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Feed Intake, Growth Performance and Economic Efficiency of Browsing Arsi-bale Goats Fed Increasing Proportions of Sweet Potato (*Ipomoea batatas.* L) Vines as a Replacement for Concentrate

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Abstract: 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 at which both biological and economic benefit is obtained. Browsing goats were supplemented with SPV and concentrate, which was gradually replaced with fresh SPV at five levels: 0% SPV (T1), 25% SPV (T2), 50% SPV (T3), 75% SPV (T4) and 100% SPV (T5). Initially, Dry matter (DM) feed intake was reduced as level of SPV inclusion in the ration increased, but 56 days later the intake was increased linearly as the amount of SPV increased in the ration. There were no significant differences among the first three treatments in body weight changes and body measurements, however; there were a tendency of reduction in rate of weight gain and body measurements as proportion of SPV increased in the ration. T1, T2 and T3 had significantly ($P<0.05$) higher overall ADG (g/day) (60.13±0.004, 59.52±0.002 & 56.34±0.003 vs. 33.01±0.003 and 20.83±0.001) than T4 and T5, respectively. Feed conversion ratio (FCR) of replacing concentrate with SPV mirrored the trends in overall ADG. Economically, T3 was the most profitable one with average net return of 41.73 (ETB)/head followed by 28.37, 28.22, 27.21 and 22.47 ETB/head for T2, T5, T4 and T1, respectively. Therefore, from this study it can be concluded that 50% sweet potato vines substitution for concentrate can be used for growing Arsi-Bale male goats finishing with acceptable weight gain, feed intake, body measurements and economic return.

Key words: Arsi-Bale goats · Profitability · Feed conversion · DM intake · Weight gain · Sweet potato vines

INTRODUCTION

Traditionally sweet potatoes have been cultivated in the tropical countries of Latin America and the Caribbean almost exclusively for tuber production to be used for human consumption, while its foliage has always been considered as a residue. In Ethiopia, sweet potato is cultivated mostly in highland part of the country and now a day its cultivation is expanding to lowland area for tuber production while the green top is rarely utilized as animal feed. The productive potential of different varieties of sweet potato is from 3 to 4 ton/ha of root (DM) and the foliage production can be from 4.3 to 6.0 ton dry matter/ha/crop [1].

Many developing countries are under increasing pressure to make more effective use of available resources in the agricultural sector both to satisfy the growing demand for livestock products and to raise rural incomes by generating value addition. The cost of balancing domestic demands for livestock products with feed or livestock imports has become prohibitively expensive. The prospect for increases in the out put of cereals of the magnitude required to meet livestock feed both to spur domestic livestock production and to free cereal supplies for human consumption are receiving closer attentions [2]. 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 [3]. In this context, interest in the potential for expanded use of sweet potato as animal feed in developing countries is arising.

Information about the utilization of sweet potato in developing countries is generally harder to come by and less reliable than is the case with other roots and tubers e.g. cassava and potato [4]. According to the international statistics about one third of sweet potato production in the developing countries is used for animal feed [2].

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Sweet potato is almost always used, in some form and amount, as animal feed wherever it is produced in developing countries. Unfortunately, information about the exact nature, extent and evolution of this practice is handicapped by a lack of knowledge about the crop generally and the use for animal feed specifically. With that observation as a caveat, the meager evidence available about present practices suggests that sweet potato is most commonly used as animal feed on the farm it self [2].

Both the tubers and vines of sweet potato are used as a feed for cattle, pigs, chickens and small ruminants [5]. Karachi and Dzowela [6] reported that sweet potato vines could be used as an alternative dry season supplementary feed for calves. Adugna et al. [7] indicated that the vines can be used as useful supplementary feed for goats in areas where the crop is grown. Getachew *et al.* [8] reported that sweet potato vines are one of the major feed sources for goats in the Harargae 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 level of substituting concentrate by sweet potato vines on feed intake, growth performance and economic efficiency of Arsi-Bale goats.

MATERIALS AND METHODS

Study Area Description: The study was conducted at Adami Tulu Agricultural Research Center, which is located 167 km south of Addis Ababa at an altitude of 1650m 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 760mm. The mean minimum and maximum temperature are 12.6°C and 27°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 [9].

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 on their body weight. Each treatment group contained eight 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 from June to October 2007. 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

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

the today's ration to calculate intake. Dry matter feed intake was calculated at every 14 days by taking average of daily intake within those days. Growth related parameters such as body weight and body measurements were also recorded at every 14 days.

