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Growth Performance of Arsi-Bale Sheep Fed Desho Grass (*Pennisetum pedicellatum*) Hay Supplemented with Different Concentrate Levels

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Abstract

An experiment was carried out at Debre-Zeit Agricultural Research Center to evaluate the performance of yearling Arsi-Bale lambs fed desho grass hay as a basal diet ad-libitum with and without supplementing concentrate mixture. Growth performance of the lambs was evaluated using desho grass hay ad libtum alone (T1) and supplemented with different concentrate mixture; 200 (T2), 300 (T3) and 400g (T4) head^{-1}. Twenty-four yearling intact lambs with an initial body weight of 20.7±1.50 (mean ± SE) were randomly allotted in to six groups of 4 animals per group and assigned to four treatments in randomized complete block design. Dry matter intake of lambs recorded in T_4 (825 g) was higher ($P\leq 0.001$) than in T_3 (732 g), T_2 (681 g) and T_1 (456 g) groups. Animals in 400g concentrate supplementation (T_4) had higher ($P\leq 0.001$) daily average weight gain (97 g), carcass yield (11.7 kg), dressing percentage (42%), and lower feed conversion ratio (8 g feed /g gain) than in T1 and other supplemented groups. It could be concluded that supplementation with 400 g concentrate (T_4) h^{-1}, d^{-1} was found to be an optimum level of concentrate diet to support greater weight gain, carcass yield and lower feed conversion ratio.

Keywords: Arsi-Bale sheep, carcass, concentrate, Desho grass

Introduction

Shortage of feed both in quantity and quality is reported to remain one of the limitations of livestock production in Ethiopia, indicating the need to investigate locally available better quality forage plants. Desho grass is native to tropical Africa and mainly found on disturbed land, road edges and recent fallows, in areas where annual rainfall ranging between 600 mm and 1500 mm with a rainy season of 4-6 months and average daily -temperatures of about 30- 35°C (FAO, 2010). In Ethiopia this grass is known as a perennial forage crop assumed to have originated in Southern region. Currently the grass is used for soil conservation practices and animal feed to support basal feed requirements. It has the potential of meeting the challenges of feed scarcity since it provides more forage per unit area and ensures regular forage supply even with multiple harvesting and various ecological adaptions that range from 1500 to 2800 m.a.s.l (Leta *et al*., 2013).

It is known that the quality of given forage as animal feeds is a function of its nutrient concentration, palatability and digestibility by animals and production performance of the animals feeding on the respective forage species (Julier *et al*., 2001). In this regard, the study conducted by Asmare *et al*. (2018) indicated that desho grass contained most of the required minerals for herbivores and high producing animals. However, there is no adequate information on feed value potential of desho grass when particularly supplemented with graded levels of concentrate to growing Arsi-Bale sheep breed. Lukuyu *et al*. (2011) reported the importance of generating enough information of locally available feed resources to include it in to livestock feeding system.

Therefore, this research activity was aimed at evaluating production performances (growth and carcass yield) and economic benefit of Arsi-Bale sheep fed on Desho grass hay supplemented with different levels of concentrate diet.

Materials and methods

Description of the study area

The experiment was conducted from March –June, 2019 at Debre Zeit Agricultural Research Centre sheep research station, located at 45 km South East of Addis Ababa (08°44'N 38°,58'E; average altitude of 1900 m a.s.l), Ethiopia. The area is known for bimodal rainfall pattern with average annual rainfall of 845 mm and annual minimum and maximum temperature of 10 and 22 °C, respectively. The area is characterized by mixed-crop livestock production system; with major crops grown include *Tef* (Eragrostis *Tef*), wheat, chick pea and lentil.

Experimental feed preparation and animal selection whistleblower

Desho grass (Areka variety)was established at Debre Zeit Agricultural research centre and subjected to harvesting at three months of age for the first cut (Leta*et al*., 2013), six and nine months of age for second and third cut, respectively. The fresh desho grass was chopped at the size of 1-10cm with small chopper and sun dried for 3-5 days. The dried desho grass was preserved for one year while still maintaining its green color up until the experimental sheep were purchased. The concentrate feed was formulated from 39% wheat middling, 40% noug seed cake, 20% ground maize grain and 1% common salt on DM basis.

