Feed Intake, Weight Gain and Carcass Characteristics of Doyogena Yearling Ram Fed on *Rhodes grass* (*Chloris gayana*) Hay and Supplemented with Local Energy-Rich Feed Sources

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Abstract: An experiment was conducted to evaluate fattening performance of Doyogena yearling ram supplemented with energy-rich feedsat Dubo research sub-station, Southern Ethiopia. Local energy rich feeds used in this study were enset corm, *Ensete verticosum (welw.) Cheesman*, taro tuber (*Colocasia esculenta*) and sugarcane whole part (*Saccharum officenarum*) on top of tethered grazing on Rhodes (*Chloris gayana*) hay. The treatments were arranged in a Completely Randomized Block Design (CRBD). Six animals were assigned to each treatment and animals were considered as replicates. All animals were fed on a basal diet *ad lib* hay plus 300 g/day of concentrate mix (86.5% wheat bran, 13% noug cake (*Guizotia abyssinica)* and 0.5% salt) in addition to 3 h per day of tethered grazing on native pasture. The treatments were: T1 = (no additional feed) as control; T2, taro tuber/ head/day); T3, enset corm DM/head/day); T4, sugar cane/head/day on DM basis. The results indicated that DM intake (DMI, g/head/day) of T1 was higher ($p<0.05$) compared to T2 and T3. The Crude Protein intake (CP) was higher for T1 compared to other treatment options. Energy intake of T2 was significantly higher ($p<0.05$) compared to T1. Sheep fed on T1 and T2 demonstrated higher ($p<0.05$) weight changes, average daily gain and feed conversion efficiency compared to sugarcane. Estimates of partial budget indicated that feeding taro resulted in 19 and 34% more feed valuesover sugarcane and enset, respectively. The results indicated that taro could be one of the potential energy rich local feeds that could be used for sheepfinishing targeting festive season markets in crop-livestock production system.

INTRODUCTION

Sheep production is an integral part of crop-livestock mixed farming systems of Ethiopia. This system is located mainly at highland agro-ecological zones of Southern Ethiopia. The system is characterized by high population pressure and land shortage, thus, feed shortage is a typical problem threatening sheep production[1]. Indigenous animals have their own merits but have genetic limits. As a result, body weight gain and carcass yield of majority of local sheep breeds (Menz, Arsi-bale, & Black head Somali) are often reported to be low[2]. Efforts were made to import exotic breeds with fast growth and better dressing capacity to improve meat in terms of yield and quality aspects. However, exotic breeds such as Awassi and Corridialehad hardly been adapted to Ethiopian smallholder management (housing, feeding and healthcare) condition[3, 4]. On the other hand, demands for mutton have been increased considerably in the past 5-10 years and so did mutton price. This necessitates improvement of plane of nutrition through supplementation of concentrates and/or forage legumes which could promote faster daily weight gain and attainment of acceptable market at earlier age[5, 6].

The government organizations engaged in rural agricultural activities are advocating community-based breed selection[3]. Selecting best rams from indigenous sheep is a sustainable tool to improve local, adapted breeds to poor nutrition, disease and parasites. All male sheep culled from the community-based selection need to be castrated for accelerated finishing. However, appropriate feed formation for strategic supplementation and economical finishing has not been studied previously, particularly with local energy-rich feed sources.

Doyogena sheep is currently identified as one of the potential flocks/populationsthat could be improved through community-based participatory breeding scheme, since, 2012. It is one of the sheep flocks with better reproductive and growth capacity in central south region[6]. Among others, feed shortage is one of the bottlenecks threatening breed improvement in the area. Strategic supplementation of locally available energy rich feeds such as taro (*Colocasia esculenta*) was considered to be used for accelerated sheep fattening. However, the utilization methods and level of inclusion of these feeds, particularly taro and enset corm, in animal diet has not been well investigated and documented. Rams left after selection of elite animals are castrated and usually meantfor fattening. This study, is therefore, aimed at improving community breed selection practices through fattening culled sheep from the flocks during selection, using energy rich local feed sources.

