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Body Weight Gain and Testicular Growth of Horro Rams Supplemented with Noug Seed Cake and Wheat Bran Mix under Grazing Management in Western Ethiopia

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Abstract

The effect of supplementation with concentrate of Noug seed cake (NSC) and Wheat bran (WB) mixture on body weight gain, body condition and testicular size of Horro rams was evaluated under grazing management at Bako Agricultural, Technical and Vocational Education and Training college, western Ethiopia. The experiment involved 18 uniform intact yearling Horro rams with average initial body weight of 18.55 ± 0.99kg (mean ± SD). Treatments consisted grazing natural pasture alone (T1;Control), or T1 supplemented with concentrate mixture at 0.9% of body weight (T2) or T1 supplemented with concentrate mixture at 1.5% of Body weight (T3). The experiment was laid out completely at random where rams were randomly allocated to three dietary treatments (six per treatment). Chemical composition of the natural pasture and supplementary feeds were analyzed using standard laboratory procedures. Data were analyzed using General Linear Model (GLM) procedure of the statistical analysis system (version SAS 9.1). Natural pasture was poor in Crude Protein (6.07%), relatively lower in In vitro digestible organic matter (54.61% of DM) and high in Acid detergent fiber (67.78%). Supplementation significantly ($P<0.05$ to $P<0.001$) increased Average daily body weight gain (ADg), final body weight gain (FBW), body condition score (BCS), and testicular traits. There was no significant ($P>0.05$) difference between T2 and T3, with respect to parameters considered, In general, since supplementation with T2 improved ADg, and testicular size in Horro rams grazing natural pasture, consistent with T3, T2 should be considered as an appropriate feeding strategy to improve productive and reproductive traits of Horro rams under small holder farming system.

Introduction

Globally, small ruminant enterprise is economically viable and contributes a substantial amount to total household income (1). Sheep plays multi-functional roles in different production systems for the rural community of Ethiopia where regular income, meat and manure are the tangible benefits of sheep (2).

Moreover, sheep plays a significant role in the Ethiopian economy, as live animals, mutton, and skins, being a commodity group that constitutes important foreign currency item. In the western part of Ethiopia, Horro sheep is an important and integral part of the rural communities farming activity, contributing substantially to the household income and food security.

However, productivity of sheep in Ethiopia is generally low with an estimated annual off take rate of 33% and carcass yield of 10kg (3). One of the factors that hamper livestock productivity in Ethiopia is low fertility of the breeding stock (4), where the fertility of the males is reported to have a greater influence on stock performance than does the fertility of females (5).

Reproductive performance of sheep is influenced by various factors including breed, physical environment, nutrition and management. However, nutritional factors are the most crucial in terms of their direct effects on reproductive phenomenon and the potential to moderate the effects of other factors (6). Earlier research works demonstrated the apparent effect of nutrition on body weight gain, and hence on reproductive traits of different sheep breeds. For example, variation in daily weight gain, scrotal circumference and body condition score due to variation in nutritional level in Menz rams was reported (7). Horro rams supplemented with concentrate had higher body weight gain and testis weight under controlled (8) and grazing management (9). In fact, nutritional regimes that improve daily gain are likely to enhance testicular development (10)

Under Ethiopian situations, livestock obtains most of their feed from grazing of natural pasture and crop residues which are generally poor in nutritive value. The natural pastures are overgrazed severely and cannot meet the nutritional requirement of livestock resulting in reduced growth rate, low production, poor fertility and high mortality particularly in dry season during which animals depend on matured herbage, aftermath and crop residues, which are low in protein, digestible energy and minerals (11).

In order to overcome the problem and thereby enhance animal productivity practical and relevant strategies should be devised. Supplementation of low quality feeds with agro-industrial by-products are among the strategies employed to improve animal productivity (12). Agro-industrial by-products contain high crude protein and metabolizable energy, low fiber constituents, better availability, and relatively cheaper compared to grains, which enables it better fit to smallholders. The most common agro-industrial by-products available in western part of Ethiopia included noug seed cake (*Guizotia abyssinica*) and wheat bran (Triticum aestivum).

