Global Journal of Research in
Multidisciplinary Studies
Journal homepage: https://gsjournals.com/gjrms/
ISSN: 2980-4191 (Online)

(RESEARCH ARTICLE)

Feed intake, body weight gain and partial budget analysis of yearling Woyto-guji goats supplemented dried moriga (*M. stenopetalla) leaflet as replacement of* concentrate mixture

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Global Journal of Research in Multidisciplinary Studies, 2022, 01(01), 022–029

Publication history: Received on 28 August 2022; revised on 07 October 2022; accepted on 11 October 2022

Article DOI: https://doi.org/10.58175/gjrms.2022.1.1.0025

Abstract

This study evaluated feed intake, body weight gain, and economic feasibility of yearling woyto-guji goats supplemented with dried moringa leaflets (DMLt) as a substitute for concentrate mixture (CM). Twenty intact bucks with an average initial body weight of 21.5 ± 0.38 kg were selected from the Baide community-based breeding program (CBBP) and assigned to one of the five treatment feeds in a completely randomized block design as: (T1= Grazing + 300 g CM, T2= Grazing + 75 g DMLt + 225 g CM, T3 = Grazing + 300g DMLt, T4 = Grazing + 225g DMLt + 75 g CM and T5= Grazing only). Supplemental feeding of air DMLt in the current experiment influenced the performance of animals by providing higher feed intake and weight gain as compared to control (T5). The ADG results for T1, T2, T3, T4, and T5 were 119 g, 105 g, 111 g, 110 g, and 85 g respectively with T1 acquired better than other treatments. Bucks fed under T1 had considerably higher DMI and FCE, with values of 1.39% bwt and 11.9% ADG, respectively. The partial budget analysis's findings, however, indicate that air DMLt (T3) supplementation was economically dominant and is, thus, advised for the initiation of yearling bucks' growth in accordance with the producer's goal. However, further study should be done to improve the limitation on the intake of moringa leaflets which may be a potential source of nutrients for Woyto-guji goats of the indicated age and other ruminants.

Keywords: Moringa leaflet; Replacing; Supplementation; Concentrate mixture; Yearling goats

1 Introduction

As wellsprings of animal protein and an action against food frailty, goats play an essential role in the economy of rural households in Ethiopia. They provide meat, milk, and skins, as well as income (Daramola et al., 2005). Goat meat is popular in most developing nations because of its moderateness and more slender than the meat of other animals (Celik et al., 2003). However, suboptimal rearing systems, in which goats are adversely affected by variations in the quantity and quality of feed, generally result in low goat productivity. To increase the productivity of goats and hence their contribution to food and nutrition security, it is necessary to supplement them during the critical periods of feed inadequacy.

Because of confined concentrates supplementation under smallholder livestock production systems as consequence of insufficiency and the exorbitant cost of commercial concentrates (Nurfeta, 2010) there is a quest for elective eccentric and modest feed sources that might contain significant components of animal eating regimens and can easily be delivered and promptly accessible to farmers. Use of fodder tree products like moringa (*M.stenopetala*) leaflet could be a potential approach for iimproving the quality and availability of feeds for resource-poor livestock farmers like in Konso, southern Ethiopia.

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Moringa is quite possibly of the fast growing tree on the planet with high biomass yield, high rough protein of up to 31%, and an impartial level of other nutrients on the leaves/leaflets (Moyo et al., 2011; Gopalakrishnan et al., 2016 and Aberra et al. 2017). It is widely distributed in the lowland parts of Konso, Derashe and Gamo zones and is utilized as vegetable food for human consumption (Takele et al., 2014). The consumable parts of the tree are extraordinarily nutritious (Teferi, 2008) and brimming with leaves during the dry season even, when different fodders are typically scant (Takele et al., 2014). There are a number of individual and emerging commercial farms cultivating and processing moringa products (dry milled leaves) for sale in local markets and export to other parts of the world. Immense amount of leaflets were therefore produced in the area during collecting for leaves yet farmers just pick leaf part for food while unloading different segments including leaflets as a waste and the potential of this items as a significant browse plant for small ruminants has not be fully assessed with live animals. Thus, Current experimental work was intended to achieve the accompanying two goals.

