

Full Length Research Paper

Market weight and carcass characteristics of intact yearling afar goats under semi-intensive feeding management

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This study was conducted at Werer Agricultural Research Center with the objective to investigate the effect of diets on growth and carcass characteristics and to identify the economic ration and duration required to meet the market body weight (25 to 30 kg) of Afar goats under semi-intensive feeding management. Grazing goat kids were supplemented with a concentrate mix composed of 75% Leucaena leaf (LL) hay (300 g/day per head): 25% wheat bran (WB) (100 g/day per head) for T1, 50% LL hay (200 g/day per head): 50% WB (200 g/day per head) for T2 and 25% LL hay (100 g/day per head): 75% WB (300 g/day per head) for T3. No supplementation provided for goats in the control group (T4). Accordingly, goats that received T2 had significantly higher ($P<0.05$) total dry matter (DM), organic matter (OM) and crude protein (CP) intake than supplemented goats in the remaining dietary treatments. As a result, the average daily weight gain of goats maintained under T2 found significantly higher ($P<0.001$) than those of treatments and control groups. Moreover, supplementation after grazing with WB and LL hay mixture tend to have increased live weight ($P<0.001$), carcass yield ($P<0.01$) and carcass characteristics ($P<0.01$) of experimental goat kids. Supplemented yearling goats attained slaughter weight in a range of 28 to 30 kg within about 168 days from the start of the experiment period as compared to the 24 kg weight recorded for goat kids managed as control group. Besides, 25 and 50% WB concentrate supplementation after grazing provides more profit than 75% WB and grazing without supplementation of yearling Afar goat.

Key words: Afar goat, semi-intensive, wheat bran, leucaena leaf, supplement feeding, carcass yield.

INTRODUCTION

Sheep and goats in Ethiopia form important economic, social and cultural functions and represent an important component of the mixed farming systems in the highland and extensive pastoral and agro-pastoral production systems in the lowland. Their contribution for income generation, food supply and financial security for the rural population is indispensable.

Geographic proximity of Ethiopia to high sheep and goat meat importing countries of the Middle East countries gives relative advantage in exploiting the organic meat demanding markets. Thus, the high demand for Ethiopian sheep and goat meat in these regions is one of the most important factors encouraging the development of sheep and goats production industry in Ethiopia. The

export market obviously demands goats that weigh up to 25 to 30 kg at yearling age. Whereas, indigenous goat breeds are commonly slaughtered at around yearling age having body weights of 16 to 18 kg (EARO, 1999). Moreover, the abattoirs' market in the country is constrained by lack of consistent and uniform supply of the required weight at yearling age (Getachew et al., 2008).

The market supply of sheep and goat originates from highly dispersed small producers that supply non-homogenous animals in small numbers to the local markets. Currently, due to the low productivity of these animals and the absence of market-oriented production systems in the livestock sector, the volume of market surplus is very low (Belachew and Jemberu, 2003). Besides, poor link between producers and other actors in the chain to the critical support services, live animals supplied to the market by pastoralist and farmers do not meet the quality attributes required by the market (Asfaw and Jabbar, 2008).

Feed and water scarcity in quality and quantity is among noted production constraints along the value chain (Getachew et al., 2008). Feed production covers requirements only in exceptional good years; the deficit reaching 35% in normal years and 70% in bad years (FAO, 2005). Developing feeding packages that support the existing traditional production and the emerging private producers and exporter is the timely intervention to increase production and productivity in order to meet the demand for meat and live animal export market (Asfaw et al., 2011). Therefore, this study was conducted to investigate the effect of diets on growth and carcass characteristics, and to identify the economic ration and duration required to meet the market weight (25 to 30 kg) of yearling Afar goats under semi-intensive feeding systems.

MATERIALS AND METHODS

Description of the study area

This study was conducted at Werer Agriculture Research Center located at an altitude of 740 masl to the southern part of Afar region where pastoral livestock production system practicing. The climate is typically semi-arid with short rainy season of 2 to 3 months duration with average rainfall of 590 mm. Monthly average temperature of the area is 26.7°C (15 to 37.8°C). Vegetation cover of the area is mainly consisting of sparse cover of low shrubs and closed thickets of bush such as *Acacia millifera*, *Acacia senegal*, *Acacia tortilis*, *Prosopis juliflora*, *Commiphora* spp. and *Avena* spp. plus associated grasses like *Aristida*, *Chloris*, *Entropagon*, *Panicum* and *Cynodon* species are the dominant vegetation.