Supplementation of sheep with either noug seed cake and/or wheat bran fed a basal diet of crop residues have been reported to improve performance in Afar and Blackhead Ogaden rams (13). However, information with regard to the effect of supplementation with mixtures of noug seed cake and wheat bran on body weight gain and testicular size of Horro rams under grazing management is non-existent. The fact that noug seed cake and wheat bran contain moderate to high CP and metabolizable energy, with low fiber constituents makes the combination an excellent supplement to improve animal performance under extensive husbandry. The information generated from this study can contribute to exploit the genetic potential of Horro rams and thereby improve the livelihood of society.

Materials and Methods

Description of the Study Area

The study was conducted at Bako Agricultural Technical and Vocational Education and Training College, West Shewa zone of Oromia National Regional State. The college lies at 09^0 06'N latitude and 37^o 03'E longitudinal, and located at a distance of about 250 km west of Addis Ababa on the main road to Nekemte, the capital of East Wollega Zone. The average elevation of the area is about 1560m above sea level. The soil texture of the area is sandy clay loam (14). Bako has a hot and humid climate and receives a

mean annual rainfall of about 1219 mm, more than 80 % of which is recorded in the months of May to September. The mean monthly maximum and minimum temperatures are 28 and 14°C, respectively

Management of the Experimental Animals

The experiment was conducted from January through April, 2011 for a period of 120 days. Twenty four intact yearling Horro rams were purchased from the local market and quarantined for 3-weeks during which they were dewormed against common endo-parasites, sprayed against common ecto-parasites and vaccinated against pastuerellosis. A total of 18 rams with mean (± SD) initial body weight of 18.55 ± 0.99 kg were selected for the experiment and acclimatized for additional 2-weeks' time for the experimental feeds and the environment. The animals were maintained on natural pasture land grazing for 8 hrs a day and supplemented with different levels of concentrate. The natural pasture of the grazing land is dominated with Hyperrhenia grass species. Water was given twice a day and mineral salt (block) was made available in their individual pen at night. All the experimental animals were ear tagged.

Experimental Design and Treatments

The experiment involved 3 treatments and laid out completely at random. Dietary treatments were randomly allocated to animals so that each animal had equal chance of receiving one of the treatments. There was no difference ($p>0.05$) in initial body weight and testicular measurements among treatments after randomization.

Treatments constituted grazing on native pasture alone (Control; T1), grazing on native pasture and supplemented with concentrate at 0.9% of body weight (T2), and grazing on native pasture and supplemented with concentrate at 1.5% of body weight (T3).

Feed Preparation and Sampling

Noug seed cake and wheat bran were purchased from local edible oil extraction mill in Bako town and Ambo Wheat flour milling factory, respectively, and the required amount was mixed daily(at 1:1 ratio) throughout the feeding period. Supplementary feeds were fed individually once a day at dusk after the animals returned back from grazing.

Representative samples of feed ingredients were taken from each batch, and pooled by feed type over the feeding period. At the end of the experiment, feed samples were sub-sampled, ground to pass through 1mm sieve size and stored pending chemical analysis.

Biomass Yield of the Grazing Pasture

One hectare of pasture land was demarcated and allocated for the experimental animals for grazing. The biomass yield of the grazing land was estimated by taking samples at three different times during the experimental period using quadrate. Five quadrate samples of 1m x 1m was established within a hectare of grazing land, four at the corners and one at the center of the hectare initially. The second and third samples were taken every month by randomly throwing the quadrate five times during sample taking time with in the grazing pasture. In both cases from each entire quadrate the herbaceous vegetations were clipped at ground level using hand shears, weighed and dried under the shade to the constant weight. The biomass yield was then determined based on the average DM content of the samples taken at three different times. Representative feed samples were ground to pass through 1 mm sieve size and stored pending chemical analysis.

