



Assessing the Availability and Nutritional Characterization of Browse Species as Camel Feed Resources in Borana Rangeland, Southern Oromia, Ethiopia

Sisay Kumsa^{1*}, Feyisa Lemessa¹

¹⁻² Oromia Agricultural Research Institute (IQQO), Yabello Pastoral and Dry land Agriculture Research Center, Ethiopia

Abstract

The study was conducted in Moyale and Yabello districts, which is situated in Borana zone of the Oromia Regional State. The objectives of this study was to assess the availability of major browse species used for camel feed resources and to characterize its nutritional value/chemical composition. The study was conducted in four purposively selected kebeles focusing on 90 randomly selected camel-owning households. According to the perception of pastoralists/agro-pastoralists browses plants are the main sources of camel feed throughout of the year. Different browse plants such as trees, shrubs and forbs were collected and analyzed for chemical composition. According to the perception of pastoralists camel supplementation practise for the purpose of feed shortage and fattening. According to the perception of pastoralist 45% and 43% of camel feed resource decreasing in Moyale and Yabello district. According to the perception of pastoralists, the availability of feed resources varies across the dry and wet season. The highest feed resources during long dry season in Moyale and Yabello is tree leaves and forbs respectively. *Bosciamossambicensi*, *Vechilla Seyal*, *Sarcostemmaviminale*, *Dalbergiamicrophylla*, *Vechilla etbaica*, *Grewia tembensis*, *Premnaschimperi*, *Phyllanthussepialis*, *Baleriaspinisepalo*, *Vechilla brevispica*, *Harmsiasidoides* and *Rhus natalensis* were major browses plants collected and analyze their chemical composition. Results indicate that the dry matter content of this browses plants varies from 88.9 to 93.6%. The highest dry matter content was recorded in *Vechilla brevispica* (95.6%) and the lowest in *Harmsiasidoides* (88.86) browses plants. Accordingly all the browses plants except *Sarcostemmaviminale* (5.71%), *Vechilla brevispica* (9.12%) and *Vechilla seyal* (8.8%) plants has good crude protein content among the collected and analyzed browses specie. *Premnaschimperi* (25.6%), *Rhus natalensis*(19.99%) and *Phyllanthussepialis*(19.12%) has highest contents of the crude protein than browse plants analyzed. *Premnaschimperi*, *Harmsiasidoides*, *Phyllanthussepialis* and *Dalbergiamicrophylla* has high total invitro organic matter digestibility among the browses species compared to other browses species. *Baleriaspinisepalo* has the lowest total invitro organic matter digestibility as compared to the other browses specie. A range of 3.11 to 16.20% and 83.6 to 96.7% were recorded for Ash and Organic matter values for the twelve browse plants. Their fibre contents showed a range of 22.1 to 51.13, 19.9 to 44.9, 3.2 to 19.5%, for NDF, ADF, ADL respectively. *Baleriaspinisepalo* has highest neutral detergent fiber(57.5%) and acid detergent fiber (52.5%) among other browses plants. Generally, according to the perception of community and the nutritive value(chemical composition) of this browses plants have potential for increase camel production but the productivity of browsing camels greatly depends upon accessibility of the browse and season. This study confirms that browses plants have potential for increased camel production but has shown that the magnitude of the contribution to the productivity browsers greatly depends upon accessibility of the browse.

Keywords: Availability, Browses plant, camel, Chemical composition

1. Introduction

The majority of the Afar, Somali and Borana people are pastoral communities who mainly depend on livestock production systems. Dominant livestock species in pastoral/agro-pastoral areas where camel, cattle, sheep and goats. High quality livestock and meat for export and domestic market are particularly from these pastoral regions. However, the sustainability of the pastoral system and people's livelihood have been



