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Chemical Compositions of Selected Browse Species Used as Goat Feed in Bena-Tsemay district of South Omo, South-Western Ethiopia

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Abstract

The browse species are an important source of nutrients for goats in arid range-land. However, the chemical compositions of browse species used as goat feed in Bena-Tsemay district have not studied and documented for future long-term utilization which target to properly balance their inclusion levels in animal diets. Thus, this study was conducted to assess chemical compositions of selected browse species browsed by goats. The leaves of fourteen browse species samples were collected from range-land and analyzed for chemical compositions in completely randomized block design by using the Generalized Linear Model (GLM) procedures of SAS. The higher ($p<0.05$) crude protein (CP) (198g/kg, DM) was observed in A. marina leaves, while the lower CP levels (125g/kg, DM) and (126g/kg, DM) were observed in A. tortilis and G. tenax leaves, respectively. The S. birrea leaves had higher ($p<0.05$) estimated dry matter intake (94.05g/kg, DM), while it was lower (58.57g/kg, DM) for A. tortilis leaves. However, the digestible dry matter (DDM), total digestible nutrients (TDN), relative feed value (RFV) and metablisable energy (ME) values were similar ($p<0.05$) among the all studied browse plant species. Based on result from this study, it can be concluded that all studied browse plants had high-quality-protein to supplement poor-quality-roughage feeds for enhanced livestock production. Also, it is suggested that future research will consider the supplementation effects of browse plant on animal performances (meat, milk and growth rate).

Keywords: Crude protein; Digestible dry matter; Dry matter intake; Relative feed value; Metabolizable energy

Introduction

Ethiopia has an approximately 38.94 million goat's population [1] which have been contributing the vigorous role over providing foods (milk and meat) and immediate cash incomes for smallholder rural communities [2]. Despite of vigorous role to rural communities, the outputs from goat production system in Bena-Tsemay district is generally quite poor due to the deficits in quantity and poor quality of goat feeds [3, 4]. In this district, the goat production systems are seldom allowed to express their genetic potentials due to poor feeding and husbandry practices. It is obvious that poorly fed goat give low output, late age of onset of puberty and low conception rates, and take too long to reach optimum slaughter and marketable weights. The proper goat feeding, health care and overall management of goats is a pre-requisite for realizing the genetic potential of breed. In Bena-Tsemay district, about 80% of the goats feeds are derived from range-lands (pasture grasses, legumes, fodder trees and shrubs) [3]. The browse species are important feed sources for goat in arid-niches where herbaceous forage productivity is low, due to their high potential to survive in severe arid niches [5]. The browse plant species are often have a higher crude-protein and mineral contents in addition to higher dry matter degradability than associated grasses, particularly during the dry season as an important attendant advantage due to a reduced dependence on purchased protein supplements [6-8]. In addition, goat keepers in the various range-lands have been known for utilizing the browser species as source feeds for goat (protein, vitamins, and minerals) and traditional medicine for healing and treating diseases and par-

asites of goats [9-12]. Also, the browse species known for prevent desertification over mitigating the effects of droughts, allowing soil fixation and restoring the degraded range-land [13]. Thus, understanding qualities and nutritive values of browse plant species is a quite an indispensable for the designing the long-term utilization of browse species which will be targeted to properly balance their levels in goat diets. However, with above merits, the browse plant species used as goat feeds were identified and well documented for Bena-tsemay district [4], but not their chemical composition have not assessed for future use in goat diet. Therefore, this study was conducted to assess chemical composition of selected browse plant species used as goat feed in Bena-Tsemay district for possible utilization as protein supplement.

Material and Methods

Description of Study Area

The study was conducted in MorigolaKebele of Bena-Tseamy district from June to July, 2020. The study rangeland site had lied between $5^0$01' and $5^0$73' North latitude and $36^0$38' and $37^0$07' East longitude in the Bena-Tsemay. An area is characterized by semi-arid and arid climatic condition, with mean annual rainfall averaged from 350-838mm with bimodal distribution and has an ambient temperature ranged from 26-35^{0}C [14]. The vegetation of the study district is dominated by varying densities of Acacia, Grewia, and Solanum woody species [4, 15]. The dominant type of land-use is agro-pastoralism [3, 4] and total land is used for grazing and browsing by cattle and goats, respectively [15]. Rain-fed agriculture is practiced and sorghum, maize, millet, bean, wheat, barley, and vegetables were the major crops grown by agro-pastoralists [15, 16].