Materials and Methods

Testicular Measurements

Measurements on Scrotal circumference (SC), Testicular diameter (TD), Testicular length (TL) and Testicular tone (TT) were taken every two weeks by restraining the rams in the standing position. SC was measured at the widest testis circumference using tailor tape while TD was measured at the anterior-posterior position on each testis at its maximum width using a caliper. TL was also measured with a flexible measuring tape on both the left and right testes in cm. Records on left and right testes on TD and TL were averaged to produce single values at each time of measurement.

Scrotal skin thickness (SST) was measured using caliper at the tip of the testes by pushing the testes up ward with one hand while the opposite hand guide and adjust the caliper. Since the scrotal skin is folded, value at each measurement was divided by two and recorded as SST.

Testicular tone (TT) was scored subjectively by palpating the testis for testicular tone as suggested for bucks (15); that ranges in scale from 1-5 (1= very soft; 2 = soft; 3= moderate; 4 = hard; 5 = very hard).

Body Weight

Body weight of the rams was taken in the morning after overnight fasting every week using suspended weighing scale that made to weigh up to 50 kg load of mass.

Body Condition Scoring (BCS)

Body condition score was determined according to (16) every two weeks by assessing several aspects of the tissues covering the backbone and the transverse and spinous process in the loin region behind the last ribs with fingers and scored using scale 0-5 (0 = emaciated; 1 = very thin; 2 = thin; 3 = moderate; 4 = fat; 5 = very fat).

Chemical Analysis of Feeds

Dried feed samples were ground to pass a 1 mm sieve mesh and analyzed for dry matter (DM), organic matter (OM) and crude protein (CP) as described by AOAC (17). Neutral detergent fiber (NDF), acid detergent fiber (ADF) and acid detergent lignin (ADL) were analyzed (18).The *IV* DOMD (*In vitro* digestible organic matter in dry matter) was determined (19)

Statistical Data Analysis

Data were analyzed using GLM procedure of the statistical analysis system (version SAS 9.1). Scored data were transformed into square root before analysis. Average daily gain was estimated for each animal using regression analysis before comparison. Initial measurements for body weight (BW) and scrotal circumference (SC) were included in the model as a linear covariate to adjust for final measurements, respectively. Since the interaction between treatment and feeding period was found to be none significant, only feeding period was included in the model for analysis of testicular size. Pearson coefficient of correlation was employed to assess the existence of associations among BW and testicular traits. The difference among treatment means were examined using Tukey's adjustment and declared significant at $P<0.05$.

Model I: Body weight

$$y_{ij} = \mu + \tau_i + \text{Cov}(IBW)_{ij} + e_{ij}$$

y_{ij} = Observations [average daily and final body weight gain]
μ = Over all mean
τ_i = the effect of i^{th} level of treatment
$\text{Cov}(IBW)_{ij}$ = Initial body weight modeled as a linear covariate
e_{ij} = The residual effect

Model II: Scrotal circumference

$y_{ij} = \mu + \tau_i + Cov\ (ISC)_{ij} + e_{ij}$

y_{ij} = Observations [average daily and final scrotal circumference change]

μ = Over all mean

τ_i = the effect of i^{th} level of treatment

$Cov\ (ISC)_{ij}$ = Initial SC modeled as a linear covariate

e_{ij} = The residual effect

Model III. [Testicular traits]

$y_{ij} = \mu + \tau_i + p_j + e_{ij}$

y_{ij} =observations[testicular traits]

μ = Over all mean

τ_i = the effect of i^{th} level of treatment

p_j =the effect of j^{th} feeding period

e_{ij} = residual effect

Results and Discussion

Chemical Composition of the Feeds

Natural pasture was poor in crude protein (CP) and *in vitro* organic matter digestibility (OMD), but rich in neutral detergent fiber (NDF) and acid detergent fiber (ADF) components (Table 1). This is so since it consisted mainly of *Hyperrhenia* grass species, which was over matured and dry during the experimental period, which eventually results in increased structural carbohydrates, and legnin and decrease in protein content. The finding was consistent with matured Digitaria grass hay fed to Wogera sheep (20). The CP content of noug seed cake (NSC) in the current study was comparable with 31.4% reported earlier (21).

