Effects of Supplementation with Graded Levels of Concentrate Mix of Oats Grain and Lentil Screening on Feed Utilization and Live Weight Gain of Menz Sheep Fed Hay

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Abstract
The effect of supplementation with graded levels of concentrate mix of Oats grain and Lentil screening in the Menz sheep fed hay was investigated at Debre Berhan Research Center. For this experiment twenty four yearling sheep with the initial body weight of 17.13 ± 1.2 kg (mean± SD) were selected from the surrounding market and randomly assigned to one of the four treatments. Treatment 1 (T1; Control) constituted hay alone, while treatments 2, 3 and 4 constituted hay with supplemented graded levels of concentrate mix of oats grain and lentil screening at a ratio of 3:1(*150, 250 and 350 g DM*), respectively. The highest mean daily BW gain (68.24±0.95) was recorded in T4, followed by T3 (47.68±0.95) and T2 (29.9±0.95g/d). Sheep in T3 and T4 (P<0.001) gained significantly higher (P<0.001) weight per day than sheep consumed T2 ration. Among the supplemented groups, T4 has higher (P<0.001) FCE than the other groups. The observed higher FCE in supplemented groups might be due to the higher CP and energy contents of supplements in providing absorbed nutrient.
Keywords: oat grain; lentil screening; feed intake and body weight gain

INTRODUCTION

Small ruminants (sheep and goats) have a unique slot in smallholder agriculture because they need small investments; have shorter production cycles, quicker growth rates and greater environmental adaptability as compared to large ruminants (Markose, 2006). Those tropical countries (including Ethiopia), animals in subsist under poor nutritional conditions since the bulk of the feed resources are poor quality native grasses and crop residues (Topps & Oliver, 1993). To avoid this deficiency, appropriate supplementation strategy with locally produced feed stuff is required. Fodder oats grain and lentil screening are among the potential feed resources that are accessible to small holder producers. Fodder oats grain is produced in North Shoa areas for use as animal and human food. It is a common cultivated cereal grain in Chacha, Sheno, Enewari, Debre Berhan zuria (Bassona Worena Woreda) and Bedelle area. Farmers around Bedelle (between Debre Berhan and Ankober) mainly use fodder oat crop as cut-and-carry green feeding and the grain produced is used as a supplement feed for donkey, horse and mule. Lentil screening is another potential unconventional feed since there is huge local processing of lentil grain for production of “misir kik” to supply to Addis Ababa market. The potential for these by-products as animal feed is enormous and its efficient utilization can contribute much in improving livestock feed security as well as performance. The use of fodder oats grain, lentil screening and agro-industrial by products available can complement each other and it is an advantage in the utilization of nutrients, and thereby improving animal performance. Although fodder oats grain and lentil screening are produced locally in the production area of Menz sheep, the proportion at which these feeds are mixed for preparing a supplement ration is not yet determined. Thus the objectives of this study is to investigate effects of Menz sheep in fed intake, digestibility and body weight change to assess the economic profitability of supplementing a concentrate mix of lentil screenings and Oat grain to fattening Menz sheep.

Materials and Methods

Description of the Study Area

The experiment was conducted from July to October, 2010 at Debre Berhan Agricultural Research Center which is found in North Shewa Amhara Regional State. The study area is located in Central Highlands of Ethiopia at about 130 km north east of Addis Ababa, at an altitude of 2800 masl and 9° 36"N latitude and 39º 38" E longitudes. The annual rainfall ranges from 900-1200 mm and the annual minimum and maximum temperatures range from 2.5°C in November to 8.4°C in July and from 17.6°C in August to 22.5°C in June, respectively (Mukassa- Mugrawa *et al*., 1995).

Animals and management

Twenty four uniform Menz sheep with an initial body weight of 17.13±1.2 kg (mean±SD) were purchased from Debre Berhane town market and randomly assigned to the four different dietary treatments for equal mean body weight and standard error. After randomization, there was no difference (P> 0.05) in initial body weight with the animals assigned into the different treatments.

