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Original Paper

Replacing Noug Seed Cake with Alfalfa Hay in the Diet of Yearling Arsi-Bale Sheep

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Abstract

The study was conducted to evaluate the effects of substituting noug seed cake with alfalfa hay on the growth performance and carcass parameters of yearling Arsi-Bale sheep. The experimental diets were formulated based on iso-nitrogenous rations and included wheat bran, noug seed cake, and alfalfa hay. The alfalfa hay was incorporated into the diets at proportions of 0%, 25%, 50%, 75% and 100%. A total of 30 one year old Arsi-Bale sheep were purchased and treated for anti-parasites before being allocated to treatments in a randomized complete block design with five treatments, each replicated six times. The feeding trial lasted for 100 days, followed by slaughtering. The final body weight, total body weight gain, average daily weight gain, hot carcass weight, dressing percentage, and most non-carcass trait of the sheep did not vary significantly among the treatments. All treatments positively affected the sheep growth performance and carcass traits. The partial budget analysis indicated that animals fed a higher proportion of alfalfa hay generated more income. Therefore, demonstrating the use of alfalfa hay as a protein feed supplements for yearling Arsi-Bale sheep is recommended.

Keywords

Substituting noug seed cake, alfalfa hay, Arsi-Bale sheep

1. Introduction

The sheep population in Ethiopia exceeds 42 million (CSA, 2021) and plays a significant role in the country's economy. However, the productivity of local sheep in terms of live weight gain and carcass yield is very low, primarily due to inadequate nutrition (Gezahegn *et al*., 2020). This is largely because of the reliance on natural pasture, crop residues, and stubble grazing, which are insufficient in meeting nutritional requirements. Dry forage from grazing areas and crop residues contain less than 7% Crude

Protein (CP), indicating poor nutritive value and failing to meet microbial requirements (Van Soest, 1994). While oil crop by-products have high crude protein, their prices are increasing in the country. Feed cost is a major affecting the economic return of sheep farming. Therefore, identifying alternative, cheaper protein sources is essential to substitute oil crop byproducts.

Dietary nutrients, especially energy and protein, are crucial for sheep productivity (Worknesh & Getachew, 2017). Various complementary and alternative strategies can be pursued in tropical regions to enhance the quality of low-quality feeds and increase the meat and milk production. According to the Preston and Leng (1987), concentrate feeding is one such strategy that increases intake and digestibility. However, the cost of concentrate feed is rising alarmingly. Utilizing local protein sources such as leguminous forage can maximize animal productivity (Popi and Mclennan, 1995). Leguminous forage plays an important role in supplementing diets of growing lambs as alternative to the oil seed cake supplements (Worknesh & Getachew, 2017).

Legume forage can meet the protein requirements of animals, particularly noug seed cake (Ajebu *et al*., 2013). Among the forage legumes, Alfalfa is a perennial forage legume known for its high forage quality and positive effects on soil fertility. Alfalfa is a commonly included in the diets of many livestock (Sen *et al*., 1998). Alfalfa leaves are high protein, while the stems are high in fiber (Palmonari *et al*., 2014). However the alfalfa crude protein varies depending on its maturity stage. Alfalfa can withstands long periods of water deficit by impeding its vegetative growth (Annicchiarico *et al*., 2010) and can accesses water from deep soil layers through its deep root system (Volaire, 2008).

Alfalfa forage plays an important role in ruminant production and can be easily produced by farmers using rain or irrigation. It is a low-cost protein sources and can be serve as a self-sufficient substitute for expensive concentrate feeds (Wang *et al*., 2019). Therefore, this study was designed with the following objectives: to evaluate effects of feeding different levels of alfalfa hay on growth performance and carcass parameters of yearling Arsi-Bale sheep and to assess the profitably of substituting alfalfa hay for noug seed cake in sheep diets.

2. Materials and Methods

2.1 Study Area

The experiment was conducted at the Adami Tulu Agricultural Research Center, located 167 km south of Addis Ababa at an altitude of 1650 meter above sea level in mid Rift Valley. The agro-ecological zone of the area is semi-arid and sub humid, characterized by acacia woodland vegetation. The mean annual rain falls is 760mm, with minimum and maximum temperatures of 12.6℃ and 27℃, respectively. The soil type is fine, sandy loam with sand: silt: clay in the ratio of 34: 38: 18, respectively.

2.2 Feed Preparation

Seeds of adapted variety of alfalfa (Hunter River) were collected from Werer Agriculture Research Center. The alfalfa seeds were sown at a rate of 10 kg/ha on well-prepared land. All necessary agronomic practices were followed, and harvested at 50% flowering and dried under shade for hay preparation. The hay was chopped to approximately 2-3cm using a grinding baler machine. Wheat bran and noug seed cake were purchased from local markets.