Experimental animals, their management, and treatment

Forty-eight yearling intact male Afar goat kids with initial body weight of 13.54±0.14 kg purchased from local markets. All the kids were ear tagged and treated against internal and external parasites before the commencement of the experiment.

The experimental animals randomly allocated into four treatment

groups. Each group contains twelve animals and all groups allowed grazing on natural pasture during daytime. The goat kids separated into their respective treatment groups and supplemented after grazing in their pens. The ration ingredients consisting of Leucaena leaf (LL) hay and wheat bran (WB) mixture formulated based on daily DM requirement of the animals. Half of the daily requirement supplemented to the experimental animals assuming that the animals secure half of their DM requirement from grazing. Accordingly, the treatment feeds contain; T1= 75% LL hay (300 g/day per head) and 25% WB (100 g/day per head), T2 = 50% LL hay (200 g/day per head) and 50% WB (200 g/day per head) and T3 = 25% LL hay (100 g/day per head) and 75% WB (300 g/day per head) on DM basis. Goat kids in the control group (T4) grazed only on a field with no supplementation. The supplementary ration, wheat bran and Leucaena leaf hay mixture, on average contain 22% CP and 10 MJ ME/ kg DM. The treatment feed gradually introduced into the animals' ration for two weeks adaptation period.

Animals supplemented in an individual pen right after return from grazing field. Supplementation done until the animals attained market weight of 25 to 30 kg. All experimental animals had full access to potable water. The total amount of feed offered and refused daily collected measured to determine the quantity of feed the goat kids consumed throughout the experimental period. Every morning the refusal collected, weighed on individual bases, and bulked for laboratory analysis. All goat kids weighed fortnightly on suspended weight balance of 200 g precision after they forced to fast overnight.

Feed chemical analysis

Dry matter (DM), ash, organic matter (OM) and crude protein (CP) of the offered and refused feeds were determined according to AOAC procedure (AOAC, 1990). Neutral detergent fiber (NDF) and acid detergent fiber (ADF) in feed samples analyzed according to Van Soest and Robertson (1985) procedure. *In-vitro* organic matter digestibility (IVOMD) determined according to the procedure of Tilley and Terry (1963). Metabolizable energy value of the feed samples estimated from the %IVOMD; $EME = 0.16 \times (\%IVOMD)$ according to McDonald et al. (1995). Hemicellulose (HC) content of supplemented feed calculated as a difference between %NDF and %ADF (Table 1).

Carcass characteristics

At the end of the feeding period, when the animals reach the desired market weight (25 to 30 kg), animals slaughtered after an overnight fasting for carcass analysis. During slaughtering, animals bled completely on plastic bowl and the blood from each slaughtered animals weighed immediately. Hot carcass weight taken immediately after removing the internal organs. Non-edible components including head, skin, feet, testes, penis and gut-fill weighed separately. The weight of edible offal components such as lung, heart, kidney, spleen and pancreas, omental fat and empty gut measured and recorded. Dressing percentage calculated from hot carcass weight as the percentage of slaughter and empty body weight. After cutting the tail at sacral-coccygeal junction, the carcass split along the dorsal mid-line into right and left half. The left half of the carcass deboned and separated to carcass tissue (lean, fat and bone).

Partial budget analysis

Goats that did not slaughtered taken to the local market to estimate their market price. Average market price used to find out the market

Table 1. Chemical composition of treatment feed ingredients and concentrate mixes.

Feed type	DM%	OM%	CP%	NDF%	ADF%	HC%	lignin%	IVOMD%	EME (MJ/kg DM)
Leucaena leaf (LL)	90.9	85.5	22.7	45.0	20.9	24.1	6.41	63.6	10.2
Wheat bran (WB)	87.9	94.5	17.4	40.5	14.0	26.5	3.71	72.5	11.6
T1 (75% LL + 25% WB)	91.1	86.9	22.9	47.6	21.1	26.5	6.54	64.4	10.3
T2 (50% LL + 50% WB)	90.9	88.4	22.7	46.3	18.5	27.8	4.73	62.6	10.0
T3 (25% LL + 75% WB)	90.4	89.8	20.5	50.3	17.0	33.3	3.43	60.9	9.8

DM, Dry matter; OM, organic matter; CP, crude protein; NDF, Neutral detergent fiber; ADF, acid detergent fiber; HC, hemi-cellulose; IVOMD, in-vitro organic matter digestibility; EME, estimated metabolizable energy; LL, leucaena leaf hay; WB, wheat bran.