Feed preparation and feeding

Hay obtained from Debre Berhan research center was used throughout the experimental period. Fodder oats grains (locally called Gerima/Shallo/Sinar) was purchased from Chacha market and stored at Debre Berhan Research Center animal retained center. Noug seed cake was purchased from Debre Berhan town animal feed store. Lentil screenings was purchased from the surrounding lentil "kik" processing mill. The supplement feed consisted of a mixture of fodder oats grain (FOG) and lentil screening (LS) at a ratio of 3:1. Noug seed cake (NSC) was fed to all animals at the rate of 50g (DM) per head per day to meet the maintenance requirement of the control animal. The supplement mixtures were offered at graded levels of 0,150, 250 and 350 g DM/head/ day in two equal portions at 0800 and 1600 h.

Feed intake

Daily feed offered to the experimental animals and the corresponding refusals of every animal were measured and recorded during the experimental period to determine daily feed intake. Both basal and supplement feed intake were determined by the difference between the amount of feed given and refused every day. The sheep were offered *ad libitum* hay at 30% refusal adjustment every week throughout the experiment period.

Body weight change

Initial body weights of each animal were determined by taking mean of two consecutive weights after overnight fasting. Body weight of the animals were measured at ten days interval after over-night fasting and mean daily body weight change were calculated by the difference between final BW and initial BW divided by number of feeding days. The feed conversion efficiency of experimental animals was determined by dividing the average daily body weight gain to the amount of feed consumed by the animal each day

RESULT AND DISCUSSION

Chemical Composition of Treatment Feeds

The results of chemical analysis of natural grass hay (offered and refusal), concentrate ingredients and their mixtures are given in Table 2. Hay DM content used in this study was comparable to the DM contents of 90.9, 89.6 and 91.4%, reported by Ewnetu (1999), Abebe (2007) and Jemberu (2008), respectively. But it is lower than the values of 92.9, 93.1, 92.0, and 92.7%, reported by Getachew (2005), Simret (2005), Abebaw (2007) and Bimrew (2008), respectively.

Table 1. Chemical composition of hay, concentrate ingredients and their mixture.

Feed type		Chemical composition				
	DM	CP	NDF	ADF	ADL	Ash
	(gkg^{-1})	(gkg^{-1}DM)				
Hay	901.8	62.9	743.9	438.2	105.3	107.5
FOG	862.7	96.8	476.3	124.5	74.5	38.9
LS	896	237.2	162.5	12.7	50.2	70.9
Mix (LS:FOG)	883.3	168.9	325.7	92.6	63.5	54.6
NSC	912.6	282.3	382.3	255.2	132.8	76.5
Refusal						
Hay (T1)	895.7	51.3	759.1	448.5	118.2	108.1
Hay (T2)	900.7	50.2	766.7	459.8	104.8	97.9
Hay (T3)	919.1	52.4	772.5	461.8	127.9	92.9
Hay (T4)	901.8	53.7	751.9	452.6	126.3	109.1

ADF = acid detergent fiber; ADL= acid detergent lignin; CP = crude protein; DM = dry matter; FOG = fodder oats grain; LS = lentil screening; NDF = neutral detergent fiber; NSC = noug seed cake

The CP content of hay offered in the current study was in agreement with the finding of Simret (2005), Abebe (2007) and Simachew (2009) which was 6.56, 6.75 and 6.9 %, respectively. But it is lower than 7.0, 9.2 and 9.2%, reported by Abebaw (2007), Matiwos (2007) and Jemberu (2008), respectively. The CP content recorded in hay used in the present experiment was higher than 5.1, 4.27, 5.6, 4.2 and 5.28% reported by Ewnetu (1999), Birhanu (2005), Getachew (2005), Mulu (2005) and Jemberu (2008), respectively. It has been stated that CP value ranging from 7-7.5% is required to satisfy maintenance requirement of ruminant animals (Van Soest, 1982). Hence, the CP content of grass hay in the current study was below that demanded for maintenance requirements of sheep. The lower CP content might be attributed to the stage of maturity, harvesting and the age condition. According to McDonald *et al*. (2002) plant cell wall constituents increase, and therefore, the structural carbohydrates such as cellulose and other components like lignin increases and the percentage of CP decreases with maturity. Stoddart *et al.* (1975) also reported that as plant matures, CP, the more readily digested carbohydrates, and phosphorous decreases, but fiber, lignin and cellulose increases.