Twenty-four yearling ram lambs of Arsi-Bale sheep breed were purchased from local markets based on dentition and information provided by the owners. Soon after arrival at the experimental station, the animals were vaccinated against ovine pasteurellosis, sheep pox, and anthrax, de-wormed against internal parasites (flatworms and round worms) and sprayed against external parasites (tick and mange). The experimental sheep was quarantined for 21 days in a separate house to get accustom to the new environment. The animals were closely observed for incidence of any ill and disorders during this period. Then the lambs were arranged in experimental pens to facilitate individual indoor feeding after which they were subjected to 15 days of adaptation to experimental diets and continued for 84 days of feeding. Desho grass was fed as a basal diet and concentrate supplement was offered in two meals at 0800 and 1600 hours. All sheep had free access to clean water throughout the experimental period.

Experimental Treatments and Design

Treatments	Desho grass hay	Concentrate
T_1	Ad libitum	0
T_2	Ad libitum	200
T_3	Ad libitum	300
T_4	Ad libitum	400

Twenty-four yearling intact lambs with an initial body weight of 20.7±1.50 (mean ± SE) were randomly allotted in to six groups of 4 animals per group and assigned to four treatments in randomized complete block design with six sheep per treatment.

Feed intake, live weight change and feed conversion ratio

With the commencement of the feeding trial, data on feed offer and refusal was taken daily and the feed intake was calculated as the difference between feed offered and refused. Live weight was measured fortnightly after overnight fasting using a 100 kg movable weighing scale with a sensitivity of 0.5 kg. The average daily body weight gain was calculated as the difference between the initial and final live weight of the lambs divided by the number of experimental days. Feed conversion ratio (FCR) of the lambs was determined as average daily feed intake divided by average daily gain.

Carcass evaluation

At the end of the feeding trial animals were kept in fasting overnight then slaughtered for carcass evaluation. Hot carcass weight and non-offal components were measured immediately after slaughter. The full reticulo-rumen was weighed using plastic bag. The carcass was chilled at 4˚C for 24 hours and cut between 12th and 13th ribs perpendicular to the backbone to measure rib-eye muscle. The transparency paper was placed on the area of rib-eye muscle first then sketched by pencil and the area again sketched from transparency paper on 0.25 cm^2 gridded paper, then the number of squares counted in the area of REMA multiplied by 0.25 cm^2 and the value taken as rib eye muscle area (Otonie *et al*.,2012). Dressing percentage was calculated on the basis of slaughter body weight using the formula;

Dressing percentage = Hot carcass weight /Slaughter body weight X 100

Feed cost analysis

The feed cost per unit live weight gain was determined using the ingredient feed cost per the respective dietary treatment divided by the total live body weight gained during the experimental period. The desho grass cost was estimated based on natural pasture grass hay.

Laboratory analysis of feed ingredients

Laboratory analysis of experimental feeds for dry matter and Nitrogene determined using AOAC official methods (AOAC, 2005). DM for feed offered and refusal samples was determined by oven drying of the samples at 105 ^{0}C to constant weigh. Nitrogen was determined using kjeldhal`s procedure then N was multiplied by 6.25 to find crude protein content.

Data Analysis

Data was analyzed using SAS software program (SAS, 2003). Mean comparison was done using Duncan's multiple range test and significant differences between the treatment groups were declared at $P \leq 0.05$.

The model fitted to calculate the different parameters were:

$Y_{ij} = \mu + a_i + + B_j + e_{ij}$

Where:

Y_{ij} = Response variables,

μ = Over all mean,

a_i = ith concentrate level effect,

B_j= jth body weight effect

E_{ij} = Effect of the ijth random error

Results and Discussion

Dry matter and crude protein composition of experimental feeds

The DM and CP content of desho grass, concentrate and refusals is presented in table 1. Crude protein content in offered desho grass was higher than the refusal desho grass in all treatment groups, which indicates there was high selectivity for palatable desho grass in all treatment groups. In the current study CP content (7.5%) of desho grass was lower as compared with 9-14% CP reported by Denbela *et al*. (2020) from different desho grass variety, whereas the value was higher as compared with natural pasture grass hay CP content of 3.5% (Bimrew, 2016). The CP percent value of noug seed cake observed by the current study (36%) was better than the value of 32% in Gashu *et al*. (2013) report. The CP content of wheat bran observed in the current study was lower than 20.1% reported by Gashu *et al*. (2013). The difference in CP content of feeds between the current and earlier reports might be due to management practice, soil type, variety, stage of maturity at harvest and climatic condition differences.

