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ORIGINAL ARTICLE

On-farm Evaluation of Enset (*Ensete ventricosum*) Leaf Supplementation on Does' Milk Yield and Composition and Growth Rates of their Kids

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ABSTRACT

On-farm study was conducted to evaluate the effects of enset (*Ensete ventricousm*) leaf supplementation on doe's milk yield and composition and growth rates of their kids. Forty-eight pregnant does were randomly divided into four feeding groups of twelve animals per treatment in a completely randomized design. Each treatment was further divided into three replications of four animals per replications. The treatments were: grazing only (T1), 74 g + grazing (T2), 148 g + grazing (T3) and 220 g + grazing (T4) on dry matter (DM) basis of enset leaf supplementation. Kids were allowed to suckle their dams during daytime up to 90 days and milk was measured every morning after overnight separation of kids and dams. Increasing the levels of enset leaf increased ($p<0.05$) enset leaf DM intake. The crude protein intake at a higher level (T4) was higher ($p<0.05$) than that of T3 and T2. Milk yield was higher ($p<0.05$) in the supplemented does than non-supplemented ones. The average milk yield (liter/day) was observed to be 0.37, 0.59, 0.50, and 0.45 for T1, T2, T3 and T4, respectively. Growth rates of kids from the supplemented does were higher ($p<0.05$) than the non-supplemented ones. The average daily gain (g) was 79.3, 90.4, 99.1 and 94.6 for T1, T2, T3 and T4, respectively. The highest ($p<0.05$) fat content was observed for T2 and the lowest for the control (T1) goats. Protein content of milk increased ($P<0.05$) with increasing levels of supplementation. Supplementary, feeding improved milk yield as well as protein and fat contents thereby enhancing the growth performance of the kids. It can, therefore, be inferred that supplementation of does with enset leaves can assist in overall improvement in family income and also nutrition of the small holder farmers in general in addition to improving the growth performance of kids.

Keywords: *Ensete ventricosum*, intake, milk yield, weight gain, goats

INTRODUCTION

Despite the large size of goat population in Ethiopia, the productivity per unit of animal and the contribution of this sector to the national economy is relatively low. This may be due to different factors one of which is inadequate quantity and poor quality of the available feedstuffs. Feed scarcity and poor quality are indicated as factors responsible for lower reproductive and growth performance of animals especially during the dry season (Legesse, 2008).

Natural pasture is the major feed sources for livestock in many parts of Ethiopia. However, productivity and availability of pasture is gradually decreasing because of increased cultivation area, overstocking and resultant overgrazing. Therefore, it is important to find alternative sources of supplement which could easily be obtained by farmers and have food-feed value. Such sources of supplement could be enset (*Ensete ventricosum*) under small scale production system in the southern and south western parts of Ethiopia. Enset is widely grown in southern Ethiopia mainly for human consumption. The leaves and leaf midrib of enset constitutes to 23 % of the total dry matter of enset (Nurfeta *et al*., 2008a) which is high in crude protein (Nurfeta *et al*., 2008a). Therefore, leaves of enset could be used as a source of protein supplement to poor quality feeds (Fekadu and Ledin, 1997; Nurfeta *et al*., 2008a). Enset leaves can play a significant role in supplementing the diet of animals, especially during the dry season and drought years. Nurfeta et al. (2008a) indicated that the use of enset as animal feed could play a significant role because of on-farm availability and easy access by farmers. Similarly, several studies indicated that enset can be a very important crop for livestock feeding particularly during the dry season (Nurfeta *et al*., 2008a; Nurfeta *et al*., 2008b).

Nurfeta *et al*. (2009) evaluated the intake and digestibility of different morphological fractions of enset in sheep feeding. Furthermore, the effect of different levels of enset as supplement to the basal diet of wheat straw on growth, feed intake, digestibility and nitrogen utilization were evaluated in sheep (Nurfeta *et al*., 2008a). However, there is lack of information on the effect of enset leaf supplementation on goats' milk yield and milk composition; and subsequent effect on the growth of kids especially under farmers' management conditions. Therefore, the objectives of this study were to evaluate the effect of supplementing graded levels of enset leaf on does milk yield and composition under grazing condition and to assess growth performance of kids where does are supplemented with enset leaf while grazing.

MATERIALS AND METHODS

Description of the study area

The on-farm experiment was carried out at Umbulo Wacho watershed which is located at 38^{o}17'E, 7'01N in Hawassa Zuria districts of Sidama zone, Southern Nations, Nationalities and Peoples Regional State, Ethiopia. It covers an area of 884 ha with approximately 1500 households. The elevation of the study area is 1820 m.a.s.l.