The NDF component of hay used in the current study is comparable to the NDF content of 73.9, 76.8 and 75.7% reported by Abebaw (2007), Mulu (2007) and Jemberu (2008), respectively. But it is lower than 79.2 reported by Fentie (200). The ADF content of hay used in this experiment was lower than 50, 48.3, 52.0, 46.8 and 45.3% g/kg DM recorded by Zinash *et al.* (1998), Asnakew (2005), Mulu (2005), Abebaw (2007) and Fentie (2007), respectively. Moreover, the result of ADF value (43.8) in the present experiment was in agreement with 44.5 reported by Abebe (2006).

The DM, CP, ADF, ash and ADL content of the hay refusals were similar among the different treatments. Comparison between the chemical composition of offered and refused hay revealed that the offer had higher CP and ash than refusals, but lower NDF, ADF and ADL values, which may be due to the fact that experimental sheep selected more edible portions of the basal diet (such as shoots) and left the more woody parts (such as stems) of the grass which has higher fiber (NDF, ADF and ADL) fractions.

The CP content of oats grain was higher than Fekede *et al*. (2008) who reported CP of 48 to 76 g kg^{-1} dry matter in different varieties. Mesfin *et al*. (2009) reported DM, CP NDF and ADF contents of 90.2, 8, 38.2 and 20.6%, respectively for oats grain used in their experiment. The CP of LS was higher than values reported earlier. The higher CP content might be due to the quality of the screening and the original grain.

Pulse crops are nutrient-dense feed grains (Bhatty *et al*., 1976; Chaven *et al*., 1986; Reed *et al*., 2004) containing moderate levels of CP and are highly digestible, which also yields valuable screening by-products for animal feeding. The CP value of lentil seed reported by Gopalan (2004), Wang and Daun (2004) and Gilbery *et al.* (2007) was 25, 21.5-30.2 and 28.9%, respectively, which is not very high compared to the value obtained in the present experiment for the screening. Yoseph (1999) reported 16% CP for lentil hulls as compared to 23% in our case for the screening. Biru (2008) reported CP of 18% for haricot bean screening, which is lower than CP value of the present LS. Feeds that contain 20% or more of protein are classified as protein supplements (Crampton and Harris, 1969; Kellems and Church, 1997) implying that LS with qualities as that used presently may be considered as protein supplement feeds.

The CP content of the mixture of OG and LS at a ratio of 3:1 (75:25%) was around 17% of DM. Lonsdale (1989) classified feed materials having >200, 200 to 120 and <120 protein content (g/kg DM) as high, medium and low protein feeds, respectively. According to this classification, the concentrate mixture used in the present study is grouped as medium quality supplement to support animal growth. Changing the ration of the ingredients could be an option to increase the CP percentage of the supplement, when required to be used as only concentrate supplement.

The CP content of NSC used in the present study was lower than the value of 33.4 and 31.3 %, reported by Amaha (1990) and Abebaw (2007), respectively. The low level of CP content of NSC in the preset study might be due to the method of processing in the extractors and the raw materials used (Solomon, 1992). The NDF content of NSC in present study was comparable with the values of 37.5 and 36.3% reported by Alemu (1981) and Abebaw (2007), respectively. The ADF as well as ADL contents of NSC in this trial were lower than the values of 28.2, 8.1% and 32.5, 28.4% reported by Beyene (1976) and Alemu (1981), respectively. McDonald *et al.* (2002) pointed out that nutrient composition of feeds varies depending on variety and method of processing.

