Journal of Fisheries & Livestock Production

Mengistu et al., J Fisheries Livest Prod 2016, 4:4
DOI: 10.4172/2332-2608.1000191

Research Article Open Access

Effects of Supplementing Cactus Cladode and Acacia Senegal Branches on Intake, Digestibility and Body Weight Gain of Tigray Highland Sheep Fed Barley Straw

Mengistu U[1], Kefelegn K[1] and Gebretnsae WM[1,2]*

[1]Department of Animal Sciences, Haramaya University, Ethiopia
[2]Department of Animal Sciences, Asosa University, Ethiopia

Abstract

The primary objective of the experiment was to evaluate the effect of supplementing different proportions of dried cactus cladode (CC) and Acacia senegal branches (ASB) fed barley straw (BS) on feed intake, digestibility, and average daily gain (ADG) using twenty four yearling male Tigray highland sheep. Experimental sheep were blocked in to six blocks of four animals based on initial body weight and randomly assigned to one of the four treatments. Treatments were ad libitum feeding of BS+60 g noug seed cake (T1, control), and T2, T3 and T4 were supplemented with 240 g CC+80 g ASB, 160 g CC+160 g ASB, and 80 g CC+240 g ASB DM/day, respectively in addition to T1 ration. The experiment was consisted for 90 days of feeding trial and 7 days of digestibility trials. The inclusion of ASB was significantly increased CP content of cactus cladode by 28.2, 45.1 and 54.5% for T2, T3 and T4, respectively. Neutral detergent fiber (67.6%), acid detergent fiber (57.6%) and acid detergent lignin (18%) of acacia senegal branches also decreased by 20.2, 13.7 and 11.4%; 25.4, 16.8 and 11.1%; 10.7, 5.0 and 3.6%, respectively in those treatment through the inclusion of cactus cladode. the CP intake, ADG and Feed conversion efficiency were significantly increased ($P<0.05$) with increasing proportion of ASB in the foliage mixture. It can be concluded that supplementation with high proportion of ASB in the mixtures has a tendency to improve growth performance of sheep.

Keywords: Cactus; Acacia; Intake; Digestibility; Weight gain; Sheep

Abbreviations: CC: Cactus Cladodes; ASB: Acacia Senegal Branches; BS: Barley Straw; ADG: Average Daily Gain; DM: Dry Matter; CP: Crude Protein; OM: Organic Matter; NDF: Neutral Detergent Fiber; ADF: Acid Detergent Fiber; T_1: Treatment One; T_2: Treatment Two; T_3: Treatment Three; T_4: Treatment Four; SEM: Standard Error of Mean

Introduction

Ethiopia has a diverse indigenous sheep population and their demand as live animal or as meat form is increasing from time to time by domestic and foreign markets [1,2]. This increased demand creates an opportunity to substantially improve food security of the population and alleviate poverty [3]. However, sheep in Ethiopia consume feeds that contain a lot of fiber during most part of the year. And reliance on crop residues is ever increasing as more land is cropped [4]. The bulky and fibrous nature of these feeds resulted in poor nutrient supply and reduced productivity of sheep.

To keep consistency of sheep productivity, recognizing appropriate indigenous feed resources like acacia and cactus is the best option. Hence, indigenous multipurpose trees have great potential to endeavour feed availability, chemical constituents and digestibility of feeds [5,6]. They have significant role in ruminant nutrition, because of their resistance to heat, drought, grazing and repeated cutting [7].

Cactus (Opuntia ficus-indica) is available in almost every farmer's backyard of eastern and southern parts of Tigray regional states of Ethiopia [8,9]. Fresh cactus has high water content (90%) and can serve as water sources during dry season for animals [10]. However, the extremely high water content may affect total dry matter intake, especially where water is not a limiting factor for animal production [11]. The intake of total digestible nutrient can be increased if the fresh cactus is wilted or dried before feeding [12].

Cactus cladode has high capacity to store nutrients, even in extremely hot environment [13]. It is rich in soluble carbohydrates and calcium, but poor in protein [10,14]. Thus, supplementing with appropriate and easily available protein sources like Acacia is mandatory.