Sample Collection and Processing

The leaves of fourteen major browse species used as goat feed were collected from MorigolaKebele in consultation with the most experienced agro-pastoralists and experts based on their high preference to goats in three replicates per each plant during the 50% flowering period and catalogued by local plant names. Upon return from the field, scientific names of certain browse plant species were nominated by using Ethiopia Flora identification Book [17], but those which were difficult to recognize scientific names in the field were registered with local name and transported to Adami Tule Agricultural Center by pressed with plant press and identified by experienced botanist. The leaves samples of browse species in three replicates per plant were processed by handpicking and air-dried at room temperature at Feed and Nutrition laboratory of Jinak Agricultural Research Center.

Chemical Composition Analysis

The chemical compositions of samples of browse plant were analyzed in Animal Science Laboratory at DebreBirhan Agricultural Research Center. Three leave samples of each selected browse species were allowed to oven dried in oven set at a temperature of 65°C for 48 hours and ground in hammer mill to pass a 1mm sieve screen for chemical analysis [18]. The crude protein (CP) and ash contents were analyzed according to the methods of [18]. The neutral detergent fiber (NDF) content was calculated according to the procedure of [19], while the acid detergent fiber (ADF) value was analyzed by the method described by [20]. The estimated relative feed value (RFV) was calculated from the estimated digestible dry matter (DDM) by using calculation described by [21]. The procedure of [22] was used to estimate dry matter intake (DMI) value of browse plant with following calculations: DDM = Digestible Dry Matter = 88.9 - (0.779 x % ADF), DMI = Dry Matter Intake (% of BW) = 120/ (% NDF), RFV = (DDM x DMI)/1.29. The estimated digestible dry matter (DDM) value was used to estimate digestible energy (DE, MJ/kg) using the equation reported by [23]; DE (MJ/kg) = 0.27 + 0.0428 (DDM%). Then, DE value was converted to ME using the formula reported by [24]; ME (MJ/kg DM) = 0.821 × DE (MJ/kg DM). The body weight used to estimate daily dry matter intake is equivalent to an estimated livestock unit metabolic weight of 250kg at 2.5% daily dry matter intake suggested for tropical condition [25].

Statistical Analysis

The chemical compositions of browse plants were subjected to analysis of variances (ANOVA) using the General Linear Model (GLM)

procedure of SAS [26] in completely randomized block design. The significant differences among the means of studied browse plants were declared at $p<0.05$ probability level and means were separated using Tukey test with following model:

Yijk=μ + BSi + eijk, where; yijk = all dependent variables; μ = overall mean; BSi = the effect of browse species and eijk = random error.