2.3 Animals and Experimental Design

A total of 30 yearling Arsi-Bale sheep were purchased from the local markets. The sheep ages were estimated using dentition techniques and information from sellers. All sheep were ear-tagged and treated for internal and external parasites. The pens were disinfected before the animals moved in and cleaned daily. Sheep were kept in individual pens during experimental period. The experiment was conducted in a randomized complete blocking design with five treatments, each replicated six times. The experimental feeds were formulated based on iso-nitrogenous rations. The control group was fed a diet consisting of 50% wheat bran, 49% *noug* seed cake and 1% salt. Alfalfa hay replaced noug seed cake of 0%, 25%, 50%, 75% and 100%. Rhodes hay was provided ad-libitum to all experimental treatments. Water was freely available to the animals.

2.4 Animal Feeding and Live Weight Gain

Animals underwent a 14-days feed adaptation period to acclimatize the animals to the feed, pens and experimental procedures. The formulated feeds were supplemented at 2.5% of body weight during the entire growth period. The animals were weighted gain at 14-days. Weighing was done in the morning after overnight fasting using weighing scale. The actual feeding trail lasted 100 days. Total weight gain was calculated by subtracting initial weight form final body weight. Daily body weight gain was calculated as the difference between final live weight and initial live weight divided by the number of feeding days.

2.5 Carcass Parameters

After the feeding trial, three experimental yearling Arsi-Bale sheep were selected randomly from each feeding group, fasted overnight, and slaughtered for carcass parameter evaluation at the Adami Tulu Agricultural Research Centre slaughterhouse. Slaughter body weights were recorded before slaughter. Post-slaughter, weights the kidney, lung with trachea, heart, liver, spleen, kidney fat, heart fat, full gut, empty gut, penis, testicle, skin with feet, tail and head with tongue were measured using digital weighing balance. The hot carcasses were split along the vertebral column into the left and right side and weighted. The carcass right side of each carcass was chilled for 24 hours at 4℃ before being weighed again. The chilled carcass was then deboned into lean, fat, and bone components. Chilling loss was calculated as the percentage of the difference between hot carcass weight and chilled carcass weight divided by hot carcass weight multiplied by 100. Dressing percentage was calculated as hot

carcass weight divided by slaughtered body weight multiplied by 100.

2.6 Partial Budget Analysis

The partial budget analysis included variable costs such as feed cost, animal purchase price, veterinary costs, transport costs and labor costs. Costs associated with alfalfa production, such as land rent, land preparation, weeding, harvesting, and seed price, were also included. At the end the trial, sheep selling prices were estimated by experienced traders. The gross return was calculated by subtracting the total cost from the revenue.

2.7 Method of Data Analysis

The data were subjected to analysis of variance using randomized complete block design with the linear model procedure of SAS (2009). The treatment means were separated by LSD significant difference test. The model used for data analysis is:

Yij = μ+ti+eij,

Where: Yij = response variable;

μ = over all mean;

ti = treatment effect;

eij = random error.

3. Result and Discussion

3.1 Growth Performance

The effects of feeding different levels of alfalfa hay as a replacement for noug seed cake on the growth performances of Arsi-Bale sheep are presented in the Table 1. The average initial weights were 18.46 kg, 18.33 kg, 18.67 kg, 18.33 kg and 18.67 kg for animals in treatments T1, T2, T3, T4 and T5, respectively. The mean of final body weight, total body weight gain and daily weight gain of the experiential sheep did not show significant variations among the treatments.

Table 1. Effect of Different Levels of Alfalfa Hay on Growth Performance of Sheep

	Growth parameters			
Treatments	**IBW(kg)**	**FBW(kg)**	**TWG(kg)**	**ADG(g/day)**
T1	18.33±1.05	28.50±1.26	10.16±0.60	100.00±5.72
T2	18.66±0.84	29.16±1.01	10.50±1.05	105.00±10.06
T3	18.33±0.49	29.00±0.68	10.66±1.02	106.7±9.73
T4	18.33±0.61	29.66±0.61	11.33±0.66	113.33±6.35
T5	18.66±0.42	29.83±0.70	11.16±0.83	111.66±7.94
Overall mean	18.46±0.30	29.23±0.38	10.76±0.36	107.54±3.47

IBW: initial body weight, FBW: final body weight, TWG: Total body weight, ADG: Average daily

weight gain.

3.2 Carcass Characteristics

The effects of supplementing different levels of alfalfa hay on the carcass parameters of experimental sheep are listed in Table 2. The slaughter weight, hot carcass weight, cold carcass weight, chilling loss, and dressing percentage of finishing lambs did not vary significantly among the treatments (*P>0.05*). The overall carcass dressing percentages ranged from 36.05% to 38.87% based on slaughter body weight.