Table 1 Experimental feed ingredient and refusals dry matter and crude protein content

Offered	DM%	CP%	Refusals	DM%	CP%
Desho grass	87.6	7.5	Treatment 1	90.2	3.5
Concentrate mix	89.9	22	Treatment 2	90.2	3.3
-Noug cake	92.3	36.2	Treatment 3	90.4	4
-WB	90.2	15.6	Treatment 4	90.5	3.3
-Maize	88.9	9			

Note: WB= wheat bran; DM= dry matter; CP= crude protein; NDF=neutral detergent fiber

Dry matter and crude protein intake

The effect of concentrate levels on the average daily feed dry matter intake (DMI) of experimental animals is presented in Table 2. The level of concentrate did not significantly ($P \geq 0.05$) influence desho grass intake of the sheep. Total DMI of lambs was influenced ($P \leq 0.01$) by levels of concentrate supplementation. Lambs fed T_4 consumed higher total DM than the other groups. The higher DMI of lambs observes with higher concentrate level can be associated to the higher palatability and digestibility of the concentrate diet than desho grass. Total crude protein intake of fattening lambs was higher in T_4 than T_3, followed by T_2 and T_1 animal groups, which was in line with the amount of dry matter consumed.

The overall total daily DMI of lamb in this experiment (673.5±47.7 g) was lower than DMI (920g/day) reported earlier by Getahun (2015) for the same sheep breed. However, DMI of Arsi-Bale lambs assigned on 300 and 400g concentrate supplemented groups in the current study was within the range reported by Getahun *et al.* (2020) that was between704-843g for the same sheep breed fed concentrate and *tef* straw. The observed DMI difference between the current and the past study could be linked to the difference in the animal's initial body weight, the feed ingredient type, proportion and difference in nutritional compositions.

Table 2. Average dry matter and CP intake (g) of Arsi-Bale sheep as affected by levels of concentrate supplementation

Treatment	Desho grass intake	Concentrate intake	TDMI	TCPI(g)	TCPI (%)
T_1	456.2	0.0^d	456.2^c	43^d	9
T_2	480.9	200^c	680.9^b	87^c	13^c
T_3	431.9	300^b	731.9^b	105^b	14^b
T_4	425.1	400^a	825.1^a	128^a	17^a
Mean ± SE	448.5± 47	225± 0	673.5 ± 47	90± 4	13 ± 1
P-value	<0.1997	<.0001	<.0001	<.0001	<.0001
Sig	NS	***	***	***	***
CV	10.6	0	9.0	3	7

Note: T_1 = Desho grass hay alone; T_2 = *Ad libtum* desho grass hay +200g concentrate supplement; T_3 = *Ad libtum* desho grass hay + 300g concentrate supplement; T_4 = *Ad libtum* desho grass hay + 400g concentrate supplement

Body weight change and feed conversion ratio

The effect of concentrate supplement levels on live weight change and feed conversion ratio (FCR) of lambs is presented in Table 3. The average initial body weight of experimental animals was similar ($P \geq 0.05$) among the dietary treatments. Average final live weight attained ($P \leq 0.01$) and daily body weight gain ($P \leq 0.001$) of the animals were higher in T_4, T_3 and T_2 groups than in T_1. Moreover, among the supplemented groups in T_4 showed higher final weight than T_2 group. Concentrate level effect was significant ($P \leq 0.001$) on FCR in terms of unit dry matter intake per unit body weight gain. The experimental sheep showed lower feed conversion ratio ($P<0.0001$) in the concentrate supplemented group compared to non-supplemented group. However, FCR of lambs remained similar ($P>0.05$) among the supplemented groups. Numerically the experimental sheep showed lower feed conversion ratio in T4 (8 g/g WG) than T2 and T3 diet groups.

