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Effect of Different Proportions of Wheat Bran and Noug Seed Cake Mixture Supplementation on Feed Intake, Digestibility and Body Weight Change of Salale Sheep Type Fed Natural Grass Hay as Basal Diet

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Abstract

An experiment was conducted using twenty five growing Salale sheep lambs with an initial body weight of 23.63 ± 1.12 kg (mean ± SD). The objective was to investigate the effect of supplementing different proportions of wheat bran and Noug seed (Guizotia abyssinica) cake on feed intake, digestibility, and body weight gain of Salale Sheep type lambs fed natural pasture hay basal diet. The sheep were treated against internal and external parasites and bacterial disease before commencing the study. A randomized complete block design (RCBD) was used. The experimental lambs were categorized into five blocks of five lambs based on their initial body weight and the five feed treatments were randomly assigned to each animal in a block., the treatments were: natural pasture hay alone (T1) (control), 350gWB (T2), 117gNSC+233gWB (T3), 233gNSC+117gWB (T4) and 350gNSC (T5) with all groups offered adlibtum feeding of natural pasture hay.. The supplements were offered at the rate of 350 g/day, which were offered at 8:00 and 4:00 hours in two equal portions daily. There was a significant difference ($P < 0.001$) in DM intake of hay among treatments with the highest value (722.37g/day/animal) recorded for T1 and the least values (543.73 g/sheep/day) and (560.69 g/sheep/day) were recorded for T2 and T5, respectively. Total daily DM and OM intake was significantly higher ($P<0.001$) for supplemented treatments than for T1. The total CP intake was in the order of T5>T4 > T3 > T2 > T1 ($P < 0.001$). The apparent DM, OM and CP digestibility was significantly higher ($p<0.001$) in supplemented sheep than the non-supplemented group. Average daily gain (ADG) and feed conversion efficiency (FCE) of non-supplemented sheep was lower ($P < 0.05$) than the supplemented ones. Sheep supplemented with T2 (350g WB/day/head) had the highest net return (604.4 ETB) and is potentially profitable in feeding of growing Salale sheep as compared to the other supplemented treatments.

Keywords: Digestibility, Natural Pasture Hay, Noug Seed Cake, Salale Sheep, Wheat Bran

Introduction

Ethiopia has large livestock population in Africa possessing 31.30 million sheep and 32.74 million goat's population [1]. Ethiopia has a diverse indigenous sheep population and their meat production is one of the most important in the country. They are distributed and adapted across the diverse ecological zones of the country. Out of the total population, about 73-75% is kept on small scale mixed farms in the highland areas while the remaining is found in the low lands [2]. There is high domestic demand for sheep meat, particularly during religious festivals. This increased demand also creates an opportunity to substantially improve food security of the population and alleviate poverty. However, livestock productivity in general and sheep particular is very low and lags behind the growth of the population leading to a net decline in per capita consumption of livestock products and feed affect livestock productivity both in terms of quantity and quality [3]. Natural pasture and crop residues are the major feed resources for livestock in Ethiopia; they are characterized by high fiber, low protein, minerals and vitamins [4]. One of the feasible methods of improving the nutritive value of these feeds is through strategic concentrate supplementation with energy and protein rich sources, which can increase digestibility, nutrient supply and intake [5]. In this regard, feed sources originated as by-products of various agro-industries are good sources of easily fermentable energy and protein and they are valuable livestock feeds that enhance animal performance [6].

In general, the availability of feed resources in Ethiopia is insufficient both in terms of quality and quantity. Farmers in Salale area have been practicing fattening of (Cattle and sheep) using agro-industrial supplement, especially wheat bran and Noug seed cake on traditional basis [7] and natural pasture grass hay is the dominant feed resource which could be used as basal diet in the area [8]. However, there is no experiment conducted to evaluate the supplementary value and levels of inclusion in the ration of these by-products and this has to be supported by research finding so that appropriate feeding system was designed. The objective of this study was, therefore, to Evaluating the effect of supplementing wheat meal by product with Noug seed (Guizotia abyssinica) cake on feed intake, digestibility, and body weight gain of Salale sheep type lambs fed natural pasture hay as a basal diet.

Materials and Methods

Description of the Study Area

The experiment was conducted in Salale University (on station) which is found in North Shewa Zone of Oromia Regional State at about 114 km North of Addis Ababa. The altitude of the area is ranged between 1300-2500 meters above sea level. It is divided into three agro

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ecologies, namely: highland (>2500 m.a.s.l) (15%), midland (1500-2500 m.a.s.l) (40%) and lowland (500-1500 m.a.s.l) (45%). The average annual rain fall of the area ranges from less than 840 mm to 1600 mm while the mean annual temperature varies between 15˚C to 19˚C [1].