Table 2. Carcass Characteristics of Sheep Fed Different Level of Alfalfa Hay

Parameter	**Treatments**					
	T1	**T2**	**T3**	**T4**	**T5**	**Overall**
SBW(kg)	29.16±1.05	28.16±0.88	29±1.00	29.5±1.45	29.33±0.57	29.30±0.53
HCW(kg)	10.93±0.63	10.96±0.82	10.90±0.37	10.85±0.42	10.23±0.34	10.78±0.22
Right side HCW	5.45±0.25	5.48±0.39	5.47±0.16	5.42±0.24	5.15±0.15	5.39±0.10
Left side HCW	5.48±0.38	5.48±0.43	5.47±0.23	5.43±0.19	5.08±0.19	5.39±0.12
Right side CCW	5.36±0.43	5.23±0.39	5.25±0.13	5.27±0.19	5.12±0.20	5.25±0.11
Chilling loss%	1.51	4.56	3.83	2.76	1.55	2.85
DP%	37.47	38.87	36.56	36.76	36.05	37.34

Notice: SW: slaughtering weight, EBW: empty body weight, HCW: Hot carcass weight, DSW: dressing percentage of slaughtering weight, DEBW: Dressing percentage of empty body weight.

3.3 Carcass Compositions

The effects of different levels of alfalfa hay on the carcass compassion are presented in Table 3. The muscles weight, fat weight, and bone weight did not vary significantly among the experimental groups.

Table 3. Composition of Muscles, Bone and Fat of the Different Treatments

	Treatments					
Parameter	**T1**	**T2**	**T3**	**T4**	**T5**	**Overall**
Muscles wt (kg)	3.36±0.24	3.23±0.44	3.33±0.07	3.18±0.10	3.00±0.5	3.22±0.07
Fat wt(kg)	0.65±0.15	0.76±0.18	0.65±0.13	0.78±0.11	0.68±0.08	0.71±0.05
Bone wt(kg)	1.28±0.08	1.23±0.04	1.18±0.08	1.33±0.14	1.40±0.03	1.28±0.04
Muscles%	63.65	61.74	64.68	60.24	59.05	**61.87**
Fat%	12.03	14.34	12.41	14.71	13.38	13.37

Bone%	24.32	23.92	22.91	25.05	27.57	24.75
Muscle : Bone ratio	2.64	2.64	2.84	2.43	2.14	2.54
Muscle : Fat ratio	5.62	4.65	5.62	4.18	4.49	4.91

3.4 Non-Carcass Parameters

The effect of different levels of alfalfa hay supplementation on non-carcass traits of yearling Arsi-Bale sheep are presented in Table 4. The group that received 50% alfalfa hays had lower kidney weights compared to others groups. The group fed 25% alfalfa hay exhibited higher kidney fat content than the other treatments. However, most of non-carcass traits did not show significant difference among the treatments. Teklu (2016) reported that the weights of offal components were not significantly affected by different feeding regimes.

Table 4. Non-carcass Components of Arsi-Bale Sheep Supplemented with Alfalfa Hay

Non carcass traits	**Treatments**						
(kg)	**T1**	**T2**	**T3**	**T4**	**T5**	**SME**	**SL**
Tongue	0.13	0.13	0.13	0.28	0.20	0.04	Ns
Heart	0.13	0.12	0.10	0.18	010	0.14	Ns
Kidney	0.13	0.13	0.1	0.08	0.1	0.01	Ns
Liver with Bile	0.47^{a}	0.48^{a}	0.40^{b}	0.52^{a}	0.45^{a}	0.02	**
Lung &Trachea	0.43	0.40	0.33	0.32	0.33	0.03	Ns
Kidney fat	0.07^{b}	0.13^{a}	0.07^{b}	0.08^{b}	0.07^{b}	0.01	**
Scrotal fat	0.08	0.13	0.12	0.13	0.10	0.01	Ns
Omental fat	0.25	0.23	0.10	0.18	0.17	00.03	Ns
Small Intestine	1.55	1.58	1.70	1.70	1.76	0.05	Ns
Large intestine	1.43^{a}	1.01^{ab}	1.35^{a}	0.92^{ab}	0.78^{b}	0.09	**
Tail	0.93	0.63	0.71	0.93	0.75	0.05	Ns
Head with skin	1.93	2.02	1.36	1.75	1.72	0.12	Ns
Skin	2.85	2.30	2.78	4.78	2.32	0.53	Ns
Feet with hooves	0.62	0.60	0.58	1.43	0.62	0.16	Ns

3.5 Partial Budget Analysis

The partial budget analysis for sheep fed different level of alfalfa hay as a replacement of noug seed cake is shown in Table 5. The gross return of Arsi-Bale sheep fed noug seed cake and wheat bran was negative.