Feed Intake

Dry matter and nutrient intake during the feeding trail

Table 3 shows the mean daily DM and nutrient intake of experimental sheep during the growth trial. The result showed that hay dry matter intake (DMI) in the control group was significantly (P<0.001) higher than the supplemented groups. Dry matter intake of hay in T3 is significantly lower than T2. The sheep supplemented with graded levels of OG and LS mixture (concentrate mix) consumed 7.8 (T2), 14.8 (T3) and 12% (T4) less grass hay than sheep in the control treatments. Higher hay intake by sheep in the unsupplemented groups as compared to supplemented ones might be due to the low CP content of hay used as a result of which the animals try to consume more hay to meet their nutrient requirement. The low hay DM intake in supplemented group might be due to the higher substitution rate of the supplement for the hay. The result of the current study is similar to Fentie (2007) and Jemberu (2008) who reported higher hay DM intake in the control than supplemented treatments in Farta and Sidama sheep, respectively.

Significant difference (P<0.001) in daily total DM intake was observed among all treatments. Total dry matter intake increased with increasing levels of supplementation. This trend is similar with that reported by Biru (2008) for Adilo sheep fed grass hay basal diet and supplemented with different levels of mixtures of sweet potato tuber and haricot bean screenings. Furthermore, the observed trend in DMI in the present experiment was in line with the results of Melese (2008) for Dangila lambs fed urea treated finger millet straw and supplemented with noug seed cake, wheat bran and their mixtures in different proportions. The values of DMI per metabolic body weight of all treatments were within the range (58.6 to 82.87 g kg-1 $W^{0.75}$) reported by Bonsi and David (1996) for Menz sheep fed tef straw and supplemented with protein sources.

Table 2. Daily dry matter and nutrient intake of Menz sheep fed natural grass hay and supplemented with graded levels of concentrate mixture during the growth trial

Parameters	Treatments T1	T2	T3	T4	SEM
Hay DMI (g/d)	450.9^{a}	415.6^{b}	384.5^{c}	397^{bc}	4. 5
Supplement DMI (g/d)	0.0^{d}	150^{c}	250^{b}	350^{a}	26
NSC DMI (g/d)	50	50	50	50	-
Total DM intake (g/d)	500.9^{d}	615.6^{c}	684.5^{b}	797^{a}	4.5
Total DMI (%BW)	3.48^{a}	3.2^{b}	3.13^{b}	2.91^{c}	0.057
Total DM intake (g/kgW$^{.75}$)	58.9^{d}	65.9^{c}	69^{b}	75^{a}	0.51
Nutrient intake(g/d)					
OM intake (g/d)	445.3^{d}	537.9^{c}	593^{b}	687^{a}	4.02
CP intake (g/d)	42.5^{d}	65.8^{c}	82.5^{b}	98.2^{a}	0.2
NDF intake (g/d)	354.6^{b}	363.6^{b}	398.9^{a}	413.3^{a}	6.1
ADF intake (g/d)	210.7^{b}	208.5^{b}	218^{a}	219.1^{a}	1.35
Substitution rate	-	0.24^{a}	0.27^{a}	0.15^{b}	0.018

a-d = means within a row not bearing a common superscript are significantly different. ADF = acid detergent fiber; CP = crude protein; DMI = dry matter intake; NDF = neutral detergent fiber; OM = organic matter; SEM = standard error of mean; T1 = Hay *ad libitum* +50g NSC; T2 = T1 diet + 150g oats grain and lentil screening mix (at a ratio of 3:1); T3 = T1 + 250g oats grain and lentil screening mix; T4 = T1+350g oats grain and lentil screening mix.

The CP intake increased significantly (P<0.001) with increasing levels of concentrate supplementation and all the supplemented groups consumed more CP (P<0.001) than the unsupplemented group. Similar to the result of this study, Abebaw (2007) and Abebe (2007) reported increased CP intake with increased dry matter intake in Farta sheep and Arsi-Bale sheep fed hay and supplemented with graded levels of concentrate mix (35% NSC, 35% WB and 30% BDG), respectively. The CP intakes for the different treatments in the current study were 8.5, 10.7, 12.1 and 12.3% of the total DM intake for T1, T2, T3 and T4, respectively. Lower CP intake in sheep of control treatment resulted in low body weight gain. As supplementation increases, the CP intake also increases across the treatments (Bondi, 1987). The higher CP intake with increasing level of concentrate supplementation might be due to increased total DM intake and higher CP content of the supplements than the basal diet.