Table 1 Chemical Compositions of feed Stuff

Feed type	DM (%)	%OM					IVDOMD (%)
		OM	CP	NDF	ADF	ADL	
NSC	91.84	91.18	32.54	34.93	29.3	6.45	65.76
WB	89.48	94.94	15.77	46.53	15.1	4	76.78
NSC + WB	90.88	92.78	23.89	38.66	19	5.39	72.95
Natural pasture	72.33	91.04	6.07	67.78	36.9	6.14	54.61

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

Body Weight

Supplementation with concentrate (T2 and T3) significantly ($P<0.05$) improved FBW and daily body weight (DBW) gain of Horro sheep compared to the control (T1). The improvement could probably be through activating microbial protein synthesis and/or providing nutrients for absorption owing to the high CP and digestible organic matter contents of the supplementary feeds used. Similarly, (21) reported ADg of 27.8 to 91.1g for Horro rams supplemented with NSC and WB mixture at 200 to 400g DM /head/day that fed on a basal diet of maize husk, while animals in the control group could not maintain body weight. Similarly, supplementation of Horro rams with 800g ground maize and 800g NSC on Rhodes grass basal diet (8) and 200 to 300g per head per day of NSC supplementation under grazing natural pasture (9)

resulted in better FBW gain and ADg compared to control groups. However, there was no difference ($p>0.05$) in ADg and FBW among the supplemented treatments. From this result, it can be said that supplementation can improve FBW and ADg of Horro rams at both levels of supplementation (T2 and T3).

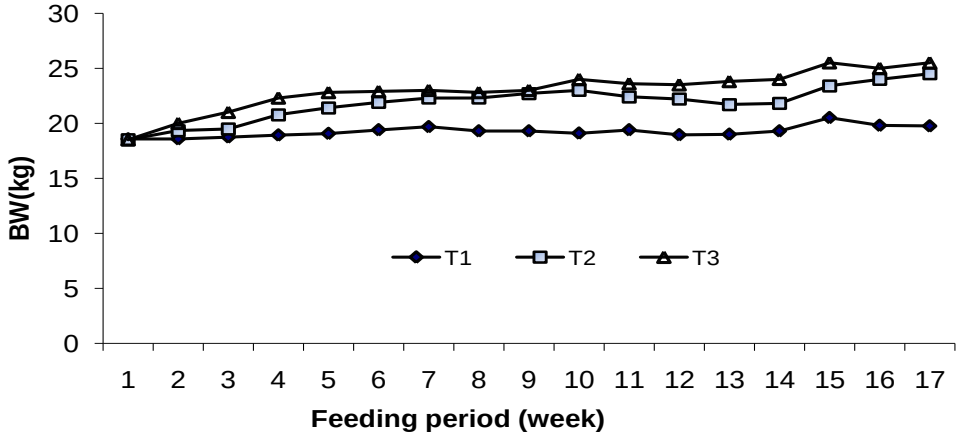
Table 2 Body Weight Change of Horro Rams

Variables	Treatments			Overall (Mean± SE)	SL
	T1	T2	T3		
IBW(kg)	18.5±1.0	18.5 ±0.87	18.5 ±0.69	18.5 ±0.85	NS
FBW(kg)	20.7±0.28[b]	24.2±0.23[a]	25.2±0.25[a]	23.4 ±0.25	*
ADg (g)	12.0±5.90[b]	40.7±5.90[a]	41.5±5.90[a]	31.4 ±5.9	*

IBW= Initial body weight, FBW=Final body weight, ADg=Average daily body weight gain, SL=Significant level, NS=not significant; *=$p<0.05$; [a-b]Means (±SE) in rows with different superscript small letters are significantly different from each other

Supplemented treatments (T2 and T3) exhibited increased body weight as feeding period advanced while rams in the control treatments (T1) maintained the lowest body weight with little change over time (Fig. 1). This might be attributed to the condition of grazing pasture, which was unable to maintain higher BW gain due to its poor quality during the dry season where this experiment was conducted. Similarly, it was reported that lambs given no supplementary feed and grazed on natural pasture in the dry season lost live weight, while supplemented lambs gain BW (22). Thus, even though rams in the control (T1) gained weight in the current study, it was by far less than the gain achieved by supplemented rams (T2 and T3) implying that supplementation is necessary to exploit the genetic potential of the animals.