Economic return analysis is computed to examine the economic profitability of substituting concentrate with sweet potato vines. The costs of depreciation of barn and utensils as well as value of dung were not included in the economic analysis because of unavailability of the data required for estimation. Moreover, sweet potato is cultivated in the area for the purpose of tuber production while the vines wasted/left on the ground after tuber harvested. Few or no farmers properly utilize the vines as animal feed and there is no tradition of buying or selling the vines for animal feed as a result it is difficult to estimate price of vines for specific unit of measurement. Hence, cost of sweet potato vines was not included in the economic analysis. The computation was done based on average value of data obtained during the experiment.To examine the rate of return on annual bases, the annual financial rate of return (AFRR) to feeding was calculated using formulae

$$AFRR=[(R-C)/C*(365/t)]*100\%$$ Baur *et al*. [10],

Where
AFRR = Annual financial rate of return
R = Revenue from selling of the goat
C= Purchase and other variable costs and
t= Number of days the animal was fed

The AFRR to feeding is thus revenue less purchase cost of the animal and other variable costs, multiplied by the number of days in the year the animal was fed. The return was decomposed in to its compounds (price, weight and their interaction) in order to examine the relative contribution of the components in the gross return. All the components are expressed as percentages of the financial margin. To disaggregate the gross margin in to its components the formulae used was:

$$100\ \%=\{ (\Delta P*Wi +\Delta WPi +\Delta P*\Delta W)/M\}*100\%$$

Where
ΔP= The difference between sale price and purchase price
ΔW= The difference between final weight and initial weight at purchase
Pi = Purchase price
Wi = Initial weight at purchase

Sensitivity analysis was also done to capture the likely change of prices of input (feed) and fattened goat. Price variation can occur for input and out put. Thus, these variations were considered in the sensitivity analysis.

Statistical Analysis: Feed intake, body weight change and body measurements data were analyzed using analysis of variance procedures for a completely randomized design experiment using the General Linear Model procedures of SAS [11] and means were subjected to Duncan's Multiple Range Tests for determination of significant differences among treatments. Mean differences were considered significant at $P<0.05$. In the analysis, except treatments all parameters considered as dependent variables.

RESULT AND DISCUSSION

Feed Intake: Average daily dry matter (DM) feed intake for Arsi-Bale goats fed different proportion of concentrate and sweet potato vines are presented in Table 2. During the first four consecutive 14 days of the experimental period, DM feed intake for T5 was significantly lower than other treatments whereas DM feed intake was highest for T5 followed by T3, T1, T4 and lowest for T2 starting from the fifth 14 days up to the end of the experiment. There was no significant difference between the first three treatments in DM feed intake during the 3rd and 4th 14 days while T4 had significantly higher DM feed intake than T5. At the beginning, DM feed intake was reduced as level of sweet potato vines inclusion in the ration increased; but 56 days later, the intake was increased linearly as the amount of sweet potato vines in the ration increased which might be due the familiarity of the experimental animals with the feed. This indicated that sweet potato vines supplementation could not affect DM feed intake negatively rather it enhances intake if the animal adapted with the feed. Lam and Ledin [12] reported that DM feed intake decreased linearly as Sesbania foliage was replaced by sweet potato vines which was not in agreement with this report that might be due to the difference in type of feed replaced by sweet potato vines. In support of current finding, Dominguez [13] reported that supplementation of sweet potato forages improves feed intake of young bulls fed sugar cane stalks.

Trends in Body Weight Change: Trends in body weight change and feed conversion ratio (FCR) for Arsi-Bale goats fed different proportion of concentrate and sweet potato vines are presented in Table 3.