According to Van Soest (1994) protein supplementation increases the supply of nitrogen to the rumen microbes, which have a positive effect on the rate of fermentation of the digesta. As the rate of degradation of digesta increases, feed intake accordingly increases, which supports the result of the present experiment. The average daily protein requirement of a 19.1 kg body weight animal for maintenance is 38 g CP (NRC, 1981). This indicates that the CP intake of T1 was above the minimum requirements for maintenance and this is reflected by positive body weight change of animals in this treatment. This is attributed to the provision of 50g DM NSC across all treatments.

The total NDF intake in T3 and T4 was significantly higher than (P<0.001) in T1 and T2; and the total ADF intake in T3 and T4 was higher (P< 0.05) than T1 and T2. However, the total ADF intake in T2 was numerically lower than all the other treatments. Among the treatments, T4 had a numerically higher amount of NDF intake which is due to the higher total DM intake. The substitution of hay with concentrate supplement in the current study was 0.24, 0. 27 and 0.15 ± 0.02 for T2, T3 and T4, respectively. Similar to the present result, Jemberu (2008) reported high substitution rate of hay with concentrate feed for Sidama sheep. Generally, the result of the current study indicated that supplementation with protein and energy diet significantly increased (P<0.001) the total DM, OM, CP and ADF intake.

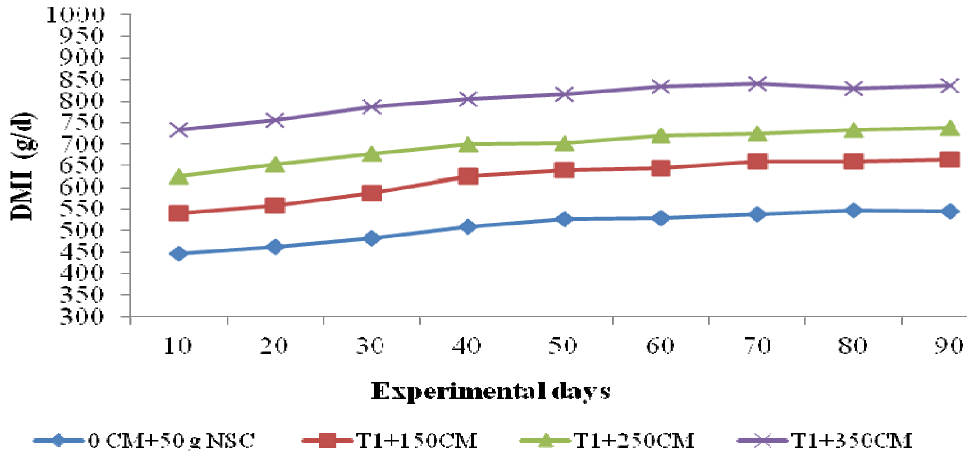

Figure 1.Trends in total dry matter intake (g DM/day) over weeks of the experiment in Menz sheep fed natural grass hay and supplemented with graded levels of concentrate mixture

Dry Matter and Apparent Nutrient Digestibility

The DM and nutrient digestibility are given in Table 4. Digestibility of DM, OM and CP were significantly ($P<0.001$) higher in the supplemented groups than in the control group. The digestibility also increased with increasing levels of concentrate supplementation. The higher DM, OM and CP digestibility observed in supplemented sheep might be due to the higher CP content of the supplements. On the other hand, the lower digestibility of DM, OM and CP recorded for the control is attributed to the lower CP content and higher fiber content of the hay. The digestibility of nutrient intake in the present result is in agreement with Jemberu (2008) and Meles (2008) who reported higher DM, OM and CP digestibility in Sidama and Dangila lambs. Similarly it is in agreement with that recorded by Mulu (2005) and Biru (2008) who found that Wogera sheep supplemented with different levels of breweries' dried grain had significantly higher CP digestibility ($P<0.001$) than the control group , and Adilo sheep supplemented with different levels of mixtures of sweet potato tuber leftover and haricot bean screenings. Contrary to result of this study, Abebe (2007) reported no significant difference in apparent digestibility of DM and OM between supplemented and non-supplemented groups in Farta sheep. The increase in CP digestibility for the high level supplemented sheep (T4) indicated that increased protein level in the feed improved apparent protein digestibility.