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questioned during the last few decades. Climate changes (e.g. drought) are considered as a major threat to the pastoral economy (Cossins and Upton 1988). The trend in climate changes in the past 50 years, and projection for the next 20 years in pastoral zones of Ethiopia showed retreat in short rainy season with about 250 mm decline in the rain (Funk et al., 2012). The drop in rainfall reduced the quantity and quality of viable pasturelands and replacement of grassland by bush encroachment, which may be utilized by only some specific livestock species.. Indigenous browse species have also high persistence in their respective areas (Woodward A, Coppock DL .1995). However, the extensive utilization of the woody plants have increased pressure on the native vegetation, resulting in degradation of the resources due to over-utilization by the pastoral communities and over- browsing by livestock and game animals (Abule E et al.,2005). Pastoral environments are also typified by high levels of unpredictable variations in feed availability where forage availability fluctuates over time and space. This fluctuation is also reflected in gross production where forage production may range from zero to several tons per hectare depending on rainfall (Alemayehu, M., 2006). The uses of woody species as feed are important to enhance livestock production (Woodward and Coppock, 1995). However, the utilization these woody species constrained by defences against browsers.

The relative high densities of livestock have results in overgrazing of rangeland, which causes progressive deterioration of the vegetation cover and, in consequence, a deficient supply of animal fodder. Feed scarcity is indicated as a factor responsible for the lower reproductive and growth performance of animals especially during the dry season (Legesse G , 2008) . Therefore, to alleviate the ruminant feed supply problems, looking for potential feed resources, particularly those which survive during the dry season, deserve due attention. In this regard, the use of browse species may have a greater potential in contributing towards alleviating the current feed shortage in natural rangelands of the country. Pastoralists developed considerable interest in camel production and livelihood diversification as a mitigation strategy to climate change. Rangelands play a significant role in camel feeding in Borana region. The rangeland consists of a diverse range of trees, shrubs and grasses. Hence looking for feed of camel is an option to sustainable utilizes the productivity of camels. Therefore, this study is designed with the objective of assessing availability and nutritional characterization of major browse species in the study district.

Specific objectives

- To inventories the browse plants used for camel
- To characterize the nutritional value of browse plants used for camel feed resources

2. Materials and Methods

2.1. Area of study

The study was conducted at Yabello and Moyale districts. Two districts selected because of the high population of camel to assess community perception on browse plants in relation to camel production. From each district two kebeles were selected randomly with the help of community leader experts. 45 (forty five) household from each kebeles were selected for survey. Accordingly, 90 households were selected using a random sampling method in two district.

2.2. Sample Collection and Chemical Analysis of the Major Browse.

Based on the survey result the major browses species were collected for laboratory analysis. Foliage samples were taken according to the perception of community for each browse species. The samples were air dried in a well-ventilated room and dried in an oven at 60°C for 72 hours until transported to Holleta Agriculture

Research Center to Nutrition Laboratory. Samples from each browse species were ground separately in a Willey mill to pass through 1 mm sieve to carry out the chemical analysis. Samples were analyzed for dry matter (DM), ash and crude protein (CP) according to the procedures of AOAC (AOAC, 1985). The neutral detergent fiber (NDF), acid detergent fiber (ADF) and Total in-vitro organic matter digestibility (TIVOMD) of each samples were also analyzed, according to the procedure described by Van Soest and Robertson (1985).

2.3. Data analysis

Statistical Package for the Social Sciences was used to summarize the data and simple descriptive statistics such as mean, standard deviation and percentile for traditional uses of major browse species. Data on chemical composition were analyzed using the general linear model procedure of SAS (version 9, 3rd Edn). The model used for chemical composition of major browse species was; $Y_{ij} = \mu + s_i + e_{ij}$, Where, Y_{ij} = Response variable μ = Overall mean s_i = Browse species effect e_{ij} = Random error

3. RESULTS and DISCUSSIONS

3.1. Major Camel Feed Sources

Different camel feed resources reported in the area were tree leaves, shrubs and forbs Table1. Based on interview result the main feed resource for camel in Moyale districts is tree leaves, shrubs and forbs used as for both during dry and wet seasons. There is no significance difference among Moyale and Yabello districts on camel feed resources. The major camel feed resource in Yabello district according to the respondent perceptions is tree leaves and shrubs. Tree leaves and shrubs have equal contribution for camel feed resources in Yabello districts. In general the main feed resources for camel in two districts are browsers which include tree leaves, shrubs and forbs areas. Among the feed resources, the tree leaves and shrubs consists of a wide range of feed resources. Shrubs and forbs also contribute a good source of feed for goats and cattle during the dry season where there is no other source of feed. This result is in line with the previous studies (Sisay, 2006; Solomon, 2007).