Table 2: LSM±SE for daily dry matter feed intake by Arsi-Bale goats fed increasing proportions of sweet potato vines as replacement for concentrate

DM feed intake, kg/day/treatment	Treatments T1	T2	T3	T4	T5
1st 14 days	2.51±0.08^{ab}	2.65±0.09^{a}	2.57±0.10^{a}	2.44±0.08^{ab}	2.23±0.13^{b}
2nd 14 days	2.73±0.08^{a}	2.67±0.06^{ab}	2.65±0.06^{ab}	2.39±0.15^{bc}	2.33±0.08^{c}
3rd 14 days	2.91±0.01 ^{a}	2.90±0.01 ^{a}	2.89±0.01 ^{a}	2.68±0.05^{b}	2.52±0.02 ^{c}
4th 14 days	2.95±0.02 ^{a}	2.93±0.03 ^{a}	2.90±0.02 ^{a}	2.76±0.02 ^{b}	2.68±0.02 ^{c}
5th 14 days	3.03±0.04^{b}	2.84±0.01^{b}	3.03±0.06^{b}	2.89±0.03^{b}	3.95±0.33^{a}
6th 14 days	3.20±0.00^{c}	2.90±0.00 ^{e}	3.26±0.00^{b}	2.96±0.00^{d}	4.83±0.01^{a}
7th 14 days	3.41±0.05^{c}	3.11±0.06 ^{e}	3.47±0.03^{b}	3.17±0.07^{d}	4.85±0.01^{a}
8th 14 days	3.48±0.02^{c}	3.18±0.01 ^{e}	3.54±0.03^{b}	3.24±0.04^{d}	4.92±0.02^{a}
9th 14 days	3.50±0.01^{c}	3.20±0.02 ^{e}	3.56±0.01^{b}	3.26±0.03^{d}	4.95±0.02^{a}
Overall	3.18±0.03^{c}	3.04±0.04^{d}	3.22±0.02^{b}	3.00±0.05^{d}	3.98±0.06^{a}
N	8	7	8	7	8

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

Table 3: LSM±SE for fortnightly changes in body weight and FCR by Arsi-Bale kids fed increasing proportions of sweet potato vines as replacement for concentrate

Fortnightly changes in body weight (kg)	Treatments T1	T2	T3	T4	T5
1st 14 days	1.75±0.23^{a}	1.50±0.60^{a}	0.44±0.32^{b}	-0.21±0.38^{bc}	-0.69±0.16^{c}
2nd 14 days	-0.31±0.21^{a}	-0.50±0.85^{a}	-0.13±0.13^{a}	-0.29±0.18^{a}	-0.56±0.34^{a}
3rd 14 days	0.63±0.35^{ab}	1.21±0.26^{a}	0.50±0.21^{ab}	0.21±0.26^{b}	0.50±0.25^{ab}
4th 14 days	1.75±0.16^{a}	1.21±0.24^{ab}	1.50±0.19^{a}	1.64±0.14^{a}	0.94±0.18^{b}
5th 14 days	1.31±0.30^{a}	1.36±0.21^{a}	1.50±0.19^{a}	0.93±0.13^{a}	1.19±0.16^{a}
6th 14 days	0.44±0.15^{a}	0.29±0.18^{ab}	-0.06±0.06^{b}	0.00±0.11^{b}	0.00±0.16^{b}
7th 14 days	0.06±0.26^{a}	0.93±0.48^{a}	0.06±0.26^{a}	0.14±0.21^{a}	0.06±0.22^{a}
8th 14 days	0.63±0.26^{b}	0.64±0.18^{b}	1.31±0.25^{a}	0.93±0.13^{b}	0.31±0.09^{b}
9th 14 days	1.69±0.30^{ab}	1.21±0.21^{b}	1.31±0.25^{a}	1.00±0.24^{b}	1.00±0.28^{b}
Overall ADG, g	60.13±0.04^{a}	59.52±0.002^{a}	56.34±0.003^{a}	33.01±0.003^{b}	20.83±0.001^{c}
FCR	6.61^{d}	7.30^{c}	7.14^{c}	12.74^{b}	23.88^{a}

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

During the 1st 14 days of experimental period, goats in T1 and T2 had significant higher body weight gain than other goats in the rest treatments and T3 had significantly higher gain than T5 while there was no significant difference among T4 and T5. However, there were a loss of weight in T4 and T5 which might be due to lower feed intake (Table 2) during the indicated period. In similar fashion, goats in all treatments had lost body weight during the 2nd 14 days which might be due to the sudden out break of diseases that affected all flocks in the center. However, goats in all treatments overcome the lost weight with higher gain in T2 during the followed 3rd 14 days.