Experimental Animals and Management

Twenty-five intact yearling male growing sheep type lambs were purchased from local (Degem) market to conduct the experiment. Ages of the Sheep were determined by their dentition and information obtained from the owners. The animals were injected with ivermectein drug against internal and external parasites and oxytetracycline drug against bacterial disease. They were vaccinated against common diseases (anthrax and pasteurelosis) during the quarantine period of 15 days at the experimental site. All animals were placed in individual pens equipped with a bucket and a feeding trough, and identified with neck collars with tag-numbers.

Feed Preparation and Feeding

Locally available pasture hay was purchased and stored under a shade to maintain its quality. The hay was chopped to the size of 4-6 cm, weighed, and offered adlibitum as basal feed in the morning. The supplements, i.e., Noug seed cake and wheat bran which were sufficient for the whole experimental period purchased from Fitche town feed market and stored in house on cemented floor and dark room to avoid its rancidity. All animals had free access to water and common salt lick (block).The amounts of supplements offered per day were 350 g/head. This is based on the National Research Council requirement of small ruminants [9].

Experimental Design and Treatments

The experiment was conducted in a Randomized complete block design (RCBD) with five treatments consisting of five sheep per treatment (Table 1). At the end of the quarantine period, the sheep were blocked into five groups (blocks) each containing five sheep based on initial body weight, which was determined as a mean of two consecutive weighing after overnight fasting. The five treatments were randomly assigned to animals in a block, which makes the number of animals/replication per treatment.

Digestibility Trial

At the end of the adaptation period, all sheep from the five dietary treatments were fitted with fecal collection bags and the animals have a three days acclimatization period to the harness followed by a 7-days collection period. Each day's collection of feces per animal was weighed and 20% was sub-sampled and stored frozen at -200C. Composite samples of feces and mixed thoroughly, sub-sampled dried for 72 hours at 600C. Feed and refusal samples from each animal were collected daily and the latter were pooled over treatment. The digestibility coefficient (DC) of nutrients were calculated by using the following equation [10].

$$AD\% = \frac{\text{Total amount of nutrients in feed-total amount of nutrients in feces}}{\text{Total amount of nutrient in feed}} \times 100$$

Feeding Trial

The feeding trial followed digestibility period and lasted 120 days. Daily feed offered to each experimental animal and the corresponding refusal were collected, weighed and recorded during the experimental period to determine feed intake. Refusals of hay were collected and weighed every morning before the next meal. The supplement feed was offered at 8:00 and 4:00 hours in equal halves each day. Representative samples of hay subsamples from each batch and refusal subsample from each animal were collected for chemical analysis. Feed intake was determined as the difference between the amount of feeds offered and refused for each animal. Refusal samples were pooled per treatment. Initial body weight (BW) of each animal was recorded at the beginning the feeding trial and in fifteen days interval then after. The BW measurements were taken in the morning after 12h fasting using a suspended weighing scale with sensitivity of 100 grams. The daily BW gain was calculated as the difference between the final BW and initial BW divided by number of experimental days.

Chemical Analysis

Representative samples of daily feed offers, refusals and feces were milled to pass through a 1mm screen. The determination of DM, ash, and N were done according to the procedure of [6]. Crude protein was estimated as N x 6.25. Neutral detergent fiber (NDF), acid detergent fiber (ADF) and acid detergent lignin (ADL) were analyzed according to the procedures of [11]. The Chemical analysis was conducted at Holleta Agricultural Research Center Animal Nutrition Laboratory.

Statistical Analysis

Data of feed intake, digestibility and body weight change was analyzed using analysis of variance (ANOVA) of the general linear model procedure of [10]. Treatment means that are significantly different was separated by least significant difference (LSD).

The model for data analysis was:

$Yij = \mu + Ti + Bj + eij$,

Where:

Yij=Response variable

μ=Overall mean

Ti=Treatment effect

Bj=Block effect

eij=Random error

Results and Discussions

Chemical Composition of Treatment Feeds and Refusals

The chemical compositions of different proportion of feeds offered and refused in the experiment were given in (Table 2). The DM content

Treatments	Hay	NSC (g/day/ animal) on DM base	Wheat bran /day/animal) on DM base	Supplement DM intake (g/d/head)
T1	*Ad libitum*	-	-	-
T2	*Ad libitum*	0	350	350
T3	*Ad libitum*	117	233	350
T4	*Ad libitum*	233	117	350
T5	*Ad libitum*	350	0	350
NSC = Noug seed cake; g= gram DM = dry matter				

Table 1: Experimental treatments.