During the dry season, an important feed source that pastoralists use next to tree leaves was shrubs in both district. The availability of camel feed in both districts was prioritized as adequate. This might be because of the fact that camels largely depend on the browse species that are available in abundance in the woody vegetation of the study area and camels are wide range browsers by nature. This result is in agreement with the previous studies (Tesfaye, 2008). In both districts, pastoralists did not stress lack of feed as a limiting factor for productivity of camel as other livestock, and did not indicate the importance of improving their feeding regime as an essential step towards any improvement program.

Table: Major feed resources for camel in the Moyale and Yabello district

District	Response	Sources of Camel Feed (<i>Frequency</i>)		
		Tree leaves	Shrubs	Forbes
Moyale	Yes	45	42	27
	No	-	3	18
Yabello	Yes	44	44	11
	No	1	1	34
χ^2 (DF)		1.05 (1)	1.05 (1)	11.66 (1)
$P < 0.05$		0.3063	0.3063	0.0006

3.2. Seasonal Availability of Feed Resources

According to the perception of pastoralists, the availability of feed resources varies across the dry and wet season. The highest feed resources during long dry season in Moyale and Yabello is tree leaves and forbs respectively.

Table 2. Camel feed resource availability in the study districts

Season	Districts	Response	Camel Feed Type		
			Tree leaves	Shrubs	Forbes
Long Dry	Moyale	Yes	43	29	16
		No	2	16	29
	Yabello	Yes	43	19	19
		No	2	26	26
$\chi^2(DF)$			0 (1)	4.46 (1)	0.42 (1)
$P<0.05$			1.0000	0.0346	0.5165
Long Rainy	Moyale	Yes	41	43	41
		No	4	2	4
	Yabello	Yes	45	43	10
		No	0	2	35
$\chi^2(DF)$			4.19 (1)	0 (1)	3.05 (1)
$P<0.05$			0.0408	1.0000	0.0810
Cool Dry	Moyale	Yes	43	35	7
		No	2	10	38
	Yabello	Yes	0	28	7
		No	45	17	38
$\chi^2(DF)$			82.34 (1)	2.59 (1)	0 (1)
$P<0.05$			<.0001	0.1074	1.0000
Short Rainy	Moyale	Yes	45	35	6
		No	0	10	39
	Yabello	Yes	45	43	12
		No	0	2	33
$\chi^2(DF)$			-	6.15 (1)	2.50 (1)
$P<0.05$			-	0.0131	0.1138

No significance difference on the availability of tree leaves during long dry season between the districts. However, there is significance difference on the availability shrubs during dry season and no significance on forbs availability between the districts.

The highest feed resources during main rain season in Moyale is shrubs, tree leaves and forbs respectively. In Yabello the major feed resources during the dry season were leaves, shrubs and forbs respectively. Significance difference on the availability of tree leaves during main rain season between the districts. However, there is no significance difference on the availability shrubs and forbs during main rain season between the districts.

Highly significance difference on the availability of tree leaves during cool dry season was observed between the districts. The highest feed resources during cool season in Moyale is tree leaves, shrubs and forbs respectively. However, there is no significance difference on the availability forbs during cool dry season between the districts. In Yabello the major feed resources during the cool dry season were shrubs, forbs and no responses during tree leaves during the season. There is highly significance between the district was

indicated on the availability of shrubs and forbs. The highest feed resources during short rain season in Moyale is tree leaves and forbs respectively. In Yabello the major feed resources during the short season were leaves, shrubs, and forbs respectively.