Weight gains in all treatments during the 4th and 5th 14 days were better than the preceding periods. However, body weight gain during the 6th and 7th 14 days period of the experiment was decreased as compared to weight gain during the 4th, 5th, 8th and 9th 14 days. This up and down trends in body weight gain was similar for all treatment with significant differences at particular period (Table 3). T1, T2 and T3 had significantly (P<0.05) higher overall ADG than T4 and T5 while T4 had significantly higher overall 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 overall ADG than goats in the rest treatment groups. This implies that sweet potato vines could replace concentrate at least up to 50% in the ration of yearling Arsi-Bale male goats. Similarly, Lam and Ledin [12] reported that fresh sweet potato vines can replace 50% of *Sesbania grandiflora* with acceptable live weight gains (60.9g/day). Semenye and Hutchcroft [14] working with dual purpose goats found that sweet potato vines met the requirements of kids when fed 30gm DM per kg of body weight per day. In support of our finding, supplementing

Table 4: LSM±SE for heart girth, height at wither and body length by Arsi-Bale kids fed increasing proportions of sweet potato vines as replacement for concentrate

Body measurements at every 14 days (cm)	Treatments T1	T2	T3	T4	T5
Heart girth					
Initial	59.38±1.05^{a}	58.43±0.78^{a}	57.75±0.70^{a}	59.71±0.68^{a}	58.63±0.56^{a}
1st 14 days	59.00±1.30^{a}	58.43±1.17^{a}	57.38±0.65^{a}	59.00±0.62^{a}	58.00±0.68^{a}
2nd 14 days	61.25±0.90^{a}	60.86±1.10^{a}	59.75±0.70^{a}	61.14±0.70^{a}	59.13±0.69^{a}
3rd 14 days	63.75±0.80^{a}	62.86±1.10^{abc}	61.13±0.44^{bc}	63.29±0.78^{ab}	60.63±0.71^{c}
4th 14 days	65.63±0.82^{a}	64.43±1.29^{ab}	63.13±0.61^{bc}	63.00±0.65^{bc}	61.13±0.58^{c}
5th 14 days	65.75±0.65^{a}	64.29±1.21^{ab}	63.50±0.78^{ab}	64.57±0.48^{ab}	62.63±0.80^{b}
6th 14 days	64.88±0.72^{a}	64.29±1.29^{a}	62.50±0.53^{ab}	62.71±0.61^{ab}	61.63±0.75^{b}
7th 14 days	66.50±0.63^{a}	65.00±0.61^{ab}	63.13±0.58^{bc}	63.29±0.61^{bc}	62.00±0.65^{c}
8th 14 days	66.63±0.63^{a}	65.43±1.09^{a}	64.25±0.88^{ab}	64.43±0.53^{ab}	62.00±0.85^{b}
9th 14 days	67.13±0.51^{a}	66.71±1.11^{a}	65.25±0.88^{ab}	65.43±0.53^{ab}	63.13±0.85^{b}
Height at wither					
Initial	60.13±0.91^{a}	59.43±1.48^{a}	58.38±0.91^{a}	60.00±0.93^{a}	59.25±0.56^{a}
1st 14 days	61.50±1.07^{a}	61.14±1.01^{a}	61.88±1.19^{a}	62.43±0.69^{a}	61.25±0.80^{a}
2nd 14 days	64.38±0.80^{a}	63.43±1.17^{ab}	61.98±1.02^{ab}	62.29±1.02^{ab}	61.88±0.74^{ab}
3rd 14 days	65.63±0.65^{a}	63.57±1.07^{ab}	62.35±1.40^{ab}	62.71±1.17^{ab}	62.63±0.56^{ab}
4th 14 days	64.38±0.92^{a}	62.71±1.04^{ab}	62.42±1.31^{ab}	63.57±1.15^{a}	61.88±1.03^{ab}
5th 14 days	66.63±0.92^{a}	63.29±1.13^{b}	62.88±1.43^{b}	63.42±0.80^{b}	62.78±0.85^{b}
6th 14 days	66.13±0.55^{a}	63.00±1.18^{b}	61.50±1.25^{b}	62.57±0.87^{b}	61.63±0.53^{b}
7th 14 days	65.75±0.56^{a}	62.71±1.08^{b}	61.75±1.15^{b}	62.86±0.80^{b}	61.75±0.53^{b}
8th 14 days	65.50±0.63^{a}	63.14±1.08^{ab}	62.50±1.30^{b}	63.71±0.71^{ab}	61.75±0.82^{b}
9th 14 days	66.00±0.53^{a}	64.14±1.08^{ab}	63.38±1.27^{ab}	64.57±0.65^{ab}	62.92±0.74^{b}
Body length					
Initial	59.00±0.76^{a}	58.29±0.71^{a}	57.63±0.84^{a}	59.29±1.06^{a}	58.13±0.74^{a}
1st 14 days	59.50±1.05^{ab}	58.43±0.72^{ab}	57.73±0.72^{ab}	59.71±1.06^{a}	58.38±0.89^{ab}
2nd 14 days	59.80±1.02^{a}	58.57±0.68^{a}	57.80±0.87^{a}	58.93±1.23^{a}	58.48±0.71^{a}
3rd 14 days	60.13±0.88^{a}	58.43±1.13^{a}	58.63±0.78^{a}	59.57±1.11^{a}	58.50±0.98^{a}
4th 14 days	60.33±0.83^{a}	59.29±1.46^{a}	60.38±1.15^{a}	60.88±0.83^{a}	59.00±0.60^{a}
5th 14 days	60.50±1.16^{a}	59.71±0.94^{a}	61.88±0.99^{a}	61.00±1.38^{a}	59.75±0.67^{a}
6th 14 days	62.75±0.75^{a}	60.86±0.70^{ab}	61.00±0.76^{ab}	60.29±1.23^{ab}	59.38±0.68^{b}
7th 14 days	62.50±0.78^{a}	61.86±0.77^{ab}	61.25±0.82^{ab}	60.57±1.11^{ab}	59.63±0.56^{b}
8th 14 days	63.63±0.60^{a}	63.14±0.59^{ab}	61.13±1.03^{ab}	63.29±1.04^{ab}	60.75±0.73^{ab}
*9th 14 days N**	64.13±0.48^{a}	64.14±0.59^{a}	62.00±0.98^{ab}	63.71±0.81^{a}	61.13±0.58^{b}
	8	7	8	7	8