Feed sample	DM	Ash	CP	NDF	ADF	ADL
	(%)	(% DM)	(% DM)	(% DM)	(% DM)	(% DM)
Hay	90.46	13.12	8.49	55.58	34.86	4.98
WB	91.09	4.48	17.94	36.74	9.99	1.85
233gWB+117NSC	91.41	12.13	23.39	39.8	14.27	4.02
233gNSC+117gWB	91.89	17.25	28.8	35.68	17.32	5.57
NSC	91.59	8.77	34.25	35.8	29.07	12.2
Feed refusal						
Hay (T1)	89.75	15.67	6.12	66.18	42.14	5.88
Hay (T2)	90.01	14.21	8.11	59.46	36.12	5.16
Hay (T3)	90.36	14.06	7.5	60.7	36.41	5.22
Hay (T4)	90.46	14.69	8.12	60.31	35.92	5.32
Hay (T5)	90.24	13.4	7.28	62.15	37.43	5.42

ADF = acid detergent fiber; ADL= acid detergent lignin; CP = crude protein; DM= dry matter; NDF = neutral detergent fiber; NSC = Noug seed cake; OM = organic matter; WB = Wheat bran

Table 2: Chemical composition of treatment feeds and refusals.

of hay (90.46%) used in this trial was comparable to the DM content of 90.52% reported by [12], but lower than the 93.42% reported by [13] and higher than 89.61% reported. The CP content of pasture grass hay used in the present study was 8.49%. This value was slightly comparable to 7.7% and 7.9% CP reported by [14,15], respectively. However it was higher than values 7.01%, 7.2%, 7.2% and 7.13% reported by [16,17], respectively but lower than value 11.5% reported by [18]. Its CP content was higher than the lower limit of 7% CP required for optimum rumen function [11]. As a result, the natural pasture diet (T1) can be considered as adequate for maintenance requirement of animals in terms of its CP content. As described by [2], the native grass hay CP value lies on the border line of the 6-7% dietary crude protein level required for promoting voluntary feed intake.

The fiber fraction of grass hay used in the current study was a little raised than expected for most natural grass hay. The NDF, ADF and ADL components of hay offer in the current study were 55.58%, 34.86% and 4.98%, respectively. Ruminants require sufficient NDF in their diets to maintain rumen function and maximize production. The NDF component of hay used in the current study was comparable to the value 55.88%, reported, but lower than 73%, 73.48% and 79.4% reported by [19-21], respectively. The NDF content of the hay used in the present study may limit ruminal fill and intake. Feeds that contain lower proportion of ADF have better availability of nutrients due to ADF being negatively correlated with feed digestibility [10]. Hence, the value of ADF observed in the hay used in the current study was relatively lower than that 37.59% value reported by [22] indicating the relatively lower availability of nutrients contained in the hay to animals.

The DM, OM, CP, ash, ADF and ADL content of the hay refusals were almost similar among all treatments. This may be due to the feeding habits of sheep which selected the most nutritious parts of the grass. Comparison between the chemical composition of hay offered and refused revealed that the basal diet hay offer had the same DM and ash to that of hay refusals and had higher CP than refusals but lower NDF and ADF values which may be due to the fact that experimental sheep selected more edible portions of the basal diet and left the more woody stem parts of the grass which had higher fiber (NDF and ADF) fractions.

In this study, the NDF, ADF and ADL contents of WB were 36.74%, 9.99% and 1.85%, respectively which was lower than 57.2%, 11.2% and 3.6% reported. The CP (17.94%) value of wheat bran used in this study was comparable with the value of 17.9% and 17.77% reported by [20,23], respectively.

The CP content of NSC used in the present study was similar with the values 34.27% and 33.4% reported by [24,17], respectively, but higher than the values 28.2% and 30.57% reported by [25], respectively and lower than the report of [21] who reported 36.2% CP. The differences in CP content of NSC may arise from variations in production management practices, agro-ecologies, soil conditions and the efficiency of processing method employed [26]. The NDF content obtained for NSC in this study was comparable with the values 36.5%, reported by [27], and lower than 39.4% that reported by [28]. The CP content of mixture 233gNSC+117gWB was higher than 117 g NSC+233 g WB mixture. This might be due to high CP in NSC as a result of high protein quality which depends on variety, climate, cultural practices and methods of processing.