Table 3. Availability of Camel Feed across Growing Seasons in Moyale District

Season	Response	Camel Feed Type		
		Tree leaves	Shrubs	Forbes
Long Dry	Yes	43	29	16
	No	2	16	29
Long Rainy	Yes	41	43	4
	No	4	2	41
Cool Dry	Yes	43	35	7
	No	2	10	38
Shot Rainy	Yes	45	35	6
	No	0	10	39
$\chi^2 (DF)$		142.31(3)	13.21 (3)	12.58 (3)
$P<0.05$		<.0001	0.0042	0.0056

There is highly significance difference of growing tree leaves shrubs and forbs across the season. Among feed types tree leaves mostly grow during long rainy season, cool dry season, short rain season and long dry season. whereas, shrubs growth during, dry, main rainy, cool dry and short rain season. Majority of shrubs growth during main rain season according to the perception of pastoralists. Forbs growth during main rain season and short rain season according to the responses of respondents. Generally the growing of the camel feed types mostly depend on the season. Feed types mostly growing during rainy season, short rain season, cool dry season in Moyale district respectively.

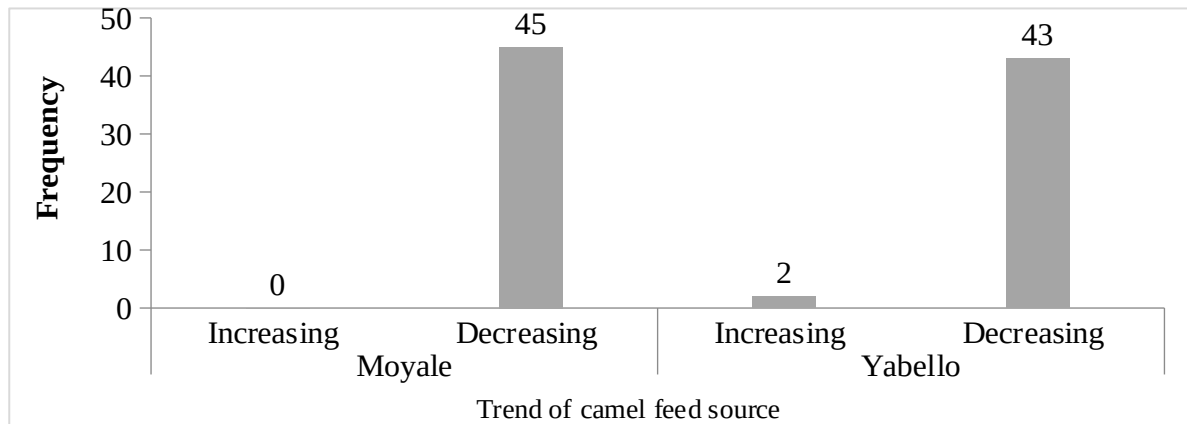
tree leaves.

Table. Availability of Camel Feed Resources across Growing Seasons in Yabello District

Season	Response	Camel Feed Type		
		Tree leaves	Shrubs	Forbs
Long Dry	Yes	43	19	19
	No	2	26	26
Long Rainy	Yes	45	43	10
	No	0	2	35
Cool Dry	Yes	0	28	7
	No	45	17	38
Shot Rainy	Yes	45	43	12
	No	0	2	33
$\chi^2 (DF)$		172.35 (3)	48.46 (3)	8.86 (3)
$P<0.05$		<.0001	<.0001	0.0312

There is highly significance difference of growing tree leaves shrubs and forbs across the season. Among feed types tree leaves mostly grow during long rainy season and short rain season in Yabello districts. Majority of shrubs growth during main rain season and short rain according to the perception of pastoralists. Forbs growth during main rain season, cool dry season and short rain season according to the responses of respondents. Generally the growing of the camel feed types mostly depend on the season. The trends of camel feed resource highly decreasing in Moyale as compared to Yabello. This may be due to the decreasing of indigenous promising browses due to the climatic factors. However, the Borana pastoralist now day s shift

their herd diversification to camel and goat. So, it needs to managing and exploring the indigenous multipurpose plant species. According to the perception of pastoralist 45% of camel feed resource decreasing in Moyale district and 43% of respondent respond camel feed types where decreased this agree with Alemayehu [14] due to lack of attention and high stocking rates communal browsing land is declining and deteriorating rapidly in pastoral areas of Ethiopia and only 2% state increasing.