The rainfall in the area is bimodal pattern with two rainy seasons, the short rain occurs between March and May (peak in May) and the long rains between June and October (peak in September). The typical dry season normally occurs between November and February. Main crops in the area are maize (*Zea mays*), enset (*Enset ventricosum*) and beans (*Phaseolus vulgaris*). The types of soil in the study area are sandy loam with sand, silt and clay (Tadesse, 2007).

Enset leaf preparation

The feeding experiment was conducted at Umbulo Wacho watershed, Tankaka Kebele (the lowest local administrative unit of a district). This Kebele was selected because of its potential area for enset production and severe feed constraints. Each farmer harvested enset leaf from their own respective fields to feed the goats allocated to them. Fresh leaves were chopped to pieces (5-7 cm) prior to feeding them. The preparation of the feed was in the late afternoon for stall feeding during the night time. The leaf offered was weighed before feeding and the overall refusal was weighed at 7 AM the following day. The amount of feed consumed per day was obtained from the difference between feed offered and refusals. The experimental periods lasted for 90 days. Enset leaf intake was recorded only in those does which were supplemented with enset leaf.

Animals and their management

Forty eight pregnant Arsi-Bale goats of approximately 2 to 3 years old and between 1 and 3 parity and in the last trimester of gestation were bought from local markets in January 2010 and distributed to the farmers randomly. Information about age and parity of the goats were obtained from the owners during purchasing. Moreover, dentition was examined to ascertain the age. The does were distributed to 12 participating farmers (4 does per farmer = 12 goats per treatment) who were pre-selected. Animals were assigned to the following treatment in a completely randomized design: 1. Grazing only, 2. Grazing + 74 g DM enset leaf, 3. Grazing + 148 g DM enset leaf, and 4. Grazing + 220 g DM enset leaf.

Initially it was planned to offer 100, 200 and 300 g DM/head/day enset leaf. However, due to the nature of the on-farm experiment and distance from the laboratory, DM could not be determined as planned and hence the realized offer was somewhat different from what was planned originally. Animals were allowed to graze/browse from 8:00 - 12:00 and 14:00 – 17:00 h and kept inside their pens at other times, which were constructed in the owner house. Animals were individually fed after their return from grazing during the night time. Two weeks of adaptation period was allowed to enable the animals to adapt to the supplement. Before the commencement of the experiment, all goats were ear-tagged and dewormed with thiabendazole and sprayed with acaricide (Asuntol) solution against internal and external parasites as prescribed by the manufacturers, respectively.

Estimation of milk production

All the kidding took place from February to March 2010. Kids were allowed to suckle their dams for the first 14 days after birth and no milk measurement was taken during this period. Complete hand milking of dams was carried out once daily in the morning after overnight separation of kids from their dams. In order to induce milk secretions, kids were allowed to suckle their dams for a short time before hand milking. The amounts of milk consumed by the kids were taken as weight of kids after suckling minus weight before suckling. Total milk yield was the sum of hand milked milk and that was consumed by kids. The lactation period lasted for 14 weeks. Total weekly production was calculated by multiplying the daily yield by 7 and lactation yield as the sum over 14 weeks.

Birth and subsequent weights

Kid birth weight was taken within 12 hours after birth. Kids were ear-tagged at birth for identification. The subsequent kid weights were recorded at weekly interval until 14^{th} weeks of lactation.

Chemical analysis of milk samples

Three weeks after kidding, milk samples from individual does were collected in 100 ml plastic sample bottles three times per individual does at early, mid and late lactation. Milk samples for fat, protein and total solid analysis were preserved by the addition of 35% solution of formaldehyde and stored at 4^0C until analysis. Fat and total solids contents were determined as described by O'Connor (1994). Total protein content was determined by Kjeldhal method.

Chemical analysis of feed samples

The refusals were collected per individual animals every morning and bulked per household. The offered leaf was collected per households; sub-samples were used for chemical analysis. The enset samples (both offered and refused) were dried at 65^0C for 48 hours. Then the dried samples were ground to pass through a 1mm sieve using a Willey mill. The dried and ground samples were allowed to equilibrate with air at room temperature for 24 h after which they were stored in tightly tied plastic bags until chemical analysis.

The procedures of AOAC (1990) were used for determination of dry matter (DM), organic matter (OM) and total ash. The N content was determined by Kjeldahl method and CP was calculated as N×6.25. Neutral detergent fiber (NDF), acid detergent fiber (ADF) and lignin were determined according to the procedure of Van Soest and Robertson (1985).