MATERIALS AND METHODS

Description of the study site: This experiment was conducted at Dubo Mante research sub-station, Areka Agricultural research center. The site is located at 305 km South of Addis Ababa with an altitude thatranges from 1660-1778 m above sea level, longitude 07' 06.4312' and latitude 037'41.688'. The rainfall of the site ranged between 900 and 1600 mm. The rainfall pattern is bimodal with the highest between July and September. Due to high atmospheric water demand, the site is reported to have the highest evapo-transpiration. During the experimental period, the temperature ranged between 6 and 16°C. About 2 hectares of *Rhodes grass (Chloris gayana)* among other forage species, *Pennisetum purpureum*, *P. glaucifolium*, *Avena sativa*, *Vignaun guilgulata*, *Lablab purpureus* planted at experimental site for research purpose.

Experimental feeds and feeding management: Medium quality *Rhodes grass* (*Chloris gayana*) hay was used as a basal diet. It was sown at Dubo Mante research sub-station, harvested at 50% flowering and dried under shade. The rams grazed tethered on natural pasture for about 3 h each day to simulate farmers practice. Concentrate mix (wheat bran, noug cake, salt) was offered for all experimental groups as positive control. Energy-rich feed sources such as taro (*Colocasia esculenta*, Bolosso-1), enset (*Ensete vertricosum welw. Cheesman* L.) andsugar cane whole parts (*Saccharum officenarum*) were offered to experimental sheep while concentrate mix was considered as a positive control because some emerging farmers practice sheep fattening using concentrate mixes. The experimental feeds were chopped and wilted on sun for half a day before offering to experimental sheep. All animals were fed on a basal diet *ad lib* hay plus 300 g/day of concentrate mix (86.5% wheat bran, 13% noug cake (*Guizotia abyssinica)* and 0.5% salt) in addition to 3 h (between 9:00 am to 12:00 am) per day of tethered grazing on native pasture. The treatments were: T1 = (no additional feed) as control; T2 = 300 taro tuber/head/day); T3 = 300 Ensetcorm DM/head/day); T4 = 300 g Sugarcane/head/day on DM basis.

Source and management of experimental animals: The 24 yearling castrated male sheep with mean 24.8±1.83 kg were purchased from Doyogena community-based sheep breed improvement cooperatives. The rams (3rd) ranked were those left after selection of elite groups as breeding male for improvement of next generations. Experimental animals were identified using ear tags[7]. The animals were de-wormed against internal parasites and sprayed against external parasites. The 6 animals were randomly assigned to each treatment using a completely randomized block design. After 14 days of adaptation period, 90 days of actual experimental weights were taken on weekly basis. The weights collected fortnightly were used to estimate feed supplement that offered in the following two weeks. Diets offered and refusals were weighed and recorded daily. Animal weights were recorded at the beginning, fortnightly and at the end of the experimental period. The experiment lasted

Table 1: Chemical composition and *in-vitro* digestibility of non-conventional feeds consumed by Doyogena yearling ram at Areka, Southern Ethiopia

	Chemical composition and *in-vitro* digestibility (%)						
Feed types	DM	OM	CP	ADF	NDF	IVOMD	Energy (MJ/kg DM)
Ensete verticosum	90.050	95.54	4.21	10.74	32.48	71.67	11.47
Colocasia esculenta	89.410	95.98	4.16	6.84	69.31	81.41	13.02
Saccharum officenarum	93.395	96.11	3.42	29.80	45.67	59.56	9.53
Concentrate mix	91.520	93.00	14.80	9.10	38.20	69.14	11.06
Rhodes hay (*Chloris gayana*)	91.460	88.01	7.13	39.49	70.24	60.61	7.95

90 days targeting markets of Ethiopian festive season, Easter. Basal diet (*Rhodes grass* hay) and water were available on *ad lib* basis. Enset and taro corms and sugarcane (stem) were finely chopped and wilted about half a day before mixing with concentrate ration. The experimental ration was offered daily half in the morning (8:30-9:00 am) and half in the afternoon (10:00-3:00 pm) after offering grass hay.