Objectives

- To evaluate feed intake, weight gain and partial budget of yearling woyto-guji goats supplemented dried M.stenopetala leaflet.
- To determine *M. stenopetala* leaflt as a cheapest source of supplementary feed to replace concentrate mixture.

2 Material and Methods

2.1 Study location

The study was conducted at Arbaminch Agricultural Research Center found in Arbaminch town, Southern Ethiopia which is located at 5°70''-6°21''N latitudinal and 37°31"-37°67"E longitudinal lines. The place is categorized as hot to sub-moist lowland agro ecological zone of SNNPR region with an altitude of 1200 – 3310 masl. Its mean annual rainfall ranges from 800 - 1200 mm and the mean annual temperature ranges from 16 to 37 °C (CSA, 2012).

2.2 Feed preparation and feeding management

Leaflets of *M.stenopetalla* were gathered during the harvesting of leaves for human use and processing for markets from the Main stations of Arbaminch Agricultural Research Center's and Baide substation. Moringa leaflets were harvested manually with leaf picking method and immediately, they were spread thinly on plastic sheet under shed in well ventilated room for drying with turning of 10-12 times/day. Finally, they were ground into meal using mortar and pestle and a milled form of leaflet was given to animals. Wheat bran (WB) and noug seed cake (NSC) were purchased from Muza animal feed production company found in Arbaminch city.

2.3 Experimental animals' management

Twenty five (25) unblemished yearling Woyto-guji bucks with an initial weight of 21.5 were chosen from Baide community based goat breed improvement program (CBPP) found in Konso Zone, Southern Ethiopia. The bucks were treated against internal and external parasites with Albendozole and Vetazinon 60% EC, respectively as per the recommended dosage. They were also vaccinated against ovine pasturelosis which is the most common disease in the area, and housed in individual pens equipped with feeding and watering troughs. They were adapted to experimental feeds for 15 consecutive days followed by 90 days of feeding trial. Besides, each experimental goat had free access to fresh water daily.

2.4 Experimental design and treatments

A randomized complete block design (RCBD) was used for the experiment, with five treatments and five animal units serving as a replication. The experimental animals were randomly assigned to the dietary treatments within the block based on the initial body weight of the bucks. The average initial body weights of the bucks in each group were 21.56, 21.52, 21.46, 21.46 and 21.48 kg for T1, T2, T3, T4 and T5, respectively. The supplements were prepared iso-nitrogenous having almost the same 30% CP and they were offered according to recommendation of Ranjhan (2004) to meet daily CP requirements of 108 g for growing bucks with body weight of 25 kg to get daily gain of 100 - 120 g.

The dietary treatments included grazing on natural grasses and supplementation with 100% CM (T1); 75% CM + 25% DMLt (T2); 100% DMLt (T3), 25% CM + 75% DMLt (T4); and Grazing only (T5) on DM basis as indicated in Table 1. Goats were allowed to graze 8:00 hours per day along with free access of water and the supplements were given twice daily in equal quantities at 7.00 am and 5.00 pm to each experimental goats.

Table 1 Experimental treatments

Treatments	Basal diet	Daily supplements	
		Con. mix (g/d)	DMLt (g/d)
T1	Grazing	300 g/100%	0
T2	Grazing	225 g/75%	75 g/25%
T3	Grazing	0	300 g/100%
T4	Grazing	75 g/25%	225 g/75%
T5	Grazing	0	0

T1: Treatment 1, T2: Treatment 2, T3: Treatment 3, T4: Treatment 4, T5: Treatment 5, Con.mix: Concentrate mixture, DMLt: Dried moringa leaflet and g/d: Gram per day

2.5 Feed intake and body weight measurements

The amounts of feed offers and refusals for each buck were recorded every day throughout the exploratory period and the DM intake was determined as difference between measures of feed offered and feed refusals on DM basis. The body weight measurement was taken fortnightly for each buck for the whole experimental period after overnight fasting. The experimental bucks' initial body weight was measured at the end of adaptation period while their final weight was measured at the end of feeding trial (growth period). The average daily gain (ADG) of the bucks was determined by deducting initial body weight from final weight and dividing in to the number of feeding days. The ratio of daily DM intake to ADG was used to determine Feed conversion efficiency.

