS (SAS, 1999). In the analysis except treatments all parameters considered as dependent variables.

RESULTS AND DISCUSSION

Body weight changes

Initial body weight (Iwt), final body weight (Fwt), total gain (TG) and average daily gains (ADG) of growing Arsi- Bale male goats fed different proportion of concentrate and vines are presented in Table 2. T1, T2 and T3 had significantly (P<0.05) higher TG and ADG than T4 and T5 while T4 had significantly higher TG and ADG than T5. There were no significant differences between T1, T2 and T3 in the parameters indicated above. Goats in T5 had significantly (P<0.05) lower Fwt, TG and ADG than goats in the rest treatment groups. This implies that sweet potato vines could replace concentrate up to 50% in the ration of yearling Arsi-Bale male goats. Similarly, Lam and Inger (2004) reported that fresh sweet potato vines can replace 50% of Sesames grandiflora with acceptable live weight gains (60.9g/day). Semenye and Hutchcroft (1992) working with dual purpose goats found that sweet potato vines met the requirements of kids when fed 30 g DM per kg of body weight per day. In support of our finding, supplementing Borana weaner calves (fed Rhodes grass hay as basal feed) with 500g/head/day of sweet potato vines effected growth equivalent to that of calves fed 200g cotton seed cake/head/day (Karachi, 1988). Likewise, the supplementation of sweet potato forages improves feed intake and weight gain of young bulls fed sugar cane stalks (Dominguez, 1992). Even though growth rate declined as concentrate was replaced by sweet potato vines, there were improvement in weight gain (Table 2) since weight gain in Arsi-Bale goats kept on grazing/browsing alone was not more than 7.94g/day (Mieso et al., 2004).

Carcass measurements

Mean carcass traits of Arsi-Bale goats fed different proportion of concentrate and vines are presented in Table 3. There were no significant differences in hot carcass weight (HCW) and hot dressing percentage (HDP) between treatments. Hot dressing percentage for this study varied from 42.13 to 43.78%. Pinkerton et al. (1994) reported that the dressing percentage in male kids varied from 45 to 52% due to various factors. Daskiran et al. (2006) reported that the hot dressing percentage in Norduz male kids raised in intensive or pasture conditions was 42.94 ± 0.48 and 46.26 ± 1.05 %, respectively. Acharya (1988) determined the dressing percentage between 42.7% and 55.4% depending on the slaughter age, nutrition and the race of the kids. Bhattacharyya and khan (1988) stated that empty body weight or the amount of rumen and intestine contents might have affected the dressing percentage. Hailu et al (2005) determined the dressing percentage of 54.11 to 55.82% and 49.41 to 53.87% for Borana and Arsi-Bale goats kept under different durations of feedlot management, respectively. Dressing percentages might be affected by organs to be included in dressed carcass as inclusion or removal of some visceral organs in hot carcass measurement might be resulted in different dressing percentages. Therefore, the lower dressing percentage in current study might be due to exclusion of some visceral organs in its determination, unlike other researchers (Daskiran et al., 2006) who included kidneys, pelvic fat and testicles in hot carcass measurements which in turn affected dressing percentages, in addition to what were mentioned.

There were also no significant differences in heart fat, kidney, empty gut, canal fat, omental + mesenteric fat and rib eye area (REA) among treatments. In general, those goats supplemented with sweet potato vines alone had low internal fat accumulation as compared to supplementation with concentrate and/or mixtures. In this study, canal fat consisted of pelvic fat, scrotal fat and kidney fat as they are difficult to separate them from each

Table 3. LSM ± SE for carcass traits by Arsi-Bale male kids fed increasing proportions of sweet potato vines as replacement for concentrate.