Table 2. LS Mean and SEM of nutrient intake and live weight change of yearling Afar goat supplemented with different level of wheat bran and leucaena leaf hay mixture.

Parameter	Overall mean	CV%	Sign. level	Feeding regime				SEM
				T1	T2	T3	T4	
Total DM intake (g/d)	395.78±8.8	7.71	*	367.43 ^b	421.39 ^a	398.52 ^{ab}	-	15.26
OM intake (g/d)	116.89±2.39	7.1	*	107.12 ^b	124.24 ^a	119.32 ^{ab}	-	4.15
CP intake (g/d)	87.44±1.88	7.47	*	84.77 ^b	95.82 ^a	81.74 ^b	-	3.27
NDF intake (g/d)	190.31±4.1	7.46	*	175.14 ^b	195.17 ^{ab}	200.61 ^a	-	7.10
ADF intake (g/d)	74.09±2.05	9.60	ns	76.65	77.88	67.76	-	3.56
Initial BW (kg)	14.34±0.16	7.82	ns	14.30	14.52	14.71	13.83	0.32
Final BW (kg)	27.82±0.26	6.46	***	28.55 ^a	29.79 ^a	28.39 ^a	24.53 ^b	0.54
ADG (g/day)	80.15±1.18	10.01	***	84.51 ^b	90.92 ^a	81.47 ^b	63.69 ^c	2.33
FCE (g feed DMI/g BW gain)	13.82±0.35	8.68	ns	12.98	13.88	14.61	-	0.60

Means in the same row with different superscript letter are significant different; ^{ns} non significant (P>0.05); *significant at P<0.05; ***significant at P<0.001; T, treatment; LS Mean, least square mean; SEM, standard error of mean; DM, dry matter; OM, organic matter; CP, crude protein; NDF: neutral detergent fiber; ADF, acid detergent fiber; ADG: average daily gain; FCE, feed conversion efficiency.

values for the different treatment groups. Wheat bran and goat purchasing cost considered for partial budget analysis. The profit analyzed using the following equation (Ibrahim and Olaloku, 2000).

$$\Delta NI = \Delta TR - \Delta VC$$

Where, NI = net income; TR = total return; VC = variable cost. The marginal profit of goat fattening was calculated from the increase in net income (ΔNI) that can be generated by each additional unit of expenditure (ΔVC), that is, $MRR\% = (\Delta NI/\Delta VC) \times 100$.

Statistical analysis

Data set from feed intake, body weight changes and carcass measurements in each treatments and control groups were analyzed using the general linear models (GLM) procedure of SAS (SAS, 2002). Model: $Y = \mu + \tau_i + e_{ij}$; Y = overall effect; μ = overall treatment mean; τ_i = the i^{th} treatment effect; e_{ij} = residual.

RESULTS AND DISCUSSION

Feed intake and live weight change

Total DM intake of goat kids in T2 (451 g/head per day) found significantly higher (P<0.05) than those received dietary T1 (Table 2). Similarly, goat kids in T2 had the

highest CP intake (P<0.05) as compared to goats under T1. Afar goat kids receiving dietary T3 showed statistically the same DM and OM intake to that of the goats in the supplemented groups. Whereas, goat kids that received T1 had significantly low (P<0.01) DM, OM and CP intake than goats in the T2. The low nutrient intake in T1 could be due to high proportion of LL hay that contains high lignin (86.9 g/kg DM) amount as compared to T2 (65.4 g/kg DM) and T3 (64.09 g/kg DM). The average daily gain of goat kids in T2 significantly (P<0.001) exceed than goat kids in the remaining supplemented and control groups. However, the final weight of goats in the supplemented groups did not show significant difference (P>0.05). The variation in nutrient intake due to supplementation might have compensated by nutrient uptake from grazing field.