Browse leaves from Acacias could form good sources of crude protein and mineral supplements to ruminants [15,16]. Acacia senegal is one of the major multipurpose trees that widely abundant in most parts of Ethiopia [17]. Leaves of Acacia senegal has good nutritive value and may be suitable as supplementation of roughage feeds, but the collection of sufficient quantity is difficult, because of the thorns and small size of leaves [18,19]. Although, indigenous multi-purpose trees are not yet scientifically used throughout the country, the foliage mixtures of cactus cladodes and Acacia senegal branches may complement each other and serve as a good supplement to poor quality feeds and can support animal growth. Thus, the study was conducted, to evaluate the effects of supplementing dried cactus cladodes and edible branches of Acacia senegal on feed intake, digestibility and body weight gain of Tigray highland sheep [20].

Materials and Methods

The experiment was conducted at Ganta-Afeshum Woreda, which is located at 14˚ 16' N latitude and 39˚ 27' E longitudes with an elevation of 2457 meter above sea level. It has Weina-Dega climate, with 552 mm mean annual rain fall and 16˚C temperature (BoANRD, 2009 unpublished docment).

***Corresponding author:** Gebretnsae WM, Department of Animal Sciences, Asosa University, P.O. Box: 18, Asosa, Ethiopia; Tel: +251-915-941-344; E-mail: gebretn12@gmail.com

Received May 24, 2016; **Accepted** June 25, 2016; **Published** July 10, 2016

Citation: Mengistu U, Kefelegn K, Gebretnsae WM (2016) Effects of Supplementing Cactus Cladode and Acacia Senegal Branches on Intake, Digestibility and Body Weight Gain of Tigray Highland Sheep Fed Barley Straw. J Fisheries Livest Prod 4: 191. doi: 10.4172/2332-2608.1000191

The experiment was carried out in a randomized complete block design with six male Tigray highland sheep per treatment. Treatment diets were consisted: barley straw (BS)+60 g noug seed cake (NSC), BS+60 g NSC+240 g cactus cladode (CC)+80 g Acacia senegal branches (ASB), BS+60 g NSC+160 g CC+160 g ASB, BS+60 g NSC+80 g CC+240 g ASB for T_1, T_2, T_3 and T_4 respectively. Cactus cladode was collected and prepared by removing the spine with fire, then both CC and ASB were chopped approximately 1-2 cm length and dried by sun for two and one days, respectively and stored separately in sacks. The dried CC and ASB were mixed according to their ratio at each feeding and offered to experimental sheep on DM base at 08:00 and 16:00 h. The basal diet, barley straw was offered ad libitum at 25% refusal adjustment and 60 g noug seed cake was offered to all experimental sheep at 08:00 h to keep their maintenance level. Feed consumption and refusals were recorded daily to determine feed intake and sub-sampled for chemical analysis. Feed intakes were determined as the difference between the quantity of feed offered and refused for each sheep.

Body weights (BW) of experimental sheep were measured at ten days interval throughout the experiment to determine BW change. The average daily gains (ADG) were calculated as the difference between final and initial BW divided by number of feeding days. The feed conversion efficiency was determined by dividing the ADG to the amount of daily feed consumed while feed conversion ratio was determined by dividing the average daily feed intake to ADG. At the end of the feeding trial, all experimental sheep were transferred to digestibility trial and fitted with fecal collection bags to which they acclimatized for three days followed by seven days of total feces collection. The apparent digestibility coefficients (DC) of DM, OM, CP, NDF and ADF of feed samples were calculated by using the equation of [20]:

$$\text{Apparent Digestibility (\%)} = \frac{(\text{nutrient intake} - \text{fecal nutrient output})}{\text{nutrient output}} \times 100$$

Samples of experimental feeds, refusals and feces were ground to pass through 1 mm sieve at Haramaya University Nutrition Laboratory. The DM, Ash and CP contents of feeds, refusals and feces were determined according to [21] procedure. Organic matter was computed by subtracting the Ash content from 100. The NDF, ADF and ADL were analyzed by using the procedures of [22].