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

* N in all tables indicate number of observation

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 [6]. Performance of goats fed the sweet potato vines at higher levels was less satisfactory compared with concentrate, suggesting that for the vines, only 25% & 50 % or, at the most, 75 % replacement of the concentrate is advisable. Feed conversion of replacing concentrate with sweet potato vines mirrored the trends in overall ADG, with declining performance as concentrate was replaced by sweet potato vines (Table 3). FCR for the T4 and T5 was by far greater than the rest treatment groups which might be due to the expected lower digestibility or higher fiber in sweet potato vines than concentrate. Similar result was reported by Lam and Ledin [12] who replaced *Sesbania grandiflora* with sweet potato vines in the ration of crossbred goats (Bach Thao x local female).

Linear Body Measurements: Mean heart girth (HG), height at wither (HW) and body length (BL) for Arsi-Bale goats fed different proportions of concentrate and sweet potato vines are presented in Table 4. There were no significant differences among treatments during the first

Table 5: Cost and economic return analysis (per animal) for Arsi-Bale goats fed increasing proportion of SPV as replacement for concentrate

	Treatments				
Items	T_1	T_2	T_3	T_4	T_5
Number of animals per treatment	8	7	8	7	8
Average purchase price (ETB*) per kg	6.75	6.75	6.75	6.75	6.75
Average live weight (kg) @purchase per head	16.81	16.79	16.19	17.57	16.56
Average purchase price (ETB) per head	113.47	113.33	109.28	118.6	111.78
Operating costs					
I. Feed (concentrate)	48.94	39.67	24.63	13.21	0.00
II. Labor	18.19	20.79	18.19	20.79	18.19
III. Medicine	1.12	1.12	1.12	1.12	1.12
Total operating costs	68.25	61.58	43.94	35.12	19.31
Average total cost per head(ETB)	181.72	174.91	153.22	153.72	131.09
Average live weight(kg)@sale per head	24.75	24.64	23.63	21.93	19.31
Total body weight gain (kg)	7.94	7.86	7.44	4.36	2.75
Average sell price per kg of live weight(ETB)	8.25	8.25	8.25	8.25	8.25
Average return (Gross return)/head(ETB)	204.19	203.28	194.95	180.92	159.31
Average net return (NR0)(ETB)	22.47	28.37	41.73	27.20	28.22
Annual financial rate of return (AFRR)(ETB)	50.15	65.77	110.44	71.78	87.30