Chemical composition and *in-vitro* digestibility of experimental feeds: Feed samples were analyzed for DM by drying the samples 105°C for 24 h, ash by ignition in muffle furnace at 600°C for 6 h and CP by the Kjeldahl procedure[8]. For all chemical composition analyses and *in vitro* studies, the oven-dried samples were ground to pass through a 1-mm sieve in a Willey mill (Arthur H. Thomas, Philadelphia, Pa, USA). CP was measured on a LECO FP-428 nitrogen and protein analyser (LECO Corporation, St Joseph, Mich, USA). NDF and ADF concentration were determined using an ANKOM200/220 fibre analyser (ANKOM Technology, Fairport, NY, USA) based on the methods described by Van Soest *et al*.[9]. Sodium sulphite and heat-stable amylase were used in the analysis of NDF. ADL was determined by solubilisation of cellulose with sulphuric acid in the ADF residue[9]. Chemical composition and *in-vitro* organic matter digestibility of indigenous energy rich non-conventional feeds is presented in Table 1.

Carcass analysis: At the end of the experimental period, three fattened Doyogena sheep were randomly selected from each treatment group and slaughtered at Export ELFORA abattoir at Debrezeit town. After the animals were slaughtered and skinned, all important organs namely kidney, heart, liver, lung, spleen, empty gut, heart fat, kidney fat, mesenteric and omental fat were eviscerated and weighed. Hot carcasses of the slaughtered sheep were dissected equally into right and left halves using carcass cutting machine. Weights of both right and left halves were recorded before putting the carcass into the chilling room of -4°C. Cold carcasses were weighed after 24 h of chilling. To evaluate the cold carcasses, the right half of the sheep's carcasses cut between 12th and 13th ribs to expose longissmus muscle of both carcass sides. Then the chilled carcasses cut into five major parts such as rib eye roll, chuck roll, chuck tender and two ribs and brisket. To evaluate the difference in primal carcass cut, all parts were separately measured. From each primal carcass cut, muscle and fat were trimmed from the bone using knife. Finally, all the trimmed muscle and fat were separately weighed.

Partial budget estimation: All fixed and variable costs were recorded during the experimental period. Partial budget analysis of experimental treatments was calculated using the formula: Net return = GR (sale price of sheet)-TVC (total cost of feed consumed+medicinal cost+labor cost).

Statistical analysis: The data on live weight, average daily gain, feed intake and carcass yield parameters were analyzed using General Linear Model (GLM) of Statistical Analysis System[10]. The estimated least squares means will be separated by Tukey's test at $p<0.05$. The statistical model employed was:

$$Yij = \mu+ai+bj+eij$$

Where:

- Yij = The dependent variable (Weight changes, ADG, carcass yield parameters)
- μ = The overall mean
- aj = The effect of energy supplement (j = 1, CMR; 2, Taro, 3, enset, 4, sugarcane)
- bj = The jth block effect
- eij = Random variation/error

Relative advantage of the alternative feeds is calculated as: percentage rate of return of feed one (taro) minus percentage of rate of return feed two (enset) divided by percentage rate of return of feed two and multiplied by 100.

RESULTS AND DISCUSSION

Dry matter and nutrients intake: The daily nutrient intake in terms of Dry Matter (DM) is one of the parameters for weight gain and performance of animals. DM and nutrient intake rate of experimental animals is presented in Table 2. Great variations were observed among the parameters, DM and nutrients intake. DM intake (DMI, g/head/day) of concentrate mix was higher ($p<0.05$) compared to taro and enset while no differences compared with sugarcane. The mean DM and organic

Table 2: Dry Matter (DMI) and other nutrient intake (g/head/day) and energy intake (MJ/head/day) of experimental ram fed on rhodes hay and supplemented with energy-rich feed sources at Areka research, Southern Ethiopia

Parameters	T1	T2	T3	T4	Mean	CV	Sign level
DMI (g/head/day)	539±10.7	532±10.7	497±10.7	513±10.7	521	5.02	*
Organic matter (g/head/day)	531±11.2	487±11.2	479±11.2	499±11.2	499	5.49	*
CP intake (g/head/ day)	8.58±0.71	22.85±0.71	21.95±0.71	18.30±0.71	17.92	4.68	***
ADF intake (g/head/ day)	52.8±1.72	38.0±1.72	55.9±1.72	15.9±1.72	76.50	5.52	***
NDF intake (g/head/ day)	221±5.05	385±5.05	169±5.05	244±5.05	254.9	4.85	***
Energy intake (MJ/head/day)	64.1±1.28	72.3±1.28	59.7±1.28	51.0±1.28	61.77	5.07	***