Comparing all the supplemented groups, goat kids received T2 showed the highest (P<0.001) daily weight gain (90.92±2.33 g/day per head). However, goat kids in each supplement groups did not show significant difference in FCE (13.82 g feed DMI/g BW). Even though goat kids in T3 had relatively better FCE as compared to T1 and T2, it does not reflect on daily weight gain of the goats. The non-supplemented group (T4) had the lowest daily weight gain as compared to all supplemented

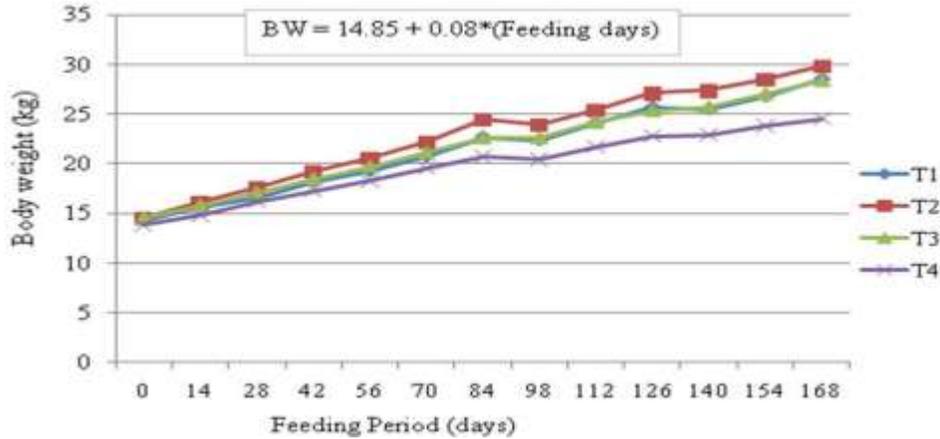


Figure 1. Live weight change of Afar goat supplemented with different level of wheat bran and leucaena leaf hay mixture.

Table 3. LS Mean and SEM of carcass characteristics of yearling Afar goat supplemented with different level of wheat bran and leucaena leaf hay mixture.

Variable	Overall mean	CV%	Sign. level	Feeding Regime				SEM
				T1	T2	T3	T4	
SWT (kg)	27.54±0.52	6.98	*	28.33 ^a	29.43 ^a	28.46 ^a	23.93 ^b	1.04
HCW (kg)	12.85±0.20	7.07	**	13.63 ^a	14.23 ^a	12.97 ^a	10.60 ^b	0.41
EBW (kg)	22.35±0.43	6.75	**	23.20 ^a	24.67 ^a	22.33 ^a	19.20 ^b	0.87
DPSBW (%)	46.60±0.64	4.77	ns	48.13	48.44	45.47	44.38	1.28
DPEBW (%)	57.49±0.99	6.02	ns	58.80	57.88	57.98	55.30	1.99

Means in the same row with different superscript letter are significant different; ^{ns} non significant ($P>0.05$); *significant at $P<0.05$; **significant at $P<0.01$; T, treatment; LS Mean, least square mean; SEM, standard error of mean; SWT, slaughter weight; HCW, hot carcass weight; DPSBW, dressing percentage on slaughter body weight base; DPEBW, dressing percentage on empty body weight base.

groups that imply the need of supplementation for grazing Afar goat kids for better growth rate (Figure 1).

Carcass characteristics

Carcass characteristics, such as carcass weight and carcass dressing percentage of Afar goat kids managed under semi-intensive feeding system summarized in the Table 3. Supplemented goat kids had better ($P<0.05$) slaughter weight than the control group (T4). Similarly, the supplemented groups achieved heavier ($P<0.01$) hot carcass weight (HCW) and empty body weight (EBW) compared to the control group. However, carcass dressing percentage did not show significant difference within the supplemented and between supplemented and non-supplemented goat kids. The overall mean of dressing percentage of Afar goat calculated on the bases of slaughter weight was 46.6%. This result is same and comparable with the value 45.5% reported for same breed by Abera et al. (2002), however; the present finding is higher than that of 43.5, 45.4 and 45.2% DP reported for the long eared Somali, Arsi-Bale and Woyto-