The digestibility of NDF in T4 is higher ($P<0.001$) than the other treatments, and T1, T2 and T3 did not statistically varied in NDF digestibility. The study also revealed no significant difference in the ADF digestibility among the treatments. The current result is in agreement with Biru (2008) who reported absence of statistical difference ($P>0.05$) in NDF digestibility between supplemented and control sheep.

Table 3**.** Apparent dry matter and nutrients digestibility of Menz sheep fed natural grass hay and supplemented with graded levels of concentrate mixture

	Treatments				
Parameters	T1	T2	T3	T4	SEM
DMD	0.6^{d}	0.63^{c}	0.67^{b}	0.71^{a}	0.009
OMD	0.65^{d}	0.67^{c}	0.73^{b}	0.74^{a}	0.47
CPD	0.61^{d}	0.71^{c}	0.74^{b}	0.77^{a}	0.015
NDFD	0.56^{bc}	0.54^{c}	0.58^{b}	0.63^{a}	0.017
ADFD	0.5	0.51	0.51	0.54	0.004

a-d = means within a row not bearing a common superscript are significantly different. ADF = acid detergent fiber; ADL = acid detergent lignin; CP = crude protein; DMI = dry matter intake; NDF = neutral detergent fiber; OM = organic matter; SEM = standard error of mean; NS = non significance; T1 = Hay *ad libitum* +50g NSC; T2 = T1 diet + 150g oats grain and lentil screening mix (at a ratio of 3:1); T3= T1 + 250g oats grain and lentil screening mix; T4 = T1+350g oats grain and lentil screening mix.

Body Weight Change and Feed Conversion Efficiency

The body weight changes and average body weight gain of Menz sheep fed hay and supplemented with graded levels of concentrate mix are given in Table 5. The final body weight and average daily weight gains were significantly higher ($P<0.001$) in the supplemented groups than unsupplemented group. Sheep in T3 and T4 ($P<0.001$) gained significantly higher ($P<0.001$) weight per day than sheep consumed T2 ration. The highest mean daily BW gain (68.24±0.95) was recorded in T4, followed by T3 (47.68±0.95) and T2 (29.9±0.95g/d).

Among the supplemented sheep, sheep in T4 attained significantly higher (P<0.001) final body weight than sheep supplemented with low (T2) and medium (T3) levels of concentrate supplementation, which could be attributed to the higher average daily weight gains. The current finding revealed that increased level of supplementation increases average daily body weight gain and body weight change. This is in agreement with the results obtained by Fentie (2007, Bimrew (2008), Ermias (2008), Jumberu (2008), and Melese (2008), who reported that concentrate supplementation improved daily body weight gain. ILCA (1986) reported live weight gain of 98 g/d for Menz sheep with high plain of nutrition, which supports the higher body weight gain attained by animals consumed the highest level of concentrate mix.

Table 4. Body weight parameters and feed conversion efficiency of Menz sheep fed natural grass hay and supplemented with graded levels of concentrate mix

	Treatments				
Parameters	T1	T2	T3	T4	SEM
IBW (kg)	17.29	17.04	17.12	17.08	0.151
FBW (kg)	17.45^{d}	19.74^{c}	21.42^{b}	23.23^{a}	0.157
BWC (kg)	0.173^{d}	2.7^{c}	4.37^{b}	6.14^{a}	0.46
BWG (g/d)	1.92^{d}	29.9^{c}	47.68^{b}	68.24^{a}	0.95
FCE	0.0029^{d}	0.038^{c}	0.065^{b}	0.091^{a}	0.0069

a-d = means within a row not bearing a common superscript are significantly differ. BWC = body weight change; DBWG = daily body weight change; FBW = final body weight; FCE = feed conversion efficiency; IBW = initial body weight; SEM = standard error of mean; NS = non significance; T1 = Hay *ad libitum* + 50g NSC; T2 = T1 diet + 150g oats grain and lentil screening mix (at a ratio of 3:1); T3 = T1 + 250g oats grain and lentil screening mix; T4 = T1+350g oats grain and lentil screening mix.