Results and Discussion

Chemical Composition

Chemical compositions of fourteen browse plants used as goat feed in Bena-Tsemay district are presented in Table1. The I. *spicata* leaves had higher ($p<0.05$) ash content than *A senegalensis*, *C. molle*, *G. villosa*, *G. tenax*, and *S.birrea* leaves, but ash content wascomparable ($p>0.05$) to *A. albida*, *A. tortilis*, *A. nilotica*, *A. seyal*, *B. discolour*, *B. aegyptila*, *A. manna* and *R. natalensis* leaves. The *A.marina* leaves contained higher ($p<0.05$) CP concentration than *A. nilotica*, *A.seyal*, *A.tortilis*, *G. villosa* and G. tenax, while CP concentration was comparable ($p>0.05$) to *S. birrea*, *B. aegyptila*, *I. spicata A senegalensis*, *A. albida* and *B. discolour* leaves. The *A. tortilis* leaves had higher ($p<0.05$) NDF content than *S. birrea* leaves, but the NDF content was comparable ($p>0.05$) to others browse species, while ADF content was similar ($p>0.05$) among the leaves of all browse plants, but higher ($p>0.05$) ADF value was noted for *G. villosa* and lower was for *A. nilotica* leaves. The higher CP concentration for *A. marina* leaves from this study is might be due to either genotypic potential of tree to fix atmospheric nitrogen and accumulate high content of nutrients which is required for optimum growth and accumulation of more nitrogen in their leaves. The CP concentration of *A. marina* leaves in this study was higher than reported value of (133g/kg, DM) by [27], (110.4g/kg, DM) by [28] and (151.4g/kg, DM) by [29]. The crude protein of *A. seyal* leaves in this study was lower than reported value of (169.6g/kg, DM) by [30] from Ethiopia. The CP concentration of *A. albida* leaves in this study was lower than reported values of (201.80g/kg, DM) and (197g/kg, DM) reported by [30] and [31], respectively. The CP concentrations of *A. toritlis*, *A. nilotica* and *A. senegalensis* leaves from this study were lower than reported CP concentrations of (152.9g/kg, 157.6g/kg, 159.3g/kg, DM) by [12], respectively but CP concentration for *B. disclour* in this study was higher than reported value of (116.4g/kg, DM) by same author. The CP level for *C. molle* from this study was lower than reported value of (160g/kg, DM) by [32], but CP concentration for *G. tenax* was higher than value of (93g/kg, DM) by the same author. The CP concentration from this study for *I. spicata* was lower than reported value of (228g/kg, DM) by [33] and for B. aegyptila was lower reported value of (172g/kg, DM) by [32] but the crude protein concentration of *S. birrea* leaves was higher than reported value of (157g/kg, DM) by the same author. The protein is the most critical nutrient in animal diets which is serving as the structural component of muscle and tissues, source of hormones, enzymes and hemoglobin [34, 35]. The animals are needed diet which has high-quality-protein to acquire desire outputs. The ruminant herbivores will transform the crude protein in the diet into ammonia by microbial digestion, and this ammonia is used as source of nitrogen for rumen microbes to synthesis microbial-protein which will used by host-animal [36]. Generally, the crude protein concentration from present study (124g/kg–198g/kg, DM) for all browse species were higher than the minimum required crude protein levels (70-80g/kg, DM) for normal microbial digestion take place in rumen of ruminant herbivores [37-39]. Also, the crude protein levels obtained from this study for the all browse species were above the minimum crude protein levels which needs ruminant animals for proper growth (113g/kg, DM) and lactation (120g/kg, DM) [40, 41]. In addition, the livestock feeds were categorized into three categories based on CP and total digestible nutrient (TDN) contents, as low-quality-feeds (CP <4% and TDN < 40%), medium-quality-feeds (CP 5-10% and TDN 40-50%) and high-quality-feeds (CP> 10%, and TDN> 50%) [42]. Based on this classification, all browse species studied in this study had categorized as high-quality-feeds which have potential to use as protein-supplements to the livestock fed on poor-quality-diets. The recognizing the cell wall contents of feed stuff is an important steps in livestock feed preparation due to feeds with high contents of cell walls are greatly influenced both feed intake and digestibility by animals [38]. The neutral detergent fiber (NDF) value of feed is greatly correlated to feed intake, while acid detergent fiber (ADF) content is related to the digestibility potential of feed [36]. The higher NDF content of *A. toritlis* leaves from this study is might be due to harvested leaves samples were at advanced age which had contained more stem parts which is responsible to higher NDF content. The NDF content of *A. tortilis* leaves in this study was higher than reported value of (338.4g/kg, DM) by [12], but lower than reported value of (506g/kg, DM) by [43]. The NDF content of *A. seyal* and *A. albida* leaves in this study were lower than reported values of (684.43g/kg, DM) and (512.8g/kg, DM) by [30], respectively. The