guji goat breeds respectively. Similarly, carcass DP of Afar, Central Highland and Long-eared Somali goat breeds fed under intensive management system was reported 44.6, 42.5 and 43.7% respectively, which is lower than the present finding (Ameha et al., 2007). However, this result was found lower than the DP of 48.5% reported for Somali goat breeds, kept under intensive management system, that were supplemented with concentrate mixture of different proportion of peanut seed cake and wheat bran (Melaku and Betsha, 2008). Goats managed under extensive, intensive and semi-intensive feeding system showed carcass DP of 38.8, 42.6 and 43.3% respectively, which is lower than the present finding (Getahun, 2001). This is in line with the contention that dressing percentage is an important parameter for assessment of meat production potential in animals that assumed to vary with age, breed, nutrition level and management system (Dzakuma et al., 2004).

Carcass tissue component

Goats supplemented with wheat bran and leucaena leaf

Table 4. LS mean and SEM of carcass tissue components of yearling Afar goat supplemented with different level of wheat bran and leucaena leaf hay mixture.

Variable	Overall LS mean	CV%	Sign. level	Feeding regime				SEM
				T1	T2	T3	T4	
Lean (kg)	8.93±0.24	9.29	**	9.73 ^a	9.73 ^a	9.27 ^a	7.00 ^b	0.48
CFat (kg)	1.52±0.07	16.98	**	1.64 ^a	1.84 ^a	1.81 ^a	0.79 ^d	0.15
Bone (kg)	2.95±0.18	21.94	ns	3.40	3.13	2.67	2.60	0.37
LBR	4.02±0.16	13.69	**	4.51 ^{ab}	3.87 ^b	5.18 ^a	2.53 ^c	0.31
LFR	6.69±0.68	35.52	*	6.04 ^b	5.34 ^d	5.39 ^b	10.00 ^a	1.37
L+FBR	4.73±0.18	13.17	**	5.28 ^a	4.60 ^a	6.21 ^a	2.82 ^d	0.36

Means in the same row with different superscript letter are significant different; ^{ns} non significant ($P>0.05$); *significant at $P<0.05$; **significant at $P<0.01$; T, treatment; LSMean, least square mean; SEM, standard error of mean; CFat, carcass fat; LBR, lean to bone ratio; LFR, lean to fat ratio; L+FBR, lean + fat to bone ratio

hay had significantly higher ($P<0.01$) lean carcass tissue weight than goat kids in the control group (Table 4). However, the amount of lean did not show significant difference ($P>0.05$) among the supplemented groups. Similarly, carcass fat followed same trend as of lean carcass tissue weight. Reports revealed that goats supplemented with diets containing high CP produced heavy muscle as compared to goats supplemented diets containing low CP (Ameha et al., 2007; Melaku and Betsha, 2008; Alemu et al., 2010). In addition, muscle development and fat deposition depend on nutrient utilization (Atti et al., 2003). In this report, however, T2 had the highest CP intake from the supplemented rations; goats under this treatment groups did not show significant difference on carcass weight. There was no significant difference on bone weight among treatment groups but the proportion of lean to bone (LBR) for goats maintained under dietary T3 was significantly ($P<0.01$) higher than those yearling goats received T2 and the control group. Despite the low carcass fat, goats in the control group showed the highest ($P<0.05$) lean to fat ratio (LFR) as compared to supplemented groups. The low fat composition of yearling goat carcass in the control group might be due to limited feed energy that the animals obtained from grazing. This result is found in line with the report of Agnihotri et al. (2006), in which goats fed on low energy feed produced low carcass fat.

Edible and non-edible offal components

Edible and non-edible offal components of supplemented (wheat bran and Leucaena leaf hay) and non-supplemented grazing Afar goats are presented in Table 5. Weight of blood, LH, SPP and GE did not show significant differences ($P>0.05$) among supplemented and between supplemented and non-supplemented goat kids. As a result, supplementing wheat bran and Leucaena leaf did not show significant weight difference on total edible offal components except that the

supplemented goats had heavier ($P<0.01$) kidney and OMF than non supplemented goat kids. The non-edible offal components did not show significant difference among treatment groups. Skin of non-supplemented group is lighter than T2 and T3 group and has no significant weight difference with T1. The percentage of total non-edible offal of non-supplemented grazing Afar goat kids were found significantly larger ($P<0.05$) than the supplemented group that received T1 and T2.