Table 3. Average weight change of Arsi-Bale sheep as affected by different concentrate levels

Parameter	Treatment means				Mean±SE	Sig	CV
	T	T	T	T			
IBW (kg)	20.41^a	20.33^a	20.08^a	20.16^a	20.7±1.50	0.8998^{NS}	7.10
FW (kg)	21.66^c	25.50^b	27.00^{ab}	28.33^a	26.21±1.32	0.0021**	5.03
TWG (kg)	1.25^c	5.16^b	5.91^b	8.16^a	5.62±1.02	0.0001***	18.15
ADWG(g)	14.88^c	61.50^b	70.43^b	97.22^a	64.54 ±11.71	0.0001***	18.15
FCR	23.8^a	12.3^b	10.8^b	8.0^b	12.8 ±3.8	<.0001***	29

Note: IBW = Average initial body weight; FW = Final body weight; DWG = Daily body weight gain; FCR = feed conversion ratio; *= P≤0.05; ** = P≤0.01; *** = P≤0.001; NS = non-significant level

The trend in the body weight change of the experimental lambs during the feeding trial is indicated in Figure 1. The live weight of lambs in all treatment groups was steadily increased during the first 14 days but then, until the end of feeding trial with the highest and lowest slop being recorded for sheep in dietary groups of T4 and T3, respectively. Growth of sheep in the control group (T1) showed more or less constant and slower rate of growth performance except towards the last days of experimental duration.

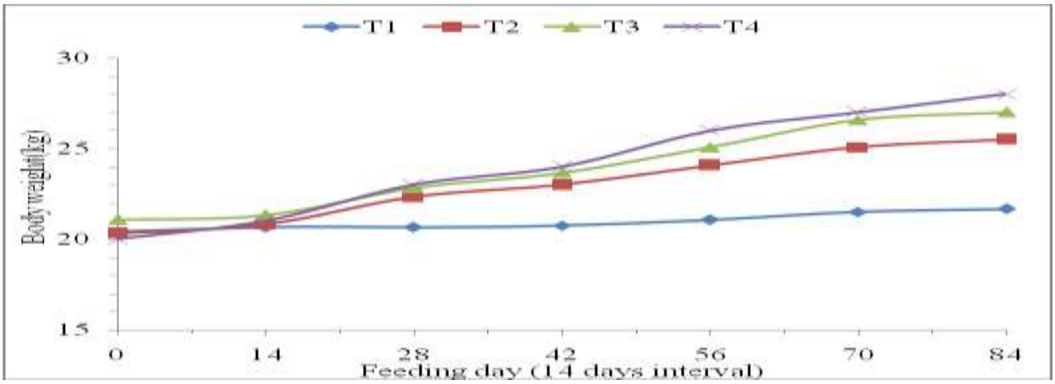

Figure 1. Body weight change as affected by treatments in14 days' interval

Most of the indigenous Ethiopian sheep on different feeding systems had 18 - 26 kg live weight with a daily average live weight gain of 16 to 126 g/day at yearling age Ayele and Urge (2019). Abebe *et al*. (2010) reported that Arsi-Bale sheep fed grass hay basal and supplemented with concentrate at the rate of 2% of initial body weight increased 69-104g live weight per day. Getahun *et al*. (2020) reported that the daily average live weight gain of Arsi-Bale yearling sheep fed on grass hay and sugarcane top silage or hay supplemented with 350g concentrate gained 80-90g per day. In the present study the average final body weight attained (28kg) and the daily live weight gain (97g) of Arsi-bale sheep was comparable with the previous studies.