2.6 Partial budget analysis

The partial budget analysis was performed to determine cost benefit analysis of substitution of DMLt for CM as supplement to Woyto-guji goats. Variable costs included feed costs for both DMLt and CM supplement consumed. Total return (TR) was determined by subtracting purchasing prices of experimental bucks from their estimated selling prices. Net return (NR) was calculated as the difference between TR and total variable costs (TVC) while change in net return (ΔNR) was calculated as difference between change in total return (ΔTR) and change in total variable costs (ΔTVC). The increase in net income (ΔNR) corresponding to each increased unit of expenditure (ΔTVC) is measured by the marginal rate of return (MRR). This is expressed by percentage as MRR% = (ΔNR / Δ TVC) X 100 and annual financial rate of return (AFRR) to feeding was calculated using the formula (Baur et al., 1989): AFRR = [(R-C)/C*(365/t)]*100% 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 return was decomposed into its compounds (price, weight and their interaction) 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 into its components the following formula was used: 100% = {(DP*Wi +DWPi +DP*DW)/M}*100% where; DP= the difference between sale price and purchase price; DW= 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 in prices of input (feed) and fattened goat. Price variation can occur in input and output. Thus, these variations were considered in the sensitivity analysis.

2.7 Statistical analysis

The data obtained from the experiment were subjected to analysis of variance (ANOVA) using the general linear model procedure of SAS version 9.2 (SAS, 2008). Significant treatment means were compared using Tukey's student zed range (HSD) test. The statistical model used for the data analysis was: $Yij = \mu + \tau i + \beta j + \varepsilon ij$, where Yij = response variable; μ = overall mean; τi = effect of treatment i; βj = effect of block j and εij = random error.

3 Results and Discussion

3.1 Weight change, DMI and FCE of yearling goats supplemented either CM or DMLt

The weight change, ADG, DM intake and FCE of goats during the 90 days feeding trial are presented in Table 2. The average initial weight, final weight, daily gain, DMI and FCE were 21.50 kg, 31.05kg, 106 g, 1.33% bwt and 10.61 g/day respectively. The initial and final weight of goats did not differ significantly across treatments. Gebru et al. (2017)

observed similar negligible results for ultimate body weight, ADG, and FCE for Abergelle sheep supplemented with dried mulberry leaf meal consisting of wheat bran and NSC, and Worku (2015) for Arsibale goats supplemented with graded level of dried mulberry leaf. Final weight and average daily gain of goats in none supplemented treatment group was 29.16 kg and 85 g/day, respectively.

Goats supplemented with sole concentrate mixtures (T1) had significantly ($p<0.05$) higher final weight gain (10.7 kg) and average daily gain (119 g/day) than the none supplemented goats followed by supplemented with sole DMLt (T3) whereas all the supplemented groups were not different ($p>0.05$) from each other reflecting the fact that the supplements were comparable in their potentials to supplying nutrients for growth of yearling goats. The increased daily weight gain for concentrate supplemented groups in the present study can be attributed to the higher protein and energy intakes and the results observed in current study was comparable to the reports of different studies. It was higher than ADG of 76.2 g and 86.2 g (Gonzalez and Milera, 2000); and between 80 g and 90 g (Martin et al., 2014) but was slightly lower than 121 g (Miller et al., 2005) for goat breeds supplemented with mulberry leaves.

Table 2 shows that T1 had the highest DM intake, followed by T2. The unexpectedly lower DM consumption attributed with solitary DMLt supplementation in current experiment could be due to the existence of greater fiber content in *M.stenopetala* leaflet. The goats in T1, had significantly ($P<0.05$) higher feed conversion efficiency followed by T3, T4 and T2 and T5 had significantly ($P<0.05$) lower FCR whereas, there was no significant ($P>0.05$) difference in FCR among T1 and T3. Similar observation for FCE has been reported on Tigray highland sheep with supplementation of 200 g wheat bran and 400 g air dried Acacia saligna leaves by Gebru, (2012) and with supplementation of 306 g sole wheat bran by Berihe et al., (2014).

Though it had a slightly lower DM intake, supplementation of DWLt as a replacement of CM in the diet of bucks had positive influence and improved ADG gain, Final weight gain and FCE while there observed no significant difference in most measured parameters between DWLt and CM supplemented diets reflecting that DWLt could be a possible replacement of CM in goat's diet specially during dry seasons where there is low accessibility of green grasses but further research need to be applied to improve the intake and digestibility of M.stenopetalla leaflet.