Figure 1 Trends in Body Weight Change of Horro Rams Across the Feeding Period (T1=Treatment 1, T2= Treatment 2, T3=Treatment 3)



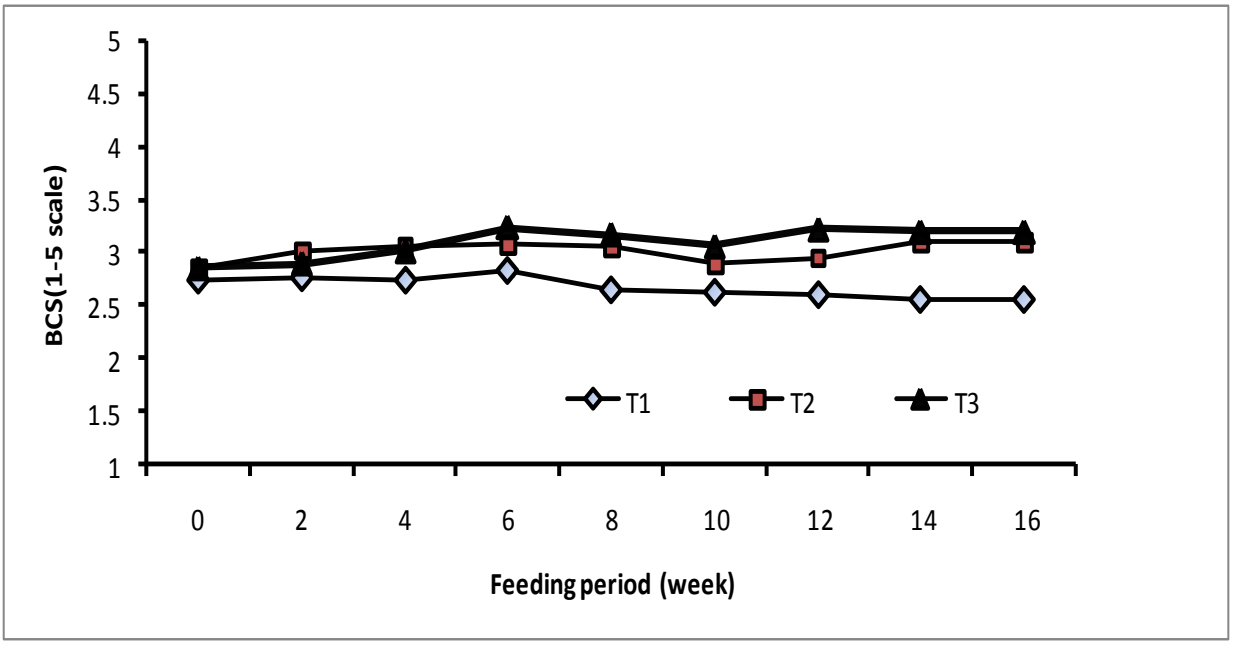
Body Condition Score (BCS)

Mean(±SE) BCS of Horro rams grazing natural pasture and supplemented with different levels of wheat bran and Noug seed cake mixture (T1=2.78 ± 0.059; T2=3.11 ± 0.035; T3= 3.19 ± 0.04) was affected (P<0.001) by supplementation. Though, there was no variation (P>0.05) between T2 and T3, the current results revealed that supplementation at both levels favorably influenced BCS.