Data were analyzed using the analysis of variance model for completely randomized block design by employing the general linear model procedure [23]. Differences among treatment means was tested using least significant difference (LSD) test. The statistical models used for analysis of the data collected were:

$$Y_{ij} = \mu + T_i + B_j + Eij$$

Where: Y_{ij}=response variable (the observation in j^{th} block and i^{th} treatment).

μ=overall mean

T_i=treatment effect

B_j=block effect

Eij=random error

Results

Chemical Composition of Treatment Feeds The inclusion of acacia senegal branches was significantly increased the crud protein (CP) content of cactus cladode by 28.2, 45.1 and 54.5% for T_2, T_3 and T_4, respectively (Table 1). Not only was that, the neutral detergent fiber (67.6%), acid detergent fiber (57.6%) and acid detergent lignin (18%) of acacia senegal branches also decreased by 20.2, 13.7 and 11.4%; 25.4, 16.8 and 11.1%; 10.7, 5.0 and 3.6%, respectively in those treatment through the inclusion of cactus cladode.

Feed offered	Chemical composition					
	DM%	CP	NDF	ADF	ADL	Ash
		(% DM)	(% DM)	(% DM)	(% DM)	(% DM)
Barley straw	92.1	4.4	81.9	56.8	5.5	11
NSC	93.9	32.7	34.4	24.72	12.2	7.3
CC	89.5	6.1	38.1	25	7.1	16.8
ASB	91.5	16.3	67.6	57.6	18	9.7
CC&ASB (3:1)	89.62	8.46	47.44	32.19	7.29	14.9
CC&ASB (2:2)	90.05	11.08	53.86	40.79	13.03	13.3
CC&ASB (1:3)	90.91	13.42	56.18	46.47	14.44	12.4
Feed refusals						
Barley straw (T_1)	92.6	3.2	88.5	63.9	7.9	8.1
Barley straw (T_2)	92.9	3.3	87.1	63.8	7.2	7.1
Barley straw (T_3)	92.8	3.3	86.4	62.7	7.2	7
Barley straw (T_4)	92.5	3.5	85.3	62.9	7.1	9.1

DM: Dry Matter; CP: Crude Protein; NDF: Neutral Detergent Fiber; ADF: Acid Detergent Fiber; ADL: Acid Detergent Lignin; NSC: Noug Seed Cake; CC: Cactus Cladodes; ASB: Acacia Senegal Branches.

Table 1: Nutritive value of experimental feeds and Refusals.

Treatments					
Intake (g/day)	T_1	T_2	T_3	T_4	SEM
Barley straw DM	404.7^a	355.3^b	351.8^b	349.8^b	5.72
NSC DM	60	60	60	60	0
Foliage DM	-	320	320	320	0
Total DM	464.7^b	735.3^a	731.8^a	729.8^a	24.91
OM	417.6^b	645.1^a	648.5^a	648.5^a	21.43
CP	37.4^d	62.9^c	70.9^b	79.0^a	3.31
NDF	352.1^b	463.4^a	481.1^a	486.9^a	11.71
ADF	244.8^c	319.7^b	345.3^a	362.3^a	9.94
Average DM (%BW)	2.8^b	3.9^a	3.7^a	3.6^a	0.13
Total DM (g/kgw^{75})	56^b	80.7^a	78.8^a	76.3^a	2.37

$^{a\text{-}c}$Means within a row not bearing a common superscript are significantly different; OM: Organic Matter; SEM: Standard Error of Mean.

Table 2: Daily dry matter and nutrient intake of experimental sheep during feeding trial.

Dry matter and nutrient intake and their digestibility

The intake of dry matter (DM), organic matter (OM), crud protein (CP), nutrient detergent fiber (NDF), and acid detergent fiber (ADF) were significantly influenced by the addition of foliage mixtures (Table 2). Moreover, the intake of crud protein and acid detergent fiber were significantly increased ($P<0.05$) as the proportion of acacia senegal branches increased in the foliage mixture.