Carcass yield parameter

The effect of concentrate levels on carcass yield of fattening Arsi-bale sheep is presented in Table 4. The slaughter weight (SW), carcass yield and dressing percentage (DP) of fattening ram lambs varied ($P \leq 0.001$) among dietary treatments. Experimental lambs in T_4 had the highest SW than in T_2 and T_1 groups. Hot and cold carcass yield of lambs were higher in T_4 and in T_3 than in T_2 and T_1 groups. The lowest and highest dressing percentage was recorded from lambs in T_1 (33.2%) and T_4 (41.6%) group, respectively. However, DP difference among the concentrate supplemented lambs was non-significant ($P \geq 0.05$). The hot carcass weight (HCW) and DP of 10±0.68 kg and 39 ± 2.12% (mean± SE), respectively obtained in this study were within the range of 7-18kg and 31% - 52% carcass weights and dressing percentage, respectively of Ethiopian indigenous sheep breeds (Ayele and Urge, 2019). Abebe and Yoseph (2015) reported dressing percentage of 36-38% from Arsi-Bale sheep fed on urea treated barley straw supplemented with 300-400g concentrate, which was similar with the DP obtained from the concentrate supplemented lambs of the current study.

The rib-eye muscle area of the carcass was statistically similar (P≥0.05) among all treatment groups. The rib-eye muscle area (17.9±3.4 cm^2) observed in the current carcass is almost similar with the rib-eye muscle area (16.7±2.7 cm^2) of previously reported (DZARC, 2020 unpublished data) for the same sheep breed fed lentil straw and concentrate supplement. Regardless of this results Otonie *et al.* (2012) reported that the area of the *longissimus dorsi* muscle (rib-eye area) is determined by breed and management, and directly related to the amount of muscle in the carcass in animal studies as an indicator of muscle development and yield of high valuable cuts supplement.

Table 4. Carcass characteristic of Arsi-Bale sheep as affected by different concentrate levels

Parameters	Treatment means (g)				Grand mean	Sig	CV
	T_1	T_2	T_3	T_4			
SW (kg)	22.62^c	25.37^b	27.37^{ab}	28.25^a	25.9±1.72	0.0029	6.66
HCW (kg)	7.52^c	10.10^b	11.30^a	11.72^a	10.1±0.68	<.0001	6.73
CCW (kg)	7.27^c	9.92^b	11.15^a	11.57^a	9.98±O.66	<.0001	6.67
DP (%)	33.21^b	39.87^a	41.31^a	41.55^a	38.98±2.12	0.0004	5.44
REA (cm^2)	16.50^a	17.00^a	19.50^a	18.50^a	17.87±3.4	0.6006	19.17

Note: HCW= Hot carcass weight, CCW= cold carcass weight, DP=Dressing percentage, REA= Rib eye area=SW=Slaughter weight

Feed cost per live weight gain

The costs of experimental feed ingredients and total feed costs and cost incurred per kg live weight gain is presented in table 5. The feed cost incurred for desho grass hay was similar among treatments. Whereas the cost required for concentrate feed ingredients (wheat bran, Noug seed cake, maize and salt) were higher in supplemented groups compared with un-supplemented with the highest cost being recorded for lambs in T_4 groups. However, total feed cost incurred per kg body weight gain was higher in T_1 groups (136 birr/kg gain) compared with the supplemented (T_2, T_3 and T_4) groups. This study showed that supplementation can improve body weight gain and reduce feed cost required to produce a unit quantity of meat. In line with this Abebe *et al.* (2010) reported that supplementation proved to be profitable, hereas feeding hay alone led to economic loss.

Table 5. Feed ingredients cost per day and feed cost per kg live weight gain (Birr)

Treatment	Feed ingredients cost per day					All feeds cost per day	Cost per kg gain
	Desho grass hay	Wheat bran	Noug seed cake	Maize	Salt		
T_1	2.6[a]	0.0[c]	0.0[c]	0.0[c]	0.0[c]	2.6[c]	136.7[a]
T_2	2.8[a]	0.6[b]	0.6[b]	0.3[b]	0.02[b]	4.3[b]	78.2[b]
T_3	2.5[a]	0.9[a]	0.9[a]	0.5[a]	0.03[a]	4.8[a]	70.8[b]
T_4	2.4[a]	1.0[a]	1.0[a]	0.5[a]	0.03[a]	5.1[a]	53.1[b]
Grand mean	2.6	0.6	0.6	0.3	0.02	4.2	80.0
P-value	0.1997	<.0001	<.0001	<.0001	<.0001	<.0.0001	0.0003
Sig	NS	***	***	***	***	***	**
Feed cost/kg	5	6	7	8	8		