*p<0.05; *p<0.01. SEM = Standard Error Mean; T1= Concentrate mix; T2 = taro; T3 = enset corm; T4 = sugarcane

matter intake was 521 and 499 g/head/day, respectively. Moisture level might have limited intake of enset corm. On the other hand, Organic Matter (OM) intake of concentrates and taro was significantly (p<0.05) higher compared to enset corm. The mean dry matter intake obtained in this study is in line with previous reports for fattening goats using concentrate mixed ration[4]. The results agree with previous reports[11]. Crude Protein intake (CP) was also higher for concentrates compared to other treatment options. Likewise, the CP intake of taro and enset was significantly (p<0.001) higher compared to sugarcane. However, these feed sources need to be supplemented strategically to be economical and avoid unnecessary fat accumulation and or bloating. Medium quality hay had nutrient content sufficient for maintenance feeding, although, lower compared to desho[12]. The quality of hay varies depending on soil type, stage of maturity and temperature during growing season. Concentrate mixes are usually higher in CP content which is in agreement with reports of Tilahun *et al*.[13].

The Acid Detergent Fiber (ADF) intake showed great variations, differing among experimental rations. ADF intake of sugar cane is the highest while intake of taro was the lowest. Neutral Detergent Fiber (NDF) intake varied among treatment rations. Taro NDF intake was the highest while feed without local energy feed sources was the lowest. There was the highest taro energy intake and it was significantly (p<0.001) higher compared to concentrates. Likewise, energy intake of concentrate mix was higher compared to enset and sugarcane. The results concur with reports of Tefera *et al*.[4] who noted higher weight gains for rams fed on high energy density feeds. Likewise concentrate intake was higher compared to enset while energy intake of sugarcane was the lowest. Feeds with better energy value are required for faster growth and earlier market weight[5, 6]. According to Talore *et al*.[1] enset corm and taro tuber are the commonly grown energy-rich feeds required by both human and animals in southern Ethiopia. Taro is one of the major crops produced in central zones of Southern Ethiopia, productivity ranging between 350-600 tones per hectare[14]. With such higher productivity, in the last 10 years, its price was very low, thus, significant number of farmers started feeding animals as meat price is usually high[11]. However, energy intake by animals might be affected by a number of factors such as genetic level of animals, environmental factors on top of feed energy level variations[13]. Doyogena breed previously known as Adilo sheep flock is a fast growing sheep, so that, a very small supplement could bring significant weight changes that could help it to reach export market weight within a short period of time[6].

Body weight change and feed conversion efficiency: Doyogena sheep flock is currently known by its higher prolificacy and fast growth[6]. Body weight changes, average daily gain and feed conversion efficiency of Doyogena sheep considered in this study is presented in Table 3. Sheep feed on enset corm (T3) demonstrated similar (p>0.05) weight changes compared to T4. On the other hand, those feed on commercial concentrate mix and taro resulted in higher (p<0.05) weight changes compared to those fed on sugarcane. The significant increase in weight gain for rations supplemented with concentrates and taro compared to sugarcane is due to high energy density nature of the feeds. With supplementation level, taro resulted in higher weight gains due to its higher energy density which is in agreement with previous reports[13]. For feeds with high energy concentrations, fewer amounts could satisfy the energy needs of the animals. The ADG obtained in this study is higher compared to reports of Tefera *et al*.[4] with similar finishing levels but is comparable with supplementation levels reported by other authors[13, 11]. The conversion efficiency obtained in the present study agrees with reports of Bassa *et al*.[11] who noted similar trends on oxenfattened using taro as energy supplement.

Carcass yield and non-carcass tissues: Carcass and non-carcass tissues are presented in Table 4. There are variations in edible carcass yield of Doyogena yearling ram but slaughter weight, hot and cold carcass weight were not significant statistically (p>0.05). Cold shrinkage of concentrates and taro supplemented rams was higher (p<0.05) compared to sugarcane ration. The mean dressing percentage did not show variations among treatment rations. The results are in agreement with Hailu *et al*.[5] who noted non-significant differences

Table 3: Feed intake, average daily gain and feed conversion efficiency of yearling lambs fed on rhodes hay (*Chlorias gayana*) and supplemented with energy-rich feeds at Areka, Southern Ethiopia