Apparent digestibility of DM, OM, CP, NDF and ADF were significantly higher ($P<0.05$) in the supplemented groups than none supplemented but there were no significant differences ($P > 0.05$) among supplemented treatments (Table 3). Thus, the result indicated that foliage mixtures have higher tendency of digestibility than barley straw and their interaction is important to compensate each other. Digestibility of feeds influenced not only by its own composition, but also by the composition of other feeds consumed with it [20]. Digestibility of low quality feeds can be increased through the action of rumen microbes by strategically mixing nitrogen and minerals that are deficient in these feed resources [24]. The increase in digestibility of crop residues in turn also increases their intake then enhances the efficiency of nutrient utilization from these feed resources.

Body weight change and feed conversion efficiency of Tigray highland sheep

The final body weight (FBW), average daily gain (ADG) and Feed conversion efficiency (FCE) were significantly increased ($P<0.05$) with increasing proportion of Acacia senegal branches (ASB) in the foliage mixture (Table 4). However, FCR was significantly increased ($P<0.05$) as proportion of cactus cladode increased in the foliage mixture.

Discussion

In the current finding, the nutritive value of acacia senegal branches was recorded lower than the values from leaves and from leaves and pods of acacia senegal [18,19]. The reason may be due to the inclusion of all parts of the branches (twigs, bark, leaves and stick) in the current study for simulating practices of farmer's efficient uses of resources and to save time spent for leave collection. In accordance with the result obtained in the present study, Norton [25] suggested that fraction of tree foliage contain higher stem and to be of lower nutritive value than leaves alone. Sanon et al. [18] and Ondiek [19] also noted that Browse and collection of leaves from Acacia senegal were difficult, since younger individuals have smaller leaves and dense thorns. Hence, the present method of preparation could avoid this problem.

Regarding intake, the increased intake of crude protein associated with the proportion of acacia senegal may be due to leguminous nature of the tree. Because of the ability of Acacia to fix nitrogen, they have adequate crude protein contents for animal production [26] and high carbohydrate quality of cactus can be used as part of a complete diet with diet contains an adequate amount of degradable protein [27]. Thus, the complementarities of those foliage mixtures were confirmed as expected to give some nutrient that can enhance sheep productivity. According to Diego and Gimenez [28] and Holst and White [29], the protein content of the whole diet needs to be above 15% protein for maximum growth rate, protein levels as low as 11% will enable some growth and feeds 8-9% crude protein may meet maintenance requirements of sheep. Thus, the results indicated that supplementing poor roughage with foliages of relatively better nutrient content increase total intake and acacia senegal branches have a potential to improve crud protein intake of sheep consumed low quality feeds at low cost.

The average daily gain result indicated that higher consumption of cactus cladode is needed for weight gain of sheep than acacia senegal branches due to its lower crud protein content. If a diet is low in protein or deficient in essential amino acids, feed intake of animals increase until their nutrient requirements are satisfied [30]. Thus, the foliage mixtures of cactus cladode and acacia senegal branches have the potential to improve growth and productivity rate of sheep in arid and semi-arid areas, especially in the dry season through complementarities of interaction.

Digestibility coefficient (%)	Treatments				
	T_1	T_2	T_3	T_4	SEM
DM	45^b	59^a	57^a	56^a	0.02
OM	52^b	63^a	62^a	60^a	0.01
CP	53^b	66^a	62^a	61^a	0.02
NDF	46^b	55^a	55^a	52^a	0.01
ADF	38^b	50^a	47^a	44^a	0.02

$^{a-b}$Means within a row not bearing a common superscript are significantly different; DM: Dry Matter; OM: Organic Matter; CP: Crud Protein; NDF: Neutral Detergent Fiber; ADF: Acid Detergent Fiber; SEM: Standard Error of Mean.

Table 3: Apparent dry matter and nutrient digestibility of Tigray highland sheep.