Note: Sig = significance; NS=non-significant; ** = significant (P≤0.01); *** = significant (P≤0.001); CV= Coefficient of variance

Conclusion and Recommendation

This feeding experiment showed that lower dry matter intake, live weight gain, carcass yield of experimental sheep and highest feed cost per unit live weight gain was recorded for the group of lambs fed on desho grass alone than those lambs in the supplemented groups. The highest dry matter intake, daily live weight gain and carcass yield, and lowest feed cost per live weight gain was recorded for 400g concentrate supplemented groups. It could be concluded that 400g concentrate level supplement was economical with acceptable DMI, live weight gain, feed conversion ratio and carcass yield of Arsi-Bale sheep fed desho grass basal diet.

References

Abebe, G and Yoseph M. 2015. Effect of Supplementation on Feed Intake, Digestibility, Body Weight Change, Carcass Parameters and Economic Benefit of Arsi-Bale Sheep Fed With Basal Diet of Urea Treated Barley Straw. Technol and Arts Res. J. 4.

Abebe, T, Solomon M⁝ and Kurt J. 2010. Supplementation with linseed (Linum usitatissimum) cake and/or wheat bran on feed utilization and carcass characteristics of Arsi-Bale sheep, Trop. Anim. Health Prod: 42:677-85. doi: 10.1007/s11250-009-9475-8.

Asmare B, Solomon D, Taye T, Firew T⁝ and Wamatu J. 2018. Appraisal of mineral content of desho grass (Pennisetum pedicellatum Trin.) as affected by stage of maturity and agro-ecologies in Ethiopia, J. Agric. Environ. Sci. 3: 56-70.

Ayele, S and Urge M. 2019. Productive and Reproductive Performances of Indigenous Sheep in Ethiopia: A Review. Open Journal of Animal Sciences, 9, 97-120. https://doi.org/10.4236/ojas.2019.91009.

Denbela H, Berako B, and Sintayehu K. 2020. Evaluation of Desho (Pennisetum pedicellatum) Grass Varieties for Dry Matter Yield and Chemical Composition in South Omo Zone, South Western Ethiopia. Agri Res & Tech: Open Access J. 25 (2): 556294. DOI: 10.19080/ARTOAJ.2020.25.556294

FAO (Food and Agriculture Organization of the United Nations) (2010). Grassland Index. A searchable catalogue of grass and forage legumes Food and Agriculture Organization of the United Nations, Rome, Italy.

Gashu M, Tamir B and Mengistu U. 2014. Effect of Supplementation with Non-Conventional Feeds on Feed Intake and Body Weight Change of Washera Sheep Fed Urea Treated Finger Millet Straw. Greener Journal of Agricultural Sciences. 4(2):067-074, http://dx.doi.org/10.15580/GJAS.2014.2.1202131003.

Getahun K, Ashenafi M, and Getachew A. 2020. Performances of Arsi-Bale Lambs Fed Diets Based on Sugarcane Tops Silage and Hay as a Partial Substitute for Natural Pasture Hay, Ethiop. J. Agric. Sci. 30:177-190.

Getahun K. 2015. Optimum Dietary Crude Protein Level for Fattening Yearling Arsi-Bale Lambs Getahun Kebede, World Journal of Agricultural, Sciences 11: 101-106.

Leta G, Duncan A, and Asebe A. 2013. *Desho* grass (*Pennisetum pedicellatum*) for livestock feed, grazing land and soil and water management on small-scale farms. ILRI, Nairobi, Kenya 2 pp.

Otonie GF, Fábio R, Régis C, Vivian F, and Marlova B. 2012. Measurement of rib-eye area by the method of digital images, R. Bras. Zootec. 41: http://dx.doi.org/10.1590/S1516-35982012000300047.

SAS (Statistical Analysis System). 2003. SAS/STAT Guide to Personal Computers, Version 7. Statistical Analysis system Institute. Inc., NC. North Carolina, USA.