	Treatment options					
Parameters	T1	T2	T3	T4	Overall mean	CV sign level
Weight changes (kg)	7.17±0.57[a]	7.29±0.57[a]	6.20±0.63[ab]	5.33±0.57[b]	6.51	21.6
Average daily gain (g/head/day)	79.6±6.37[a]	81.0±6.37[a]	68.9±6.98[ab]	59.3±6.37[b]	72.3	13.7
Feed conversion efficiency	0.88±0.07[a]	0.90±0.07[a]	0.77±0.08[ab]	0.65±0.07[b]	0.80	21.5

*p<0.05; *p<0.01. T1 = Concentrate mix; T2 = taro; T3 = enset corm; T4 = sugar cane

Table 4: Edible carcass yield of Doyogena yearling ramfed on rhodes hay and supplemented with energy-rich feeds at Areka, Southern Ethiopia

Parameters	T1	T2	T3	T4	Sign level
Slaughter weight (kg)	26.33	26.0	24.67	25.67	NS
Hot carcass weight	11.78	11.18	10.66	11.33	NS
Cold carcass weight	11.56	10.95	10.49	11.15	NS
Cold shrinkage	0.23a	0.23a	0.18ab	0.16b	*
Dressing percentage	44.74	42.94	43.20	44.15	NS
Blood weight	0.91	1.11	1.05	1.03	*
Lung weight	0.49	0.54	0.48	0.50	*
Liver weight	0.46	0.38	0.34	0.38	NS
Spleen and pancreas	0.07	0.07	0.04	0.06	NS
Empty upper gut	0.89	0.83	0.79	0.85	NS
Omental fat	0.18	0.12	0.11	0.15	NS
Kidneys	0.13	0.11	0.11	0.14	*
Edible non-carcass component	3.13	3.17	2.92	3.11	*

T1 = Concentrate mix; T2 = taro; T3 = enset corm; T4 = sugarcane

Table 5: Partial budget estimation (US$) of Doyogena yearling ram supplemented with energy-rich feed sources and fed on rhodes hay as a basal diet at Areka, Southern Ethiopia

Parameters	T1	T2	T3	T4
a. Total treat diet consumed (kg/head)	0	2.81	3.3	2.48
b. Total concentrate consumed (kg/head)	4.96	4.96	4.96	4.96
C. Total feed cost (kg/head)	4.96	7.76	8.26	7.43
d. Labor cost	6.88	7.66	7.66	7.66
e. Medicine cost	0.59	0.59	0.59	0.59
d. Purchase of sheep	45.89	45.89	45.89	45.89
e. Total variable costs, TVC (a+b+C+d)	58.32	61.9	62.4	61.57
f. Sale of sheep, ETB/head	78.06	81.19	78.69	75.47
g. Net return (Sale of sheep, profit-TVC)	19.74	19.29	16.29	13.9
i. Marginal rate of return	0.34	0.31	0.26	0.23

T1 = Concentrate mix; T2 = taro; T3 = enset corm; T4 = sugarcane; ETB = Ethiopian Birr

on dressing percentage due to variation in feeds. Asmare *et al*.[12] and Tilahun *et al*.[13] also noted that supplementation of energy density feeds improve carcass yield and quality. Carcass quality found in this study agrees with reports of Bassa *et al*.[11] who noted increased carcass quality on oxen fed on taro as energy supplement. Chemical composition and nutrients reported on taro[14] is an indication for accelerated finishing with better meat quality obtained for sheep fed on taro.

Partial budget estimation: The enterprise profitability estimated using partial budget analysis is indicated in Table 5. The partial budget analysis indicated that Marginal Rate of Return (MRR) indicated that lambs supplemented with wheat bran and Taro had similar MRR while those supplemented with sugar cane showed the least. The MRR of taro (31%) is 19% and 35% more relative percentage valueover sugarcane and enset, respectively. Due to high energy density nature of the crop, small amount of taro could fatten sheep within short period of time saving labor and feed resources. The economic benefit of oxen fattened using taro was reported previously[11].

CONCLUSION

Results of feed intake, daily gain and feed conversion efficiency indicated that taro tuber could substitute commercial concentrate mixture predominately as energy feed option. Partial budget estimation also indicated that feeding taro resulted in 19 and 35% more relative return over sugarcane and enset, respectively. The results indicated that taro could be one of the potential alternative energy rich local feeds that could be used for accelerated finishing targeting festive season markets in crop-livestock production system.

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