Carcass traits (kg)	Treatments				
	T1	T2	T3	T4	T5
Slaughter weight	25.00±0.76[a]	23.5±1.15[a]	23.5±1.80[a]	22.5±1.04[ab]	18.67±1.20[b]
HCW	10.61±0.47[a]	9.9±0.69[a]	9.93±0.57[a]	9.85±0.2[a]	7.87±0.48[a]
HDP (%)	42.44±0.63[a]	42.13±0.96[a]	42.26±1.27[a]	43.78±1.33[a]	42.15±1.60[a]
REA(mm^2)	29.67±2.19[a]	25.00±3.51[a]	25.00±4.36[a]	24.00±2.52[a]	22.67±3.38[a]
Fat thickness (mm)	1.67±0.33[a]	1.17±0.44[d]	1.33±0.33[b]	1.17±0.17[d]	1.23±0.15[c]
Liver + bile	0.47±0.020[a]	0.43±0.022[ab]	0.49±0.025[a]	0.43±0.023[ab]	0.39±0.026[b]
Kidney	0.08±0.006[a]	0.07±0.007[a]	0.08±0.003[a]	0.08±0.006[a]	0.06±0.003[a]
Empty gut	1.62±0.077[a]	1.5±0.060[a]	1.66±0.145[a]	1.32±0.068[a]	1.30±0.119[a]
Heart fat	0.02±0.003[a]	0.02±0.006[a]	0.02±0.003[a]	0.02±0.003[a]	0.03±0.003[a]
Canal fat	0.09±0.029[a]	0.08±0.012[a]	0.08±0.018[a]	0.08±0.010[a]	0.06±0.012[a]
O + M fat[d]	0.12±0.026[a]	0.13±0.023[a]	0.19±0.072[a]	0.09±0.007[a]	0.09±0.032[a]
No. observation	3	3	3	3	3

Means in the same row with different letters are statistically significantly (P<0.05)
[d]O +M = Omental and Mesenteric fat

Table 4. LSM ± SE for primal cuts at right half carcass by Arsi-Bale male kids fed increasing proportions of sweet potato vines as replacement for concentrate.

Primal cut (kg)	Treatments				
	T1	T2	T3	T4	T5
Leg total	1.47±0.02[a]	1.45±0.12[a]	1.48±0.11[a]	1.48±0.03[a]	1.20±0.08[b]
Bone	0.38±0.04[b]	0.39±0.04[b]	0.36±0.03[b]	0.44±0.02[a]	0.32±0.02[c]
Muscle	1.09±0.02[a]	1.00±0.10[a]	1.07±0.08[a]	1.07±0.03[a]	0.83±0.06[b]
Fat	0.04±0.01[a]	0.04±0.01[a]	0.03±0.01[a]	0.04±0.00[a]	0.03±0.01[a]
Loin total	0.49±0.04[a]	0.46±0.05[ab]	0.47±0.05[ab]	0.42±0.03[bc]	0.37±0.03[c]
Bone	0.17±0.01[a]	0.14±0.03[ab]	0.13±0.01[b]	0.14±0.02[ab]	0.12±0.01[b]
Muscle	0.31±0.04[a]	0.29±0.02[a]	0.31±0.04[a]	0.26±0.02[a]	0.23±0.02[a]
Fat	0.02±0.01[a]	0.02±0.01[a]	0.02±0.01[a]	0.02±0.01[a]	0.02±0.00[a]
Rack total	0.65±0.06[a]	0.63±0.06[a]	0.69±0.04[a]	0.65±0.02[a]	0.49±0.09[a]
Bone	0.23±0.02[a]	0.19±0.02[a]	0.23±0.03[a]	0.22±0.02[a]	0.20±0.04[a]
Muscle	0.39±0.04[a]	0.39±0.03[a]	0.4±0.03[a]	0.4±0.02[a]	0.28±0.04[a]
Fat	0.02±0.00[b]	0.02±0.00[b]	0.03±0.01[a]	0.02±0.00[b]	0.02±0.01[b]
Breast and shank total	0.37±0.02[a]	0.35±0.01[a]	0.36±0.02[a]	0.36±0.03[a]	0.28±0.01[a]
Bone	0.09±0.01[b]	0.08±0.02[b]	0.08±0.01[b]	0.09±0.01[b]	0.06±0.27[a]
Muscle	0.25±0.02[a]	0.23±0.01[a]	0.24±0.01[a]	0.23±0.03[a]	0.18±0.01[a]
Fat	0.02±0.01[a]	0.03±0.01[a]	0.04±0.01[a]	0.03±0.01[a]	0.02±0.00[a]
Shoulder and neck total	1.86±0.10[a]	1.65±0.17[ab]	1.68±0.12[ab]	1.66±0.02[ab]	1.43±0.12[b]
Bone	0.46±0.06[a]	0.45±0.08[a]	0.46±0.00[a]	0.42±0.03[a]	0.38±0.08[a]
Muscle	1.24±0.02[a]	1.11±0.10[b]	1.12±0.12[b]	1.10±0.03[b]	1.00±0.04[c]
Fat	0.03±0.01[a]	0.07±0.01[a]	0.07±0.02[a]	0.05±0.02[a]	0.04±0.01[a]