Data analysis

ANOVA tests were performed using SPSS (2007). Mean comparisons were made using Duncan's multiple range test. The following models were used:

i) **Model 1:** The effect of level of enset leaf supplementation on nutrient intake of does

$Y_{ijk} = \mu + A_i + e_{ij}$ where Y_{ij} is nutrient intake of does (DM, OM, CP, ADF, NDF), μ is overall mean, A_i is the effect of level of enset leaf supplementation (i = No supplement, 74, 148, and 220 g DM enset leaf supplementation), E_{ij} is random error.

ii) **Model 2:** The effect of level of enset leaf supplementation, does parity and birth type on total lactation milk yield.

$Y_{ijkl} = \mu + A_i + B_j + L_k + AB_{ij} + e_{ijkl}$ where Y_{ijkl} is total lactation milk yield, μ is overall mean, A_i is level of enset supplementation (as indicated above), b_j is parity of does (i=2 parity 2 and 3), C_k is birth type (k=2, single and twin), AB_{ij} is feed type × parity interaction, e_{ijkl} is random error term.

iii) **Model 3:** The effect of enset leaf supplementation and parity of doe on milk composition

$Y_{ijkl} = A_{il} + A_i + B_j + e_{ijk}$ where Y_{ijk} is milk composition of does (% protein, fat and total solid content of milk), μ is overall mean , A_i is level of enset leaf supplementation (as indicated above), B_j is parity of does (j=2, 2^{nd} 3^{rd} parity), E_{ijk} is random error.

iv) **Model 4:** The effect levels of enset leaf supplementation, kid sex and birth type on kid daily weight gain.

$Y_{ijkl} = \mu + A_i + B_j + c_k + AB_{ij} + A_{cik} + e_{ijl}$ where Y_{ijkl} is kid daily weight gain, μ is overall mean, A_i=level of enset leaf supplementation to does (as indicated above), B_i is sex of kid (j=2, male, or female), C_k is birth type of kid (k=2, single or twin), AB_{ij} is A×B interaction, A_{cik} is A × C interaction, E_{ijkl} is random error.

RESULTS AND DISCUSSION

Chemical composition of enset leaf

The chemical compositions of feeds used in the experiment are shown in Table 1. The crude protein (CP) and digestible organic matter in dry matter (DOMD) contents were high in offered enset leaf compared to refusal, while refusal had high lignin, ADF, NDF and total ash content as compared to the offer. The CP content in leaf as estimated in the study was similar to the values reported by Nurfeta *et al*. (2008a) and Fekadu and Ledin (1997). The higher CP content in offer than refusal of enset leaf indicated that goats being selective feeders consumed the leaf lamina more than other leaf part (leaf midrib). Nurfeta *et al*. (2009) reported similar results in sheep fed different levels of enset supplemented with wheat straw. They indicated that provision of excess amounts of enset leaf may play a beneficial role in allowing selection for leaf lamina which is rich in protein over leaf midrib which is low in CP content. The observations in the study regarding selective feeding are in consonance with the observation of Owen (1994).

Table 1. Chemical composition (%) of enset leaf offered and refused

Types of Sample	Components						
	DM	Ash	CP	NDF	ADF	Lignin	DOMD
Offer	16.7±0	6.26±2	13.12±05	63.62±3	39.24±0.2	8.35±02	52.92±3
Refusal	16.7±0	10.09±3	10.3±0.2	66.08±5	44.21±02	10.09±3	45.27±3

DM, dry matter; CP, crude protein; NDF, neutral detergent fiber; ADF, acid detergent fiber; DOMD, digestible organic matter in dry matter

Feed intake of does supplemented with different levels of enset leaf

The feed intake of goats supplemented with different levels of enset leaf is presented in Table 2. The intake of DM, CP, OM, NDF and ADF increased with increasing levels of enset leaf. The result is in agreement with the observations of Nurfeta *et al*. (2009) who also reported a tendency of increasing intake of DM and nitrogen (N) with increasing levels of enset leaf supplementation. The authors also reported that among the enset fractions, the highest CP intake was observed in those sheep fed enset leaf and the intake of digestible OM and N were highest at higher levels of supplementation for both pseudo-stem and corms diet. Moreover, Nurfeta *et al*. (2008a) observed variations in chemical composition in leaves of enset collected from ten enset varieties. It is possible that different enset varieties might be kept by different households. This in turn could affect the levels of intake and refusal. However, in the current experiment intake varied with levels of supplementation.