Body weight	Treatments				
	T_1	T_2	T_3	T_4	SEM
IBW (kg)	16.9	17	16.9	16.9	0.35
FBW (kg)	17^c	19.2^b	19.7^{ab}	20.5^a	0.45
BWC (kg)	0.05^d	2.18^c	2.95^b	3.38^a	0.07
ADG (g)	0.6^d	24.8^c	30.1^b	37.6^a	2.9
FCE (g ADG/g DMI)	0.004^d	0.03^c	0.041^b	0.053^a	0.01
FCR (g DMI/g ADG)	17.5^c	31^a	24.3^b	19.1^c	1.18

$^{a-d}$Means within a row not bearing a similar superscript letter significantly differ; IBW: Initial Body Weight; FBW: Final Body Weight; BWC: Body Weight Change; ADG: Average Daily Gain; FCE: Feed Conversion Efficiency; FCR: Feed Conversion Ratio; SEM: Standard Error of Mean.

Table 4: Body weight and feed conversion efficiency of experimental sheep.

Conclusions

Considering the results of this study, supplementing foliage mixtures of cactus cladode and Acacia senegal branches have a positive effect on feed intake, feed conversion efficiency and average daily gain. The effects are more pronounced at higher proportion of Acacia senegal branches supplementation. Therefore, it is concluded that supplementation of 240 g dry mater Acacia senegal branches and 80 g cactus cladode to barley straw based diet can be used for improved sheep productivity at smallholder level, especially in the dry season.

Acknowledgement

We want to thank all technicians of animal nutrition and soil chemistry laboratories of Haramaya University, for their valuable comments and cooperation in laboratory analysis of the experimental feeds and feces samples. Funding for this study was provided by Ethiopian Ministry of Education, Ethiopia.

References

1. Ameha S (2011) Export requirements for meat and live small ruminants: How can development agents assist producers to improve small ruminant export? In: Alemu Y, Merkel RC, Gipson TA (eds.) Ethiopia Sheep and Goat Productivity Improvement Program Technical Bulletin, Ethiopia.
2. Kefyalew A, Tarekegn A (2013) Meat and Live Animal Export in Ethiopia: Status, Challenges and Opportunities. Global Advanced Research Journal of Food Science and Technology 2: 054-059.
3. Adane H (2008) Sheep and goat economics of production and marketing. In: Alemu Y, Merkel RC (eds.) sheep and goat production handbook for Ethiopia. Ethiopian Sheep and Goat Productivity Improvement Program: 296-314.
4. Malede B, Takele A (2014) Livestock Feed Resources Assessment, Constraints and Improvement Strategies in Ethiopia. Middle-East Journal of Scientific Research 21: 616-622.
5. Haile A, Tolemariam T (2008) The feed values of indigenous multipurpose trees for sheep in Ethiopia: The case of Vernonia amygdalina, Buddleja polystachya and Maesa lanceolata. Livestock Research for Rural Development 20: 1-7.
6. Dambe LM, Mogotsi K, Odubeng M, Kgosikoma OE (2015) Nutritive value of some important indigenous livestock browse species in semi-arid mixed Mopane bushveld, Botswana. Livestock Research for Rural Development 27.
7. Rahman AHH, Mohamed MI, Gehad AE, Awadallah IM (2006) Ameliorating the anti-nutritional factors effect in Atriplex halimus on sheep and goats by ensiling or Poly ethylene Glycol. International Journal of Agriculture and Biology 6: 766-769.
8. Brutsch MO (1997) The Beles or cactus Pear (Opuntia ficus-indica) in Tigray, Ethiopia. Journal of the Professional Association for Cactus Development: 130-141.
9. Mehari W (2010) Development of hand operated cactus cladodes chopping machine applicable for small-farms, In: Nefzaoui A, Inglese P, Tesfay B (eds), Improved Utilization of Cactus Pear for Food, Feed, Soil and Water Conservation and other Products in Africa. Proceedings of International Workshop Mekelle, Ethiopia: 111-113.
10. Angela MV, Batista AC, Lucena RB, Santos DC, Dubeux JB, et al. (2009) Chemical composition and ruminal degradability of spineless cactus grown in northeastern Brazil. Rangeland Ecology and Management 62: 297-301.
11. Firew T, Kijora C, Peters KJ (2001) Effects of incorporating cactus pear

(Opuntia ficus-indica) and urea-treatment of straw on the performance of sheep in Ethiopia. Doctoral Dissertation, Mekelle University, Mekelle, Ethiopia.