Table 2 Mean body weight gain, DM intake (kg/day) and FCE of yearling Woyto-guji goats fed DWLt supplemented diets as a replacement of Concentrate mixture

Items	**Treatments**					**P-value**	**CV%**
	T1 (Sole CM)	**T2**	**T3 (Sole DMLt)**	**T4**	**T5**		
Initial weight	21.56^{a}	21.52^{a}	21.46^{a}	21.46^{a}	21.48^{a}	1.000	9.0
Final weight	32.28^{a}	31.02^{a}	31.42^{a}	31.36^{a}	29.16^{a}	0.099	5.4
FWG (kg)	10.72^{a}	9.50^{ab}	9.96^{ab}	9.90^{ab}	7.68^{b}	0.043	15.0
ADG (kg)	0.119^{a}	0.105^{ab}	0.111^{ab}	0.110^{ab}	0.085^{b}	0.043	15.0
DMI (%,bwt)	1.39^{a}	1.38^{a}	1.25^{b}	1.28^{b}	-	0.001	2.0
FCR (%,ADG)	11.91^{a}	10.56^{ab}	11.07^{ab}	11.00^{ab}	8.53^{b}	0.043	15.0

bwt: Bodyweight, CV: Coefficient of variation, %: Percent, FWG: Final weight gain, ADG: Average daily gain, DMI: Dry matter intake, FCR: Feed conversion ratio

3.2 Partial Budget analysis

The partial budget analysis was conducted to assess the economic benefit of moringa leaflet supplemented to grazing woyto-guji goats under semi-intensive management condition. The partial budget analysis indicated that yearling woyto-guji goats supplemented for 90 days with CM consisted 90 g NSC + 210 g wheat bran (T1), 225g CM + 75 g moringa leaflet (T2), 300 g moringa leaflet (T3), and 75g CM + 225 g moringa leaflet (T4) was found to give a net return of Birr 441,402, 780 and 665 per head, respectively. On the other hand the net return of 552 birr per head was generated from none supplemented groups (T5).

According to present results from partial budget analysis, feed supplement of 300g moringa leaflet (T3) and 75 g CM with 225 g moringa leaflt (T4) showed higher net profit of yearling goats but was not found to be economically feasible compared to the none supplemented groups (T5). The result suggested that supplementation with CM, Moringa leaflet and their mixtures for woyto-guji goats under grazing condition was not potentially profitable compared with no

supplementation (grazing only). The potential reason for this condition was likely due to the better feed availability in the current study area and during the time of the study the pasture condition was good both in quality and quantity. This better feed situation of the area might favour those genes responsible for better growth rate. That is why supplemented and none supplemented groups of goats gained live weight though the magnitude of gain has differed between the two groups. The second possible reason was an attractive market price during the time of animal selling and slightly lower feed intake attributed by goats under dried moringa leaflet supplementation.

From the results of the current study, it can be concluded that in areas where concentrate mixtures and moringa leaftlet are available at required time, quantity and reasonable price, finishing of yearling woyto goats at a level of 300 g/head/day for 3 months was profitable. But compared to the control group it is imperative to consider additional research works which may include treating of moringa leaflets to improve its intake by animals (May be good if fed as fresh base or silage making to break fiber) and strategic time of supplementation particularly in dry season. Similar result was reported by Thegaye (2009) on yearling Metema goats.

Table 3 Average expenditure and benefits of yearling goats supplemented MSLt (ETB)

Items	**Treatments**					
	T1 (Sole CM)	**T2**	**T3 (Sole Mlt)**	**T4**	**T5**	**G. mean**
Expenditures						
T. expense	3432	3320	2990	3098	2947	3158
F. costs	507	507	507	507	507	507
V. costs	2926	2814	2484	2592	2440	2651
Benefits						
GFSA	3874	3722	3770	3763	3499	3726
G. return	1714	1570	1624	1617	1351	1575
N. return	441	402	780	665	552	568
Rate of returns						
MRR	15.5	14.4	31.2	26.3	23.3	22.1
AFRR	100.9	99.5	137.8	127.0	123.9	117.8

GFSA: Gain from sell of animal, T.: Total, F.: Fixed, V.: Variable, G. Gross, ETB: Ethiopian birr, MRR: Marginal rate of return, and AFRR: Annual financial rate of return, CM: Concentrate mix, Mlt: Moringa leaflet, T1-T5: Trearments

3.3 Components of the gross margin

The results from the gross margin analysis when described as percentages of financial return also indicates that weight gain, as a whole, accounted for 95.54% of the gross margin while price changes and the interactions accounted for 3.09 and 1.37%, respectively (Table 4). This suggests that weight gains over the feeding periods played an important role in the determination of profitability.