This phenomenon was also reported (23), where goats lose body condition in the dry season and gain during the wet season. Concentrate supplementation improved BCS in Horro rams (9). Similarly, nutritional supplementation with khat left over and agro-industrial by-products improved BCS in indigenous male goats as compared to those of non-supplemented goat fed grass hay only(12) indicating the need for supplementing male animals for better performance.

BCS is sensitive to seasonal change, consequently, to feed availability, and hence it could be used as a management tool in farm animal (24). BCS exhibited an increasing trend for supplemented rams while it showed decreasing trend (Fig. 2) for the control implying that supplementing improved BCS of Horro rams under grazing management.

Figure 2 Trends in Body Condition Scoring Of Horro Rams Across the Feeding Period (T1=Treatment 1, T2= Treatment 2, T3=Treatment 3)



In the current study, even though rams in the control (T1) did not lose body weight, they showed a decrease in BCS, which could be related to the sensitivity of body condition to feed scarcity. The result was consistent with (23) who demonstrated that changes in BW did not parallel with BCS in Sahel goat and indigenous Tsawana goat, which might be attributed to the fact that BCS reflects body lipids more than BW does as the latter is affected by gut fill, which vary according to the type and quality of feed availability. The same authors also indicated suitability of BCS for assessing the nutritional consequences of the dry versus wet season under extensive management condition.

Testicular Measurements

Supplementation improved (P<0.001) scrotal circumference (SC) in T2 and T3 compared to the control maintained under grazing management on natural pasture (Table 3). There was no difference (P>0.05) in SC between T2 and T3. The higher SC in the supplemented group was comparable with 23.5 ± 0.30 cm of earlier report (25). Although SC recorded in the current study was within the range (21 to 28cm) reported earlier (26), it was lower compared to 28.7 cm reported (27) for the same breed. The disparity might be due to differences in the age of the experimental animals used since this study employed yearling rams as compared to rams of 2 to 3 years old used in the latter case. As BW significantly affects SC (27), rams of 3 years old attain higher BW and consequently higher SC would be expected. Another report indicated that the mean SC for Horro rams was found to be 27cm (2). This high value, in comparison to the current finding, may be attributed to the fact that the author used different age classes of rams since age influences SC of the animal.

Table 3 Means (±SE) Scrotal Circumference of Horro Rams

Variables	Treatment			Overall (Mean± SE)	SL
	T1	T2	T3		
ISC (cm)	20.83 ± 0.48	20.58 ± 0.51	20.83± 0.55	20.75± 0.5	NS
FSC (cm)	20.29±0.25^{b}	24.49±0.3^{a}	24.54±0.2^{a}	23.11±0.25	***
TCSC (mm)	-4,57±2.5^{b}	37.47±2.6^{a}	37.92±2.5^{a}	23.61±2.55	***
AD CSC (mm)	-0.04±0.02^{b}	0.33±0.0^{a}	0.34±0.0^{a}	0.21±0.01	***

ISC= Initial scrotal circumference; FSC= Final scrotal circumference; TCSC= Total change in scrotal circumference; ADCSC=Average daily change in scrotal circumference; SL= Significant level; ***=p<0.001; $^{a-b}$Means (±SE) in rows with different superscript small letters are significantly different from each other;

Supplementation with NSC and WB mixture at 0.9 % (T2) and 1.5 % (T3) of BW on DM basis was found to increase SC for T2 and T3, respectively, while there observed a reduction in respective traits for T1 (Table 3).The favorable results regarding the increase in SC, with supplementation may be due to the beneficial effect of dietary nutrients on the testicular traits. This is similar to earlier report (28) which indicated that selenium supplementation favorably affects cells of testes and increased SC in Suffolk Egyptian rams.