Daily Dry Matter and Nutrient Intakes

There was a significant difference ($P < 0.001$) in DM intake of hay among treatments with the highest value (722.37g/day/animal) recorded for T1 and the least values (543.73) and (560.69 g/sheep/day) were recorded for T2 and T5, respectively. More pasture hay intake in the control group might be to satisfy their nutrient requirements.

The total daily DM and OM intake was significantly higher ($P<0.001$) for supplemented treatments than for T1. This was probably due to the low fiber fraction in concentrate mixtures of NSC and WB, addition of extra CP that can stimulate efficient rumen fermentation, more passage rate and intake, which increased the basal diet intake and resulted in better total DMI [10]. According to [29] concentrate added to roughages of low digestibility tends to be consumed in addition to the roughage since supplementation of concentrate stimulates micro-organism function in the rumen, reduces retention time and thus increases the total DM and nutrient intake. The reason for low intake of DM in T1 may be due to the quality of the hay and its low digestibility as well as the significantly lower crude protein intake by this group. In the current study the NDF contents of the hay higher than concentrate mixture and the high level of NDF in the hay might have limited the total DM intake of animals in the non-supplemented group, indicative of low rate of digestibility of the grass hay when fed alone because of its high NDF and ADF content as compared to the supplemented.

The total OM intake was similar trend to that of total DM intake. Response in total CP intake in the present study was consistent mainly with increase in the supplemental level of NSC and partly may be associated with the increases in total DM intake with increasing level of concentrate supplementation. Generally an increased level of supplemental feed concentrates might have led to better balance of nutrients and consequently a higher DM and nutrient intakes in the current study, which might have resulted to improvement in the

performance of animals signifying the importance of supplementation of hay or roughage based diets. Total DM intake as percent of body weight (%BW) and per metabolic body weight (g/kg W0.75) in the current study was significantly higher ($p<0.05$) in T3 and T4 than T1. Total DM intake as percent of BW in the current study ranged between 2.68-2.95% and per metabolic BW ranged 61.52-70.54 on g/kg W0.75. The total DM intake expressed as percent of BW obtained from the current study is slightly similar to the values 2.08-2.22% and 3.3-3.9% reported by [30,31] for Begait and Farta sheep, respectively. The total DM intake in the present study was in the range of the recommended dry matter intake (2-4%) for sheep and goat [32].

Apparent Dry Matter and Nutrient Digestibility

Digestibility of dry matter and nutrients in Salale sheep type fed pasture hay basal diet and supplemented with different proportion of Noug seed cake and wheat bran mixtures are presented in (Tables 3-5). The apparent DM digestibility was significantly higher ($p<0.001$) in supplemented sheep than the control group, although no significance difference ($p>0.05$) was noted between T1 and T3. Similarly, OM and CP digestibility was highly significant ($p<0.001$) for supplemented groups as compared to non-supplemented ones. However, no significance differences were observed ($p>0.05$) among supplemented treatments T3 and T5 for DM and OM digestibility. The higher DM, OM and CP digestibility observed in supplemented sheep in the current study might be due to the higher CP content of the supplemented feeds.also reported that higher CP intake is associated with better CP digestibility [10]. On the other hand, the lower digestibility of DM, OM and CP recorded for the control group might be due to lower CP content and higher fiber content of the hay. Most of the differences in digestibility of total diet with supplemented versus non-supplemented sheep might be attributed to the high digestibility of supplements as observed by [33]. The same author reported that the high fiber and low CP contents of low quality forages are expected to result in low apparent digestibility of nitrogen. The digestibility of NDF and ADF were not significant ($p>0.05$) between supplemented and control group. Similarly, [34,35] documented absence of significance difference on digestibility of NDF and ADF between the supplemented and non-supplemented group in Farta and Tigray highland sheep, respectively. However, there was a significant difference ($p<0.05$) in ADF between T2 and T5.