Table 4 Different components of the gross margin

Treatments	**Components of gross margins (%)**			**Weight gain overprice (folds)**
	Price	**Weight**	**Interaction**	
T1	2.70	95.89	1.41	35.51
T2	3.06	95.57	1.37	31.23
T3	2.94	95.71	1.35	32.55
T4	2.98	95.64	1.38	32.10
T5	3.78	94.87	1.36	25.10
Average	3.09	95.54	1.37	31.30

3.4 Sensitivity analysis

The sensitivity analysis hypothesized for 20% increase in concentrate feed and 10% decrease in selling price of goat to capture the likely change of price of input and fattened goat is summarized in table 5. In agricultural production, decrease or increases in input and output price have great impact on farmers' return (Kebede et al., 2011). Apart from purchase price which constituted about 68.3% of the total production cost, feeding was the most expensive commodity ranging from 11.3% to 22.4%. A 20% increase in concentrate feed price would decrease the return per head by 65.1%, 67.1%, 91.3%, 86.6% and 100% for T1, T2, T3, T4, and T5, respectively. The result indicates that it is better for the farmers to reduce the utilization of concentrate in the ration and look for cheaper feed sources that could substitute, commercially, produced feeds. Accordingly the use of moringa leaflet is vital in this case to fetch good profit.

Table 5 shows that a 10% drop in the selling price of fattened goats will result in a 12.2%, 7.4%, 51.7%, 43.4%, and 36.6% loss in net return in ETB/head for T1, T2, T3, T4, and T5. Since the purchase price accounts for more than 68% of the total cost of production, the analysis revealed that feeding the goats was significantly affected by changes in the selling price of fattened goats, particularly for those fed Moringa leaflet/T3, 75% moringa leaflet/T4 and control/T5.

Table 5 Sensitivity analysis of net return for 20% increase in feed price and 10% decrease in selling price of fattened goats

Variables	**Treatments**				
	T1	**T2**	**T3**	**T4**	**T5**
NR0 (ETB)	441.1	401.9	779.9	664.7	552.2
NR1 (ETB)	287.2	269.6	712.4	575.6	552.2
NR2 (ETB)	53.7	29.7	402.9	288.4	202.3
ΔNR1 (ETB)	65.1	67.1	91.3	86.6	100
ΔNR2 (ETB)	12.2	7.4	51.7	43.4	36.6
Feed cost over total cost of production (%)	22.4	19.9	11.3	14.4	0
Purchase price over total cost of production (%)	62.8	64.8	71.8	69.3	72.9

NR0: Initial net return without an increase in feed price and a decrease in selling price; NR1: Net return with 20% increase in feed price without a change in selling price; NR2: Net return with 10% decrease in selling price without changes in feed price; ΔNR1 (%): percentage change in net return with 20% increase in concentrate without a change in selling price; ΔNR2 (%): percentage change in net return with 10% decrease in selling price without a change in feed price

4 Conclusions

Most of the supplementary treatments in current experiments provided comparable results in terms of body weight gain, feed conversion efficiency and most nutritional parameters measured except for lower DMI with Sole DMLt (T3) which may need further investigation. The net return and ΔNR parameters in the partial budget analysis showed that sole DMLt supplementation (T3) had highest economical gain over all the dietary treatments except control (T5) which was almost comparable with T3. The unfeasible result when compared with control occurred in current study may be due to lower intake and the time of the trail which was conducted during the high access of green feeds. Hence, it seems economical to substitute DMLt for CM contained wheat bran and NSC for Woyto-guji bucks reared under smallholder farmer especially during dry season where there is scarcity of green feeds.

Compliance with ethical standards

Disclosure of conflict of interest

The authors declare that the publication of this manuscript does not present any conflict of interest.

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