Average daily body weight gain followed the same trend as that of total DM intake, implying that increased intake resulted in improved performance of the animal. Since all animals offered with 50 g NSC, the control treatment maintained their body weight. The recommendation by NRC (1981) which states that animals fed poor quality hay alone could not meet the maintenance energy requirement validates the result of the current experiment. According to Gihad (1976) and Kaitho (1997), animals fed hay and tef straw as a sole diet cannot obtain the minimum nutrient required for body weight maintenance and suggested that growing animals on such diets could loss body weight. Moreover, Bonsi *et al.* (1996) reported that sheep on the unsupplemented diet needed to mobilize energy and protein from tissue, which might have led to weight loss.

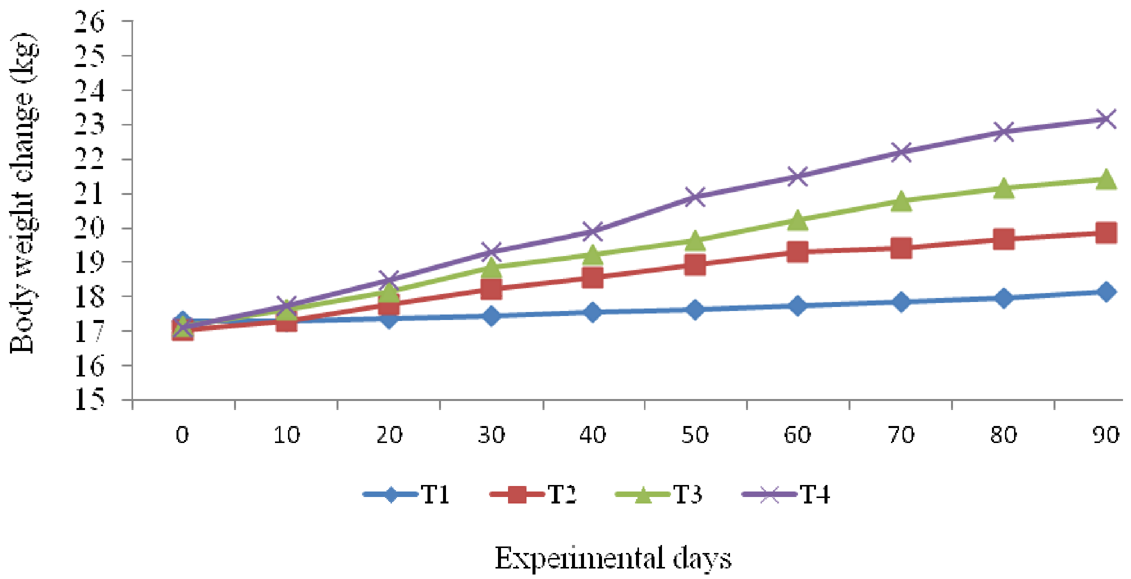

Figure 2. Trends in live weight of Menz sheep fed natural grass hay and supplemented with graded levels of concentrate mix

Figure 2 indicates trends of live weight gain of Menz sheep fed grass hay basal diet supplemented with concentrate mix at different graded levels. Body weight of T_2, T_3 and T_4 steadily increased, but body weight of unsupplemented sheep (T1) remained almost the same throughout the experimental period.

The feed conversion efficiency (FCF) was higher (P<0.001) in supplemented treatments as compared to the unsupplemented group. Among the supplemented groups, T4 has higher (P<0.001) FCE than the other groups. The observed higher FCE in supplemented groups might be due to the higher CP and energy contents of supplements in providing absorbed nutrients. This result agreed with that reported in other previous studies

(Abebe 2006; Bimrew, 2008; Ermias, 2008; Hirut, 2008). According to Brown *et al. (*2001), animals that have high FCE are considered efficient users of feed, which confirms the significantly higher gain recorded in the current experiment.

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