Body Weight Change and Feed Conversion Efficiency

Both average daily gain (ADG) and feed conversion efficiency (FCE) was lower ($P < 0.05$) for the non-supplemented sheep than the supplemented ones. Differences among the supplemented treatments in ADG and FCE were not significant ($P > 0.05$). The lower FCE and ADG for T1 was probably because of the relatively low CP and energy intake and higher fiber content of the basal diet that might have caused the use of Metabolizable energy to be depressed slightly. Adebowale

	Treatment					
Intake (g/day)	T1	T2	T3	T4	T5	SEM
Hay DM	722.37^{a}	543.73^{b}	643.64^{ab}	605.12^{ab}	560.69^{b}	7.08
concentrate DM	0.0^{e}	318.80^{d}	319.90^{c}	321.60^{a}	320.60^{b}	0.1
Total DM	722.37^{b}	862.54^{a}	963.58^{a}	926.74^{a}	881.26^{a}	7.09
OM	627.60^{b}	823.90^{a}	846.70^{a}	766.87^{a}	803.97^{a}	6.25
CP	59.44^{e}	154.74^{d}	225.38^{c}	266.90^{b}	301.83^{a}	13.98
NDF	542.29^{a}	538.15^{a}	465.13^{a}	483.07^{a}	481.49^{a}	16.66
ADF	529.4^{a}	327.9^{a}	327.1^{a}	316.1^{a}	352.9^{a}	17.6
Total DM (% BW)	2.68^{bc}	2.71^{abc}	2.95^{a}	2.93^{a}	2.90^{ab}	0.23
DM (g/$BW^{0.75}$)	61.52^{c}	63.88^{b}	70.54^{a}	69.47^{ab}	68.04^{ab}	4.9

$^{a, b, c,d,e}$ = means within rows having different superscript letters are significantly different at= $P<0.005$, ADF = acid detergent fiber; CP = crude protein; DM= dry matter; NDF = neutral detergent fiber; OM = organic matter; SEM= standard error mean.

Table 3: Daily dry matter and nutrient intakes of Salale sheep type fed on hay basal diet and supplemented with different proportion of wheat bran and Noug seed cake mixtures.

	Treatment					
Digestibility coefficient	T1	T2	T3	T4	T5	SEM
DM	0.57^{c}	0.76^{ab}	$0.69b^{c}$	0.75^{ab}	0.87^{a}	0.073
OM	0.59^{c}	0.84^{ab}	$0.72b^{c}$	0.73^{bc}	0.92^{a}	0.069
CP	0.26^{e}	0.63^{d}	0.69^{c}	0.77^{b}	0.84^{a}	0.027
NDF	0.46^{a}	0.43^{a}	0.43^{a}	0.38^{a}	0.41^{a}	0.062
ADF	0.52^{ab}	0.72^{a}	0.69^{ab}	0.63^{ab}	0.48^{b}	0.12

$^{a, b, c}$ = means within rows having different superscript letters are significantly different at= $P<0.005$, ADF = acid detergent fiber; CP = crude protein; DM= dry matter; NDF = neutral detergent fiber; OM = organic matter; SEM= standard error mean.

Table 4: Digestibility coefficient of dry matter and nutrients of salale sheep type fed on hay basal diet and supplemented with different proportion of Wheat bran and Noug seed cake mixtures.

	Treatment					
Parameters	T1	T2	T3	T4	T5	SEM
Initial BW (kg)	23.95^{a}	23.16^{a}	23.83^{a}	23.55^{a}	23.70^{a}	1.12
Final BW (kg)	26.92^{b}	32.34^{a}	32.62^{a}	31.70^{a}	30.75^{ab}	2.3
ADG (g/days)	25.0^{b}	78.0^{a}	75.0^{a}	69.0^{a}	60.0^{a}	0.01
FCE (g ADG/g DMI)	0.03^{b}	0.09^{a}	0.08^{a}	0.075^{a}	0.068^{a}	0.01

$^{a, b}$ = means within rows having different superscript letters are significantly different at= $P<0.005$; BW= body weight ;ADG= average daily gain; FCR= feed conversion ratio; SEM= standard error mean.

Table 5: Body weight change and feed conversion efficiency of Salale sheep type fed on haybasal diet and supplemented different proportion of wheat bran and Noug seed cake mixtures.

also reported that the low degree of digestion coupled with low passage rate through the alimentary tract limit net energy availability for production. However, supplemented sheep (T2-T5) did significantly (P>0.01) differ with non-supplemented group in these parameters. The results of this study agree with the finding of [12] who supplemented sheep with different levels of peanut cake and wheat bran.