Table 2 .Average[†] feed intake of grazing does supplemented with different levels of enset leaf

Intake (g/day)	Level of enset leaf supplementation (g DM)			SEM
	Grazing + 74 (T2)	Grazing + 148 (T3)	Grazing + 220 (T4)	
DM intake	73.9[a]	145.2[b]	220[c]	2.3
Crude protein intake	9.8[a]	19.5[b]	29.5[c]	0.3
Organic matter intake	63.8[a]	136.2[b]	206.3[c]	2.1
Neutral detergent fiber	47.1[a]	92.4[b]	139.9[c]	1.4
Acid detergent fiber	29.0[a]	56.8[b]	86.5[c]	0.9

[†]Row means with different superscript letters are significantly different ($P<0.05$); SEM, Standard error of the mean.

The observations are similar to that of Tolera and Sundstøl (2000) who also reported improvement in DM intake in lambs supplemented with varying level of *Desmodium intortum* hay to basal diet of crop residue. According to McMeniman *et al*. (1988) an ideal supplement should increase or at least maintain intake of fibrous basal diet. Nurfeta (2010) also reported that total CP intake and N retention increased with increasing levels of legume hay in both pseudostem and corm diets. In the current experiment, despite increment in the intake of nutrients, does milk yield and growth rate of kids fail to increase linearly above T2 which could be due to the poor utilization of enset leaf.

Effect of different levels of enset leaf supplementation on milk yield and composition of grazing does

The results of milk yield and composition are given in Table 3. The total milk yield in the non-supplemented goats were lower ($p<0.05$) than the supplemented groups. As noted earlier (Table 2), there was increased CP intake with increasing levels of enset leaf, which could be the contributing factor for high milk yield. It was indicated that protein supplementation improve milk production in dairy goats (Negesse *et al*., 2001). There was no significant difference between T3 and T4 in milk yield but the yields in these groups were significantly higher than T2. Similarly, improvement in nutritional regime was reported to increase production (Greyling *et al*., 2004) which is mainly affected by feed intake.

The milk yield as obtained in the study was comparable with those of non-dairy goat breed in the tropics, which produce up to 0.5 liters of milk as reported by Tekele *et al*. (2006). According to reports from FARM-Africa (1996), daily off-take of 0.25 to 0.5 liters was recorded in the highlands of Sidama.

Table 3. Mean† total milk yield and milk composition of does supplemented with different levels of enset leaf

	Level of enset leaf supplementation (g DM)			
Variable	Grazing alone (T1)	Grazing + 74 (T2)	Grazing + 148 (T3)	Grazing + 220 (T4)
N	11	12	12	11
Total milk yield (lit/lactation)	33.0 ± 2.08^{a}	53.5 ± 2.0^{c}	45.1 ± 2.31^{b}	40.6 ± 2.44^{b}
Milk yield (lit/day)	0.37 ± 0.1^{a}	0.59 ± 0.2^{c}	0.50 ± 0.1^{b}	0.45 ± 0.1^{b}
Milk Composition:				
N	33	36	36	33
Protein (%)	3.5 ± 0.12^{a}	3.7 ± 0.11^{a}	3.8 ± 0.12^{ab}	4.1 ± 0.14^{b}
Fat (%)	4.2 ± 0.17^{a}	5.4 ± 0.16^{c}	4.9 ± 0.18^{b}	4.8 ± 0.20^{b}
Total solid (%)	13.4 ± 0.15^{b}	13.1 ± 0.15^{ab}	12.7 ± 0.16^{a}	13.3 ± 0.18^{b}

†Row means with different superscript letters are significantly different ($P<0.05$)

Min *et al*. (2005), in their study, indicated that increasing the levels of nutrition would lead to an increase in daily milk yield. Similarly, increasing the levels of supplementation increased the amount of milk produced in Begait and Abergelle goats (Berhane and Eik, 2006). In the current study, increment in enset leaf level beyond low level (T2) did not improve the milk yield even though the yield was higher than that of the control group (T1). This could be due to the low degradability (Nurfeta *et al*., 2008a) and digestibility (Nurfeta *et al*., 2008a) of enset leaf.

There was no significant difference on milk yield among parities (Table 4) though numerically parity one produced less milk compared with the other parities which is contrary to literature information. Carnicella *et al*. (2008) indicated that goats in the 3rd and 4th lactation produced more milk compared with the first lactation. Does with twins had more ($p<0.05$) milk yield as compared to those that had singles (Table 4), the observations being in agreement with that of Carnicella *et al*. (2008). However, Browning *et al*. (1995) reported that does with single kids produced more milk than those bearing the twins. As reviewed by the same author, the increase in milk yield could be due to increased secretion of placental lactogen or removal of local negative feedback regulatory inhibition.