NDF values of *A. toritlis* and *A. nilotica* leaves from this study were higher than reported value of (3384g/kg, 342g/kg, DM), respectively by [12], but NDF value was lower than reported values of (630g/kg, DM) and (635.2g/kg, DM), respectively for *A. senegalensis* and *B. disclour* by the same author. The NDF values for *C. molle* and *G. tenax* in this study was lower than reported values of (524.4g/kg, DM) and (870g/kg, DM) by [32], respectively. The NDF content in this study for *I. spicata* was higher than reported value of (363g/kg, DM) by [33] and NDF value for *B. aegyptila* was lower reported value of (319g/kg, DM) by [32], but the NDF content for *S. birrea* leaves was higher than reported value of (148g/kg, DM) by the same author. Based on result of NDF content from this study, all leaves of tested browse plants have NDF content which is below the recommended levels (600–650g/kg, DM) which impairs the dry-matter intake in ruminant animal [19]. Moreover, the ADF values from this study are ranged from 233 to 451g/kg DM, which falls within the acceptable range where browse substrates are expected to be digestible [44] and would not negatively influence feed digestibility.

S/No	Scientific Name	DM%	Ash	CP	NDF	ADF
1	*A. albida*	916.7	96^{ab}	159^{abcde}	527^{ab}	385
2	*A. tortilis*	910	104^{ab}	135^{de}	551^{a}	413
3	*A. nilotica*	916.7	88^{ab}	126^{e}	441^{ab}	233
4	*A. seyal*	910	101^{ab}	137^{cde}	404^{ab}	324
5	*B. discolor*	876.7	155.67^{a}	191^{ab}	418^{ab}	302
6	*C. molle*	900	57^{b}	140^{cde}	462^{ab}	385
7	*A. senegalensis*	906.7	67^{b}	151^{abcde}	494^{ab}	400
8	*G. villosa*	920	59^{b}	129^{e}	548^{a}	451
9	*G. tenax*	903.3	54^{b}	125^{e}	442^{ab}	306
10	*I. spicata*	913.3	156^{a}	184^{abc}	427^{ab}	338
11	*B. aegyptila*	910	117^{ab}	162^{abcde}	496^{ab}	285
12	*A. marina*	890	88^{ab}	198^{a}	467^{ab}	385
13	*S. birrea*	893.3	54^{b}	182^{abcd}	347^{c}	259
14	*R. natalensis*	920	94^{ab}	147^{bcde}	500^{ab}	422
	SEM	1.80	4.79	4	7.87	9.33

Keynote: (Means along column with different letters for ashes, CP, NDF and ADF are significantly different at $p<0.05$; DM%, dry matter percent; CP, crude protein; NDF, neutral detergent fiber; ADF, acid detergent fiber; SEM, standard error of mean).

Table 1: Chemical composition (g/kg, DM) of selected browse plant used as goat in Bena-Tsemaydistrict of South Omo Zone, South-western, Ethiopia.

The estimated metabolizable energy (ME), digestible dry matter (DDM), Dry matter intake (DMI), total digestible nutrient (TDN) and relative feed value (RFV) of selected browse plants used as goat feed in Bena-Tsemay district are presented in Table 2. The result in this study revealed that *S. birrea* leaves had higher ($p<0.05$) estimated DMI than *A. albida*, *A. tortilis*, *A. senegalensis*, *R. natalensis* and *G. villosa* leaves, but DMI was comparable ($p>0.05$) to other browse plants. The estimated digestible dry matter (DDM) in this study was higher ($p>0.05$) for *A. nilotica* leaves followed by *S. birrea* leaves, but the DDM was lower for *G. villosa* leaves. The *A. nilotica* leaves had higher ($p>0.05$) estimated total digestible nutrient (TDN) followed by *S. birrea* and *G. tenax* leaves, but TDN value was lower ($p>0.05$) for *G. villosa* leaves. The *B. aegyptila* leaves had higher ($p>0.05$) estimated relative feed value (RFV) followed by *A. tortilis* and *A. nilotica* leaves, but RFV was lower for *G. villosa* leaves. The higher estimated dry matter intake (DMI) for *S. birrea* leaves in this study is due to lower NDF and ADF contents of leaves (Table 2). It is obvious that the feed that have higher NDF and ADF values, slows the rate of nutrient digestion process which have resulted in lower dry matter intake and allows animals to consume less forages [38]. However, animals fed on high-quality-forages are expected to quickly consume more due to high digestion and rate of passage [45]. Similar to