In the current study, sheep fed hay alone gained 25g ADG, indicating that the hay was just sufficient in maintaining BW of the animals. More and probably better balanced nutrient supply as the result of supplementation might have been followed with concomitant improvement in ADG and FCE in the current study for the supplemented sheep. The results of this experiment indicated that supplementation of different proportion wheat bran and Noug Seed Cake mixtures improved feed intake partly as the result of increased digestibility due to the supply of sufficient CP and/or energy that enhanced microbial multiplication and activity, with consequent increase in ADG and FCE. The ADG of sheep 75 g/d at T3 (233g wb+117g NSC) in the present study was comparable with the value of (75.56 g/d) reported by [22] fed concentrate mixed ration. However, [36-39] reported higher value of ADG (87.8 g/d) for Arsi-Bale sheep fed faba bean haulms supplemented with different proportion of Barley bran and lean seed meal as compared to lambs in T2 (78g/d) and T3 (75g/d) of the present study. The variation in ADG might be obtained from difference in the level of supplements.

Trends in body weight change of Salale sheep type fed hay alone or supplemented with different proportion of wheat bran and Noug seed cake mixtures is presented in (Figure 1). It was made clear from the (Figure 2) that as the feeding period advanced, body weight change of experimental animal varied. Thus, animals in the un-supplemented maintained their body weight. However, animals in the supplemented group (T2-T5) showed an increasing trend across the feeding period.

Conclusions and Recommendations

Generally, the present study indicated that supplementation of Salale sheep type lambs with concentrate mixtures of noug seed cake and wheat bran at different proportions had improved feed intake, digestibility and body weight change. Moreover, it was concluded that supplementation of hay with 350 g/day wheat bran (T2) is biologically efficient and potentially profitable in feeding of Salale sheep compared to other proportions of supplements. The current study was conducted on station; therefore, in order to guarantee the importance of the

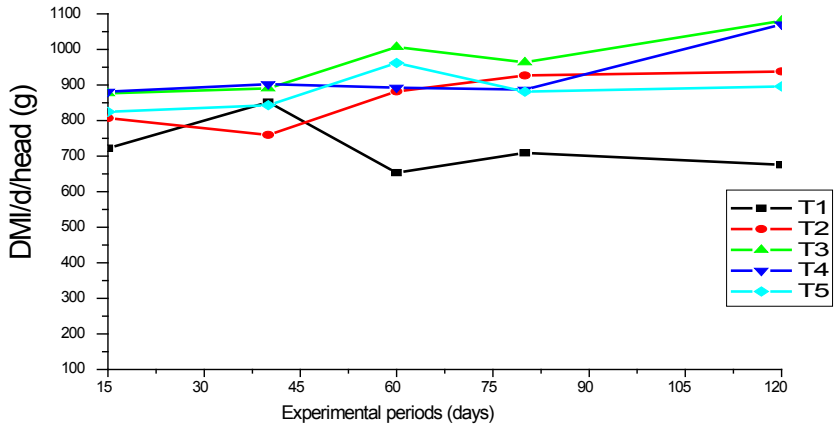

Figure 1: Daily dry matter and nutrient intakes of Salale sheep type fed on hay basal diet and supplemented with different proportion of wheat bran and Noug seed cake mixtures.

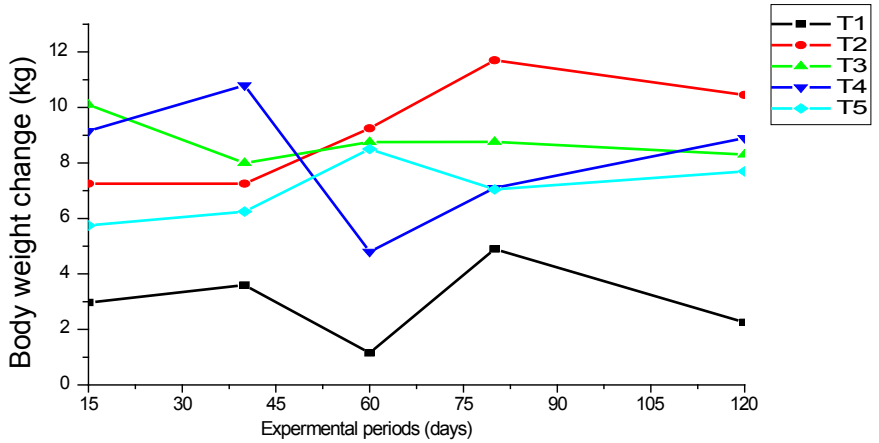

Figure 2: Body weight change and feed conversion efficiency of Salale sheep type fed on hay basal diet and supplemented different proportion of wheat bran and noug seed cake mixtures.

supplementation at producers' level, undertaking on farm trial using the recommended treatment (T2) used in the present study is advisable.

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