Table 5. Partial Budget Analysis of Sheep Fed Different Alfalfa Level

Items (Birr)	Treatment				
	T1	T2	T3	T4	T5
Purchasing price per sheep	1500	1500	1500	1500	1500
Total feeds cost per sheep	1353.2	1217.1	1051.8	940.6	788.2
Cost of transport per sheep	20	20	20	20	20
Labor cost per sheep	250	250	250	250	250
Veterinary cost per sheep	90	90	90	90	90
Total cost per sheep	3183.2	3077.12	2911.8	2800.6	2648.2
Final sell per sheep	3100	3100	3100	3100	3100
Gross return per sheep	-113.2	22.88	188.2	299.4	451.8
Gross margin per sheep	-679.1	137.29	1129.1	1796.6	2710.8

4. Discussion

The observed values of sheep for final body weight, total weight gain, and daily weight gain did not show significant differences among the treatments. This might be due to the iso-nitrogenous formulation of diets, was on the basis of crude protein content of the ingredients in such a way that dietary rations were iso-nitrogenous. The overall final body weight gain in this study was higher than that of yearling Arsi-Bale rams fed a diet of 50% wheat bran and 49% noug seed cake, which attained a final weight of 25.3 kg in 75 days at Adami Tulu Agriculture Research Center, targeting export market weight (Aman *et al*., 2019).

The overall final body weight of experimental sheep in this study was lower than that of yearling Afar Sheep fed different wheat bran and leucaena leaves mixtures, which reached 30 kg in 98 days at Werer Agriculture Research Center (Abebe *et al*., 2013). However, the final body weight in the current study was similar to that of Arsi-Bale sheep fed 400 gm concentrate and Desho grass at Debra Zeit Agricultural Research Center (Worknesh *et al*., 2021).

The daily weight gain observed in this study was lower than the 111.9 g/day reported by Tedesse *et al*. (2014) for the Arsi-Bale sheep fed concentrate blocks at southern part of the country. However, the average daily gain in this study was higher than yearling Arsi-Bale sheep (96 g/day) fed sugarcane tops silage at Debre Zeit Agricultural Research Center for ninety days (Getahun *et al*., 2020). The average daily gain was relatively similar to the 104 g/day reported by Abebe *et al*. (2010) for Arsi-Bale lambs fed linseed cake and wheat bran. The study indicates that the supplementation of alfalfa hay positively affects on the yearling Arsi-Bale sheep.

The carcass yield in this study ranged from 10.23 to 10.96 kg. The average carcass yield was higher than the findings of Abdi *et al*. (2019), who reported an average carcass weight of 8-9 kg per yearling

indigenous sheep. The carcass yield observed was similar to the report by Abebe *et al*. (2010) for Arsi-Bale lamb (10-11 kg) fed linseed cake and wheat bran. The carcass yield is influenced by factors such as nutrition quality, genotype, season, age and sex of the animals. The chilling loss percentage in this study was similar to that reported by Getahun *et al*. (2020) for Arsi-Bale sheep fed sugarcane tops silage, indicating minor effects on dressing percentage. The dressing percentage observed in this study (36-38%) is consistent with the range reported by Ayele and Urge (2019) for Arsi-Bale sheep fed urea-treated barley straw with 300-400 gm concentrate. Girma *et al*. (2010) also reported similar dressing percentage (36.2-38.5%) for yearling lambs raised on pasture.

The observed values showed that muscle proportion was highest, followed by bone and fat. These values are close to the findings of Getahun (2015) on the Arsi-Bale sheep fed different dietary crude protein level.

The group fed 25% alfalfa hay showed no loss or gain in the partial budget analysis. However, group fed higher proportion of alfalfa hay were more profitable compared to those fed lower proportions. The profit variation among the experimental groups was mainly due to the price of noug seed cake. Esubalew *et al*. (2020) reported that replacing noug seed cake with cow pea showed better profitability at 75% and 100% replacement levels.

5. Conclusion and Recommendation

The substitution of noug seed cake with alfalfa hay at 0, 25, 50, 75, and 100% had a similar positive effect on growth performance and carcass parameters of yearling Arsi-Bale sheep. The result suggests that alfalfa hay can replace noug seed cake in the diet of yearling Arsi-Bale sheep feeding without impairing the growth and carcass traits. Furthermore, substituting noug seed cake with alfalfa hay at 100% is more profitable than at 75% followed by 50%. Supplementing with alfalfa hay as a substitute for noug seed cake holds significant economic importance for Arsi-Bale sheep fattening. Therefore, it is recommended to evaluate and demonstrate use of alfalfa has as a protein feed supplement for yearling Arsi-Bale sheep at the on-farm level.

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