Partial budget analysis

The partial budget analysis calculated based on cost of wheat bran and animal purchase and average sale price of the goat at the local market. The net income calculated from total cost and total revenue obtained from the sale of goat. Fattening Afar goat kids by supplementing 25% wheat bran and 75% Leucaena leaf hay mixture after grazing brought the highest net income (244.45 ETB) than the 50 and 75% combination rate for wheat bran in the concentrate mix. Similarly, the MRR analysis indicated that T1 showed the highest MRR (146.7%) as compared to other treatment groups. Goat kids under T3 had the lowest marginal return rate (99.15%) as compared to all supplemented and non-supplemented groups. It was observed that little concentrate mix supplementation for goat under semi-intensive feeding system where better grazing pasture is available can bring more profit for goat producers. This result concurs with the report of Legesse et al. (2005), in which combining grazing with concentrate supplementation for goat provide more profit than either grazing without concentrate supplementation or pen-feeding with no grazing.

Conclusion

This experiment was designed to determine the market

Table 5. LS mean and SEM of edible and non-edible offal component (kg) of yearling Afar goat supplemented with different level of wheat bran and leucaena leaf hay mixture.

Variable	Overall LS Mean	CV%	Sign. level	Feeding regime				SEM
				T1	T2	T3	T4	
Blood	1.02±0.03	11.36	ns	1.03	1.07	1.03	0.93	0.07
LH	0.61±0.03	15.44	ns	0.60	0.66	0.66	0.50	0.05
Liver	0.52±0.02	14.39	*	0.55 ^{ab}	0.60 ^a	0.54 ^{ab}	0.41 ^b	0.04
SPP	0.09±0.01	22.48	ns	0.11	0.10	0.09	0.09	0.01
Kidney	0.08±0.001	7.84	**	0.09 ^a	0.10 ^a	0.08 ^{ab}	0.07 ^b	0.004
Gut empty	0.82±0.08	33.41	ns	0.90	0.87	0.67	0.63	0.15
OMF	0.29±0.02	26.93	**	0.30 ^{bc}	0.32 ^b	0.38 ^a	0.15 ^c	0.04
TEOC	3.43±0.11	11.67	ns	3.57	3.71	3.45	2.99	0.23
TPEOC	12.45±0.35	9.84	ns	12.58	12.62	12.12	12.49	0.71
Skin	2.83±0.09	11.21	**	2.80 ^{ab}	3.20 ^a	3.10 ^a	2.23 ^b	0.18
Head	1.52±0.06	14.29	ns	1.70	1.53	1.53	1.33	0.12
TP	0.30±0.01	17.13	ns	0.30	0.30	0.32	0.29	0.03
GF	5.19±0.19	12.93	*	5.13 ^a	4.77 ^b	6.13 ^a	4.73 ^b	0.38
PTNEOC	43.93±0.58	4.59	*	42.46 ^u	41.88 ^u	44.75 ^{au}	46.61 ^a	1.16

Means in the same row with different superscript letter are significant different; ^{ns} non significant (P>0.05); *significant at P<0.05; **significant at P<0.01; T, treatment; LSmean, least square mean; SEM, standard error of mean; LH, lung and heart; spp, spleen and pancreas; OMF, omental fat; TP, testis and penis; GF, Gut fill; TEOC, total edible offal components; TPEOC, total percent edible offal components; PTNEOC, percent total non-edible offal component

weight of male Afar goat kids supplemented with concentrate mix that consisted of wheat bran and leucaena leaf in various proportions after grazing in order to partially simulate the extensive feeding management condition that operates under pastoralist management. As a result, supplementation of yearling goat has turned out to be much effective in improving live weight changes and carcass characteristics of experimental goats in the current study. Consequently, goats attained market live weight of 29 to 30 kg at their yearling age when fed for 168 days. On the other hand, supplementation increased carcass tissue weight such as lean and carcass fat. The higher carcass tissue weight of supplemented yearling Afar goats positively influenced the ratio of lean to bone and lean + fat to bone (P<0.01) than the non-supplemented group. From the result and discussion, it can be concluded that supplementation of high percentage leucaena leaf hay (50 to 75%) mix with 25 to 50% wheat bran improves the market weight of yearling Afar goat and the ration also economically sound.

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