Means in the same row with different letters are statistically significantly (P 0.05).

other while dressing. Liver + bile in T5 were significantly lower than that of T1 and T3. Even though there were no significant difference between treatments in REA, T1 had highest REA followed by T2, T3, T4 and lowest T5. In our finding REA (Table 3) and muscle amount (Table 5) in all primal cuts varied from 22.67 to 29.67mm^2 and 2.52 to 3.29kg, respectively. This implies that there were positive relationship between muscle amount in carcass and rib eye area. In line with this finding, Devendra and Owen (1983) stated that there was a positive correlation

Table 5. Mean tissue weight and proportions in dissected half carcass of all primal cuts

Tissues	Treatments				
	T1	T2	T3	T4	T5
Muscle:					
Kg	3.29[a]	3.02[a]	3.14[a]	3.06[a]	2.52[b]
%	68.85[a]	68.82[a]	68.41[a]	67.65[a]	67.26[a]
Bone:					
Kg	1.33[a]	1.25[a]	1.26[a]	1.31[a]	1.08[a]
%	27.04[a]	27.05[a]	27.45[a]	28.90[a]	28.94[a]
Fat:					
Kg	0.17[a]	0.18[a]	0.19[a]	0.15[a]	0.11[a]
%	4.01[a]	4.03[a]	4.14[a]	3.45[ab]	2.80[c]

Means in the same row with different letters are statistically significantly *(*P 0.05*)*

between muscle amount and REA in goat and sheep, and REA from various studies ranged from 4.03 to 16.12 cm^2. Daskiran et al. (2006) also reported that REA in Norduz male kids raised in intensive or pasture conditions was 7.02 to 8.88cm^2 and muscle/lean amount was 187.7 to 195.8g, respectively. Hailu et al. (2005) reported for Borana and Arsi-Bale goats REA of 38.38 to 47.31mm^2 and 23.87 to 36.37mm^2, respectively. Other author (Mesfin, 2007) reported REA in Arsi-Bale goats was varied from 28 to 49.25 mm2. Fat thickness in T1 (1.67 ± 0.33mm) was highest (P<0.05) followed by T3 (1.33 ± 0.33mm), T2 (1.17 ± 0.44mm), T4 (1.17 ± 0.17mm) and lowest for T5 (1.23 ± 0.15mm). This value was highest (on average 6.4mm) for the same breed of goats castrated at different ages which might be attributed to differences in slaughter age, feeding management and castration effect (e.g. Tesfaye K et al, Adami Tulu Agricultural Research Center, article in preparation for publication). In agreement with current finding, Mesfin (2007) reported that yearling Arsi-Bale goats kept in feedlot had 1.67 ± 0.33mm fat thickness which increased with age. In other study conducted on the same breed of goats under different durations of feedlot management, fat thickness was varied from 1 to 1.56 mm which increased with durations of feeding (Hailu et al., 2005). The same authors also reported that back fat thickness in Borana goats under different durations of feedlot management was ranged from 1.4 to 3mm which increased with durations of feeding. Oman et al (1999) reported for Bore x Spanish and Spanish goats an unadjusted fat thickness of 12 and 7 mm, respectively. Arsi-Bale goats possessed thin fat thickness which perhaps increased as they get access to concentrate feeds since those goats supplemented with concentrate alone (T1) had better fat thickness than others. This breed type in an age from 6 to 12 months had no fat cover along the surface of rib eye area while they kept on range alone with out concentrate supplementation (Mesfin, 2007).