*ETB=Ethiopian birr, 9.5 Birr=1US dollar

Table 6: Different components of the Gross Margin

	Components of Gross Margin (%)			
Treatments	Price	Weight	Interaction	Weight gain over price (folds)
T_1	27.79	59.08	13.13	2.13
T_2	28.00	58.98	13.11	2.11
T_3	28.35	58.62	13.03	2.07
T_4	42.29	47.22	10.49	1.12
T_5	52.26	39.06	8.68	0.75
Average	35.74	52.59	11.69	1.64

Table 7: Sensitivity analysis of net return for 20% increase in feed price and 10% decrease in sell price of fattened goats

	T1	T2	T3	T4	T5
Initial net return(NR0) (ETB)	22.47	28.37	41.73	27.21	28.22
NR1(ETB)	12.7	20.44	36.8	24.56	28.22
NR2(ETB)	2.05	8.04	22.23	9.11	12.29
ΔNR1(ETB)	44	28	11.8	9.75	0
ΔNR2(ETB)	91	71.7	46.72	66.5	56.46
% of feed cost over total cost of production	26.93	22.68	16.07	8.59	0.00
% of purchase price over total cost of production	62	65	71.3	77.2	85.3

NR0:Initial net return with out increase in feed price and decrease in sell price
NR1:Net return with 20% increase in feed price with out change in sell price
NR2:Net return with 10% decrease in sell price with out change in feed price

ΔNR1 (%): percentage change in net return with 20% increase in concentrate with out a change in sell price
ΔNR2 (%): percentage change in net return with 10% decrease in sell price with out a change in feed price

two consecutive 14 days in heart girth measurements. T1 and T2 had significantly higher heart girth than T5 starting from 43 days of experimental period up to the end of the experiment. There were no significant difference among treatments in height at wither and body length during the first four consecutive 14 days interval measurements while T1 had significantly higher height at wither and body length than other treatments during the 5^{th} up to 7^{th} consecutive 14 days of the experiment. T1 had also significantly higher height at wither and body length than T5 during the last 28 and 14 days of the experimental period, respectively. Generally, linear body measurements decreased as proportion of sweet potato vines in the ration increased which is similar to body weight changes obtained in this experiment.

Economical Analysis: An economic analysis was carried out in the rations using the average prices at purchase and sale. The results are shown in Table 5. Even though the analysis revealed that feeding goats using all feed options in the trial is profitable, T3 was the most profitable one followed by T2, T5, T4 and T1 in that order. One way farmers might increase profitability is by reducing feeding costs per animal. Therefore, reducing the amount of concentrate in the ration which represents about 40% of the total operating cost and 64% for T2 could result in profit making.

Different Components of the Gross Margin: The results from the gross margin analysis that described as percentages of financial return also indicates that the weight gain as a whole accounted for 52% of the gross margin while price changes and the interactions accounted for 36% and 12%, respectively (Table 6). This suggests that weight gains over the feeding periods relatively played an important role in the determination of profitability.

Sensitivity Analysis: Sensitivity analysis was hypothesized for 20 % increase in concentrate and 10% decrease in sell price of goat in order to capture the likely change of price of input and fattened goat. In Ethiopia this year (2007/2008) commercially produced feed increased more than 100% ever than before. Based on this fact price variations were considered in the sensitivity analysis. In agricultural production, decrease or increases in input and out put price have great impact on farmers return. Apart from purchase price which constituted about 72% of the total production cost, feeding was the most expensive commodity ranging from 8% to 27%. A 20% increase in concentrate feed price would decrease the return per head by 44%, 28%, 11.8% and 9.75% for T1, T2, T3 and T4 respectively. The result indicates that it is better for the farmers to reduce the utilization of concentrate in the ration and look for cheap feed source that substitute commercially produced feeds. Accordingly the use of sweet potato vine is vital in this case in order to fetch good profit.

A 10% decrease in sell price of fattened goat will reduce net return in ETB/head by 91%, 71.7%, 46.72%, 66.5% and 56.46% for T1, T2, T3, T4 and T5, respectively (Table 7). Relatively speaking the analysis indicates that feeding goat is highly affected by change in sell price of fattened goats especially for those fed on T1 and T2 compared to other treatments since price accounts for more than 72% of the total cost of production.