result on estimated DMI from present study, [8] reported differences in estimated dry matter intake for five browse plants from Indonesia. The estimated dry matter intake obtained in this study (58.57- 94.05g/kg, DM) is higher than reported value of (12.5g/kg, DM) for S. lancea leaves and (17.7g/kg, DM) for M. oleifera leaves by [8]. The higher estimated digestible dry matter (DDM) for *A. nilotica* and *S. birrea* leaves in this study is due to lower ADF content. The feeds with higher ADF contents have a higher indigestible fiber fraction (cellulose, lignin, silica) which is clues to lower digestibility of feeds [36, 42]. The estimated DDM in this study (636.24 -707.47g/kg, DM) is higher than reported values ranged from (270.4g/kg, DM) to (366g/kg, DM) by [8] for five browse plants, but DDM value was relatively within range of reported values (677-748g/kg, DM) by [46] for four Sevena browse species from Ghana. The similarity in estimated relative feed value (RFV) values from this study for browse plants is might be due to similarity in ADF contents among the tested browse plants. This is due the fact that, the RFV is estimated from the DMI and DDM of feeds, which is directly influenced by ADF content of feeds. Indeed, it was reported that feed with higher RFVs had lower NDF and ADF contents which indicates the higher forage quality [47-49]. The relative feed value obtained from this study for all browse species were within the recommended ranges which will be considered as quality feed ingredients for inclusion in ruminant ration (RFV>151) by [50]. The RFV obtained in this study were similar to reported values which ranged from (496.5g/kg, DM) to (921.6g/kg, DM) by [8] for five browse plants, but it was higher than reported values (120.2-212.6g/kg, DM) by [46] for four Sevena browse species from Ghana.

S/No	*Scientific Name*	*DDM(g/kg DM)*	*DMI (g/kg DM)*	*TDN(g/kg DM)*	*RFV(g/kg DM)*	*ME (MJ/Kg)*
1	*A. albida*	589.09	64.52^{b}	534.47	717.66	0.20
2	*A. tortilis*	567.27	58.57^{b}	513.43	751	0.20
3	*A. nilotica*	707.47	73.27^{ab}	648.68	746.26	0.25
4	*A. seyal*	636.34	79.84^{ab}	580.06	617.98	0.22
5	*B. discolor*	653.48	78.45^{ab}	596.60	648.16	0.23
6	*C. molle*	588.83	70.61^{ab}	534.22	652.30	0.21
7	*A. senegalensis*	577.66	65.59^{b}	523.45	686.15	0.20
8	*G. villosa*	537.41	58.85^{b}	484.62	707.82	0.19
9	*G. tenax*	667.24	75.61^{ab}	609.87	695.48	0.23
10	*I. spicata*	625.70	75.57^{ab}	569.79	641.84	0.23
11	*B. aegyptila*	650.11	65.35^{b}	593.34	777.97	0.23
12	*A. marina*	585.32	68.93^{ab}	530.90	663.74	0.24
13	*S. birrea*	686.98	94.05^{a}	628.91	570.79	0.24
14	*R. natalensis*	560.52	61.28^{b}	506.92	719.57	0.19
	SEM	8.24	3.02	0.02	8.02	0.02

Keynote: (Means along column with different letters (a, b) for DDM, DMI, TDN, RFV and ME are significantly different at P<0.05; DDM, digestible dry matter; DMI, dry matter intake; TDN, total digestible nutrient; RFV, relative feed value; ME, metabolizable energy; MJ, mega joule; SEM= Standard error of mean)

Table 2: Digestible dry matter (DDM), Dry matter intake (DMI), total digestible nutrients (TDN), relative feed value (RFV) and metabolizable energy (ME) of selected browse species used as goat feed in Bena-Tsemay district of South Omo Zone, South-western Ethiopia.

Conclusion

The leaves of all browse which have been utilizing as goat feed in the study area had higher crude protein which is above the minimum required CP levels (70-80g/kg, DM) for normal microbial digestion and categorized as high-quality-forage classes. Thus, based on result from this study, it could be concluded that all browse plants evaluated in this study had higher crude protein and will be used as alternative protein source to supplement animals fed on poor-quality-roughage diets. The in-situ-future feeding trials to develop

more informative confidence and put strong recommendation about studied browse plants.

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