Primal cut measurement

Primal cuts of Arsi-Bale male kids fed different proportion of concentrate and vines are given in Table 4. In all treatment groups, shoulder and neck followed by leg, rack, loin and breast and shank had the highest amount in carcass mass. Similarly, muscle followed by bone and fat had the highest amount in each primal cut for all treatment groups. These results were all in agreement with the result of other researchers (Daskiran et al., 2006). Large amounts of muscle were found on leg and shoulder and neck parts of primal cut which were in line with other study conducted on the same breed of goats castrated at different ages (e.g. Tesfaye K et al, Adami Tulu Agricultural Research Center, article in preparation for publication). Similar results were also reported for Borana and Arsi-Bale goats kept in feedlot for different durations (Hailu et al., 2005). There were no significant differences among the first four treatments in leg muscle content. T1 and T5 had significantly (P<0.05) higher and lower shoulder and neck muscle mass than other treatments respectively. There was no significant difference between treatment groups in leg fat deposit. T5 had significantly (P<0.05) lower leg total, leg muscle, leg bone, loin total and shoulder and neck muscle content than other treatment groups while T4 had significantly (P<0.05) higher leg bone than the rest treatment groups. T1 had significantly higher (P<0.05) loin total than T4 and T5 whereas there was no significant differences between treatment groups in loin muscle and fat content. There were no significant differences in rack primal cut between treatments except for rack fat of T3 which was significantly (P<0.05) higher than other groups. T5 had significantly (P<0.05) higher shank and breast bone whereas no significant difference between treatments in other component of breast and shank primal cut. T1 had significantly higher (P<0.05) shoulder and neck muscle than other treatments and there were no significant difference observed between T2, T3 and T4 in this trait. There were

also no significant difference among treatments in shoulder and neck bone and fat mass.

There were no significant differences among treatments in lean meat and bone proportions except for fat proportion which was significantly lower in T5 as compared to others (Table 5). In this study, lean meat proportion varied from 67.26 to 68.86%. This is in agreement with the report of Hailu et al. (2005) for Borana and Arsi-Bale goats, Mesfin (2007) for Arsi-Bale goats.

The proportions of fat ranges from 2.8 to 4.14% agreeing with the report of Hailu et al. (2005) and Mesfin (2007) for Arsi-Bale goats, but lower than the report of Hailu et al. (2005) for Borana breed (5.63 to 10.56%). The proportion of bone increased as concentrate replaced by sweet potato vines. It ranges from 27.05 to 28.94%. In line with this, other authors (Hailu et al., 2005; Mesfin, 2007) reported similar value for the same breed and Borana goats, but lower than the report of Oman et al (1999) for Bore x Spanish and Spanish goats kept on range condition.

Conclusion and recommendation

There were no significant differences among T1, T2 and T3 in TG and ADG. Also there were no significant differences between treatments, in hot carcass weight, dressing percentage and rib eye area and primal cuts. This implies that fresh sweet potato vines can replace concentrate at least up to 50% in the ration of growing Arsi-bale goats resulting in acceptable live weight gain and carcass parameters. Therefore, fresh sweet potato vines can used as supplemental feed for goats where the crops grown. To clearly judge the potential of sweet potato vines as alternative supplemental feeds for goat, future study should carried out in dry period when goats can not get alternative browse.

Acknowledgement

The authors would like to acknowledge Mr. Djene Tadesse, Mr. Abe Barko, Mr. Endalkachew Benti and Mr. Osho Tibeso for their contribution in data collection. We would also like to thank Ethiopian Institute of Agricultural Research for funding the project. Our sincere gratitude go to Adami Tulu Agricultural Research Center for facilitating logistic and other required materials during the project implementation.

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