On the other hand the decrease in SC for non-supplemented group could partly be explained by the decrease in scrotal skin thickness (SST) by 12.5%. Furthermore, the loss in these testicular traits in non-supplemented rams might be attributed to the decline in feed availability during that particular dry season, which consequently resulted in the loss of testicular subcutaneous fat. Similarly (29) reported that Arsi-type rams fed on sole basal diet of chickpea haulms were found to reduce their SC by 10% due to loss of fat from scrotal tissues. Testicular size was drastically reduced in grazing rams (30) and rams either gain or lose testicular size at greater rate than live weight that have associated depressed testicular growth with protein deficiency in rams (31)

Other testicular traits were also significantly (P<0.001) affected by supplementation. Except SST and Testicular length (TL), other testicular variables were not significantly (P>0.05) influenced by the feeding period (Table 4). Highly significant (P<0.001) differences were observed in testicular tone (TT), testicular diameter (TD); TL and SST between supplemented and non-supplemented groups, with the lowest value being recorded for non-supplemented (control) animals, while no significant variation (P>0.05) was observed between T2 and T3. Except for TD measurements, values for SST, was lower than the average values of 0.75 ± 0.06 to 0.9 ± 0.06 cm earlier reported (29). The variation might be attributed to difference in the reported BW and breed differences.

Table 4 Means (±SE) Testicular Dimensions of Horro Rams

Parameters	Treatment			Overall (Mean ±SE)	Significance	
	T1	T2	T3		T	P
TT*	2.5±0.09[b]	3.28±0.08[a]	3.37±0.06[a]	3.05±0.07	***	NS
TD(cm)	3.37±0.11[b]	3.96±0.07[a]	4.11±0.06[a]	3.82±0.08	***	NS
SST(cm)	0.127±0.006[b]	0.158±0.005[a]	0.196±0.01[a]	0.16±0.007	***	***
TL(cm)	7.76±0.23[b]	9.72±0.15[a]	9.73±0.15[a]	9.07±0.17	***	**

TT*= Original data of testicular tone (1-5 score); TD= testicular diameter (cm); SST=scrotal skin thickness (cm); TL=testicular length (cm); ***=p<0.001;**=P<0.01; [a-b]Means (±SE) in rows with different superscript small letters are significantly different from each other; T= treatment effect; P= period effect

TD measurements in the current study for supplemented groups were comparable with values reported by (25), which were 46.5 ± 0.72 mm.

As indicated by testicular measurements in the current study, testicular size was affected by nutrition, with values being lower for control than supplemented groups which indicated that testicular growth can be

positively affected when animals are fed above their maintenance requirement. Hence supplementing Horro rams during the dry season is mandatory as lower testicular size has been associated with poor fertility and a lower libido (29). Generally, supplementation was found to favorably affect all testicular traits considered in the current experiment, while there appeared a reduction in these traits across the experimental period in non-supplemented group which underline the importance of supplementing Horro rams.

Correlation Among Body and Testicular Traits of Horro Rams

The current result indicated that body weight (BW) was positively and highly correlated to TD, SC and TL (Table 5). In agreement to this, (29) demonstrated the existence of high correlation among BW and SC ($r=0.79$; $p<0.01$) in Arsi ram breed supplemented with different level of leucaena leaf hay and concentrate mixture. Similarly, BW was found to be highly and positively correlated($r=0.79$) to SC in Horro rams (2).

Table 5 Correlation Among Some Traits in Horro Rams

	BWT	SC	TD	TL
BWT	1	0.90(p<.001)	0.85(p<0.001)	0.93(p<0.001)
SC		1	0.96(P<0.001)	0.91(P<0.001)
TD			1	0.91(P<0.001)
TL				1

BW= body weight (kg), SC= scrotal circumference (cm), TD=testicular diameter (cm), TL= testicular length (cm).

Conclusions

The result of this study showed that supplementation with concentrate at 0.9 and 1.5% of body weight improved ADG, body condition score and testicular size of Horro rams compared to the control maintained under grazing management alone. since supplementation with T2 improved ADg, and testicular size in Horro rams grazing natural pasture, consistent with T3, T2 should be considered as an appropriate feeding strategy to improve productive and reproductive traits of Horro rams under small holder farming system. Further, there were positive and linear associations between body size and testicular traits considered in the current study suggesting that selection on one or both of these traits would have favorable correlated response in the other traits of Horro rams.

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