Table 4. Effect of parity and birth type on milk yield

Variable	N	Weekly mean milk yield (liters)
Parity:		
1	5	2.97±0.26[a]
2	21	3.03±0.12[ab]
3	20	3.12±0.13[ab]
Birth type:		
Single	36	2.74±0.1[a]
Twins	10	3.34±0.18[b]

Column means (for the same variable) with the different superscripts letters are different ($p<0.05$).

The composition of milk could vary considerably depending on the breed, stage of lactation, age and health status. Herd management practices, environmental conditions also influence milk composition (O'Connor, 1994). The protein content of milk for T4 was higher ($p<0.05$) than that of T1 and T2 (Table 3). There were no significant differences among T1, T2 and T3 in protein content. The highest ($p<0.05$) fat content was for T2, while the lowest was for T1 goats. The fat content for T3 and T4 were similar. The total solids were similar for T1, T2 and T3. There was no significant difference on protein and fat content among parities (Table 5). The similarity in fat and protein content among the different parities is not consistent with the study by Carnicella *et al*. (2008) who observed higher fat and protein content in the first lactation.

Table 5. The effect of parity on milk composition (%)

Number of parity	Protein	Fat	Total solid
1	3.57±0.2	4.73±0.35	14.15±0.29[a]
2	3.72±0.09	4.73±0.16	13.15±0.14[b]
3	3.80±0.9	4.92±0.14	13.08±0.14[b]

Column means with the different superscripts letters are different ($p<0.05$).

Effect of enset leaf supplementation on body weight gains of kids

Mean daily weights of kids born by does supplemented with different level of enset leaf are presented in Table 6. Supplementation significantly improved the weight gain of kids compared with T1 (control group). There was no significant difference in final weight gain of kids among the supplemented does but supplementation of lactating does significantly ($p<0.05$) improved growth performance of kids compared with non - supplemented does. This result is comparable with that of Abebe (1996) who indicated that kids suckling supplemented dams were heavier than kids suckling non-supplemented dams. The same author reported that weaning weight was higher by 25.8% for kids suckling supplemented does. Das and Sendalo (1990) reported that single-born kids had higher growth rates than twin born kids, which disagree with the present results. The same author also reported that male kids were heavier and grew faster than female kids, which is contrary to the current experiment. Abebe (1996) reported that differences in weight development between male and female kids were noticeable from early stage of lactation.

Kids weight was significantly ($p<0.05$) affected by enset leaf supplementation. Growth rates of kids may vary which could be largely to the different environments and supplementary feeding practices. The quality and quantity of feed available to the does and the kids, therefore, contributed significantly to final weight.

Table 6. Mean† daily weight gain (g) of kids born by does supplemented with different level of enset leaf

		Level of enset leaf supplementation (g DM)			
Body weight change	N	Grazing alone (T1)	Grazing + 74 (T2)	Grazing +148 (T3)	Grazing + 220 (T4)
Initial (kg)	55	3.7±0.23	3.38±0.22	3.06±0.22	3.56±0.23
Weaning weight (kg)	55	10.9±0.27[a]	11.5±0.27[b]	12±0.28[b]	12.1±0.29[b]
Total gain (kg)	55	7.1±0.23[a]	8.1±0.22[b]	8.94±0.23[b]	8.5±0.24[b]
Average daily gain (g)	55	79.3± 2.58[a]	90.4± 2.49[b]	99.1± 2.56[b]	94.6 ±2.68[b]

†Row means with different superscript letters are significantly different ($P<0.05$)

In the present study, increasing the levels of enset leaf supplementation resulted in an increase in growth rate and average daily gain of kids born from supplemented does when compared with kids which were born from non-supplemented does. The average daily gain was higher ($p<0.05$) for kids suckling supplemented does than non-supplemented does. This was in agreement with results observed by Santra *et al*. (2002), who reported that limited amounted of concentrate supplementation in free grazing goats improved body weight gain as well as finishing body weight of kids.

CONCLUSION

This study indicated that enset leaf supplementation improved milk yield, milk composition and kids' body weight gain. Despite increasing levels of enset leaf supplementation and subsequent increase in intake, does at high levels fail to respond accordingly. Therefore, further work is necessary aiming at increasing the efficiency of utilization of enset leaf.

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