CONCLUSION AND RECOMMENDATION

Initially, DM feed intake was reduced as level of sweet potato vines inclusion in the ration increased; then after the intake was increased linearly with sweet potato vines increment in the ration. This indicated that sweet potato vines supplementation could not affect DM feed intake negatively rather it enhances intake if the animal adapted with the feed. There were no significant differences among the first three treatments in body weight changes and linear body measurements, however; there were a tendency of reduction in rate of weight gain as proportion of sweet potato vines increased in the ration. Similarly, there were no significant differences among T1, T2 and T3 in overall ADG. T3 was the most profitable one followed by T2, T5, T4 and T1. It would be profitable if feed price increased up to 20% and sell price decreased by 10%. Weight gains played an important role in the determination of profitability. 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, feed intake and economic returns. 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.

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REFERENCE

1. Ruiz, M.E., D. Pezo and L. Martinez, 1980. The use of sweet potato (*Ipomoea batatas L.(Lam*)) in animal feeding. I. Agronomic aspects. Tropical Animal Production, 5(2): 144-151.
2. Scott, G.J., 1992. Sweet potato as animal feed in developing countries: present patterns and future prospects by G.J. Scott. In: Roots, tubers, plantains and bananas in animal feeding. FAO Animal production and Health Paper 95.

3. An, L.V., 2004. Sweet potato leaves for growing pigs: Biomass yield, digestion and nutritive value. Doctoral thesis, Swedish University of Agricultural Sciences, Uppsal.
4. Horton, D., J. Lyn am and H. Knipscher, 1984. Root crops in developing counterirritant Economic Appraisal. In Sixth symposium: International society for Tropical Root crops, Lima.
5. Woolfe, J.A., 1992. Sweet potato: an untapped food resource. Cambridge university press, Cambridge, pp: 643.
6. Karachi, M.K. and B.H. Dzowela, 1988. The potential of sweet potato (Ipomoea batatas L.) as dual purpose crop in semi-arid crop-livestock systems in Kenya. In: utilization of research on forage and agricultural by product materials as animal feed resource in Africa. Proceeding of the first workshop held in Lilongwe, Malawi from, Dec.1988, 5-9: 518-531.
7. Adugna, T., C.M. Roger, L. Arthur, Goetsch, S. Tilahun and N. Tegene, 2000. Nutritional constraints and future prospects for goat production in east Africa. In: R.C.Merkel, G. Abebe and A.L Goetsh(eds.). The opportunities and challenges of enhancing goat production in East Africa. Proceeding of conference held at Debub University, Awassa Ethiopia from November 10-12, 2000. E (Kika) de la Garza Institute for Goat Research, Langston University, Langston, Ok, pp: 43-47.
9. ATARC (Adami Tulu Agricultural Research Center), 1998. Thirty years of research experience. Oromia Agricultural Research Coordination service. Bulletin no 1.
8. Getachew, A., C.M. Roger and S. Tilahun, 2000. Increasing food security through improved goat production: a progress report of a UNCEF- funded international development partnership between Langston University and Alamaya University. In: R.C.Merkel, G. Abebe and A.L Goetsh(eds.). The opportunities and challenges of enhancing goat production in east Africa. Proceeding of conference held at Debub University, Awassa, Ethiopia from November 10-12, 2000. E (Kika) de la Garza Institute for Goat Research, Langston University, Langston, Ok, pp: 118-126.
10. Baur, H., K. Sissoko and S. Debrah, 1989. The economics of peasant cattle fattening in Mali. African Research Network for Agricultural By-products (ARNAB).1989. Overcoming constraints to the effective utilization of agricultural by-products as animal feed. Proceeding of the fourth annual workshop held at the institutes of animal research, Mankon station, Bameeda, Cameroon, 20-27 October 1989. ARNAB, Addis Ababa, Ethiopia. pp: 49-60.
11. SAS, 2000. SAS Users Guide: statistics (Version 6 Ed.). SAS Inst., Cary, NC.
12. Lam, V. and I. Ledin, 2004. Effect of feeding different proportions of sweet potato vines (Ipomoea batatas L.) and Sesibania grandiflora foliage in the diet on feed intake and growth of growth of goats. Livestock Research for Rural Development 16(10): (http://www.cipav.org.co/lrrd/lrrd16/10/).
13. Dominguez, P.L., 1992. Feeding of sweet potato to monogastrics. FAO Animal Production and Health Paper No.95, Food and Agriculture Organization of the United Nation, Rome., pp: 217-234.
14. Semenye, P.P. and T. Hutchroft, 1992. On farm research and technology for dual purpose goats. SR-CRSP, Nairobi, Kenya, pp: 144.