12. De Kock GC (1998) The use of cactus pear (Opuntia spp.) as a fodder source in arid areas of Southern Africa. International Symposium on cactus Pear and Nopalitos Processing and Uses. FAO International Cooperation Network on cactus Pear: 83-95.
13. Dos Santos DC, De-Albuquerque SG (2001) Opuntia as fodder in the semi-arid northeast of Brazil. Food and Agriculture Organization of the UN 92: 1859-1897.
14. Nefzaoui A, Salem BH (2001) Opuntia spp A strategic fodder and efficient tool to combat desertification in the Wana region, In: Jacobo CM, Gonzalez SP (eds.), cactus as forage. FAO plant production and protection, paper 169, FAO, Rome, Italy, pp: 73-90.
15. Rubanza CD, Shem MN, Bakengesa SS, Ichinohe T and Fujihara T (2007) The content of protein, fibre and minerals of leaves of selected Acacia species indigenous to north-western Tanzania. Arch Animal Nutrition 61: 151-156.
16. Sabuni GJ (2011) Potentials of acacia senegal (L) wild as fodder in livestock production in Bukombe district, Shinyanga, Tanzania. MSc, Thesis, Sokoine University, Morogoro, Tanzania.
17. Jiregna G, Lisanework N, Heluf G (2007) Potential, Distribution, Ethno-botany and Tapping Procedures of Gum Producing Acacia Species in the Somali Region, Southeastern Ethiopia. East African Journal of Sciences 1: 69-78.
18. Sanon HO, Kabore CZ ,Ledin I (2008) Nutritive value and voluntary feed intake by goats of three browse fodder species in the Sahelian zone of West Africa. Animal Feed Science and Technology 144: 97-110.
19. Ondiek JO, Abdulrazak SA, Njoka EN (2010) Chemical and mineral composition, in-vitro gas production, in-sacco degradation of selected indigenous Kenyan browses. Livestock Research for Rural Development 22: 1-25.
20. McDonald P, Edwards RA, Greenhalgh JFD, Morgan CA, Sinclair LA, et al. (2002) Animal Nutrition, 6th edition. Prentice Hall, Harlow, England, London: 693p.
21. AOAC (1990) Official Method of Analysis. 15th ed. Washington DC. p: 1298.
22. Soest VPJ, Robertson JB (1985) Analysis of Forage and Fibrous Feeds. A Laboratory Manual for Animal Science. Cornell University, USA: 613.
23. SAS (Statistical analysis system) (2008) SAS/STAT Guide to personal computers, version 9 edition, prentice Hall, London p: 477.
24. FAO (2012) Crop residue based densified total mixed ration – A user-friendly approach to utilise food crop by-products for ruminant production, In: Walli TK, Garg MR, Harinder PS, Makkar (eds.) FAO Animal Production and Health Rome, Italy.
25. Norton BW (1998) Animal production from tree legumes In: Gutteridge RC, Shelton HM (eds), Forage Tree Legumes in Tropical Agriculture. The Tropical Grassland Society of Australia, pp: 155-181.
26. Gebeyew K, Beriso K, Mohamed A, Gsilassie G, Melaku S, et al (2015) Review on the Nutritive Value of Some Selected Acacia Species for Livestock Production in Dryland Areas. Journal of Advances in Dairy Research 3: 139.
27. Batista CS, Detmann E, Lazzarini I, Augusto SM, Fonseca MP, et al (2009) Rumen dynamics of neutral detergent fiber in cattle fed low-quality tropical forage and supplemented with nitrogenous compounds. Journal of Revista Brasileira de Zootecnia 38: 560-569.
28. Diego M, Gimenez JR (1994) Nutrient Requirements of Sheep and Goats. Albama Cooperative Extention System ANR-812.
29. Holst P and White A (2007) Supplementation guide for sheep: Central and southern NSW. PRIMEFACT 532.
30. Forbes JM (2007) Voluntary feed intake and diet selection in farm animals. (2ndedn) CABI American: 171-219.