Camel Feed Supplementation

According to the perception of pastoralists camel supplementation practise for the purpose of feed shortage and fattening. The majority of feed supplementation practice in Yabello districts as compared to Moyale district. According to pastoralists responses practice supplementation both for feed shortage and fattening purposes and in Yabello only for feed shortage. The types of feed supplementation is leaf and pods.

Item	Response	Districts		χ^2 (DF)	P<0.05
		Moyale	Yabello		
Supplementation (N=90)	Yes	13	17	0.80 (1)	0.3711
	No	32	28		
Types of supplementation (N=30)	Leaf and Pod	9	12	0.01 (1)	0.9359
	Leaf Only	4	5		
Reason of supplementation (N=30)	Feed Shortage	12	13	4.59 (2)	0.1009
	Fattening	1	0		
	Both	0	4		

About 28.9% and 37.8% of the respondents reported that supplementation of camel feed resource practiced during availability of feed resource for fattening and for feed shortage during dry season in Moyale and Yabello districts respectively. About 71.1% and 62.2 % of the respondents reported that supplementation of camel feed resource not practiced throughout the year. According to the perception of pastoralists they interest to migrate to a place of feed and water availability rather to purchase feed supplementation during the feed shortage.

Supplementation of feed during dry season is not well known in study districts. However, supplementation of feed for camel in Yabello more than Moyale districts. More respondent not provided supplementation for their camel during dry season. leaves and pods is the most common supplementation for those practice feeding additional feed resources. leaves and pods of Vechillaspecies mostly supplemented by the Yabello district than Moyale districts. leaf supplementation practice both in Moyale and Yabello districts. In both study site they provided supplementation for feed shortage and fattening purposes. The major problem of supplementation is for feed shortage during the dry season according to the respondents of pastoralists.4% of respondent use supplementation for both fattening and feed shortage problem. Yabello respondents not

use supplementation for fattening purposes. Highest Poison plants present in Moyale as compared to Yabello districts. Especially, those poison plants are very serious during dry season. those plants have moisture during dry season and camels or any livestock species consume for a purpose of its moisture content and the suffered to death.

3.3. Chemical Composition of Main Browsers Species

The lowest ($P < 0.05$) Crude protein (CP) content was noted for *Sarcostemmaviminale* among the browsers species. The current crude protein value of *Rus natalensis* higher than (Welay K, et al. 2018) on traditional utilization and chemical composition of major browse species in range lands of Mieso districts. In the current study the crude protein content of *Grewia tembensis* (19.09%) but higher than (Welay K, et al. 2018) findings. However, the crude protein (CP) content result of the present study is within the range reported by (Dicko MS, Siken, LK, 1992) reported for different browse species (6 to 23% CP). The Variation in nutrient content of browse species is may be because of soil fertility difference and inherent ability of the plant to accumulate nutrients from the soil. The CP contents of these browsers were higher than the minimum of 7- 8% necessary to provide the minimum ammonia levels required by rumen micro- organisms to support optimum rumen activity and required to satisfy the ruminal micro-organism of sheep and goats (Norton BW, 2003). The CP values of the current study were also above the requirement for lactation (12% CP) and growth (11.3% CP) in the diets of ruminants as reported by ARC [43]. This indicates the selected browse plants analysed in this study may be well used as a protein supplement to low quality feeds such as crop residues due to a higher level of crude protein of all the browse plant species. *Baleriaspinisepalo* had significant ($P < 0.05$) higher neutral detergent fiber (NDF) percentage as compared to the other browse species.

Table 1: Chemical Composition of Main Browsers species on Dry Matter Basis(%DM)

Scientific Name	Vernacular name	DM	Ash	OM	CP	NDF	ADF	ADL	TIVOM D
<i>Bosciamossambicensi</i>	Qalqalcha	91.299	14.051	85.949	13.925	38.273	44.879	13.68	70.089
<i>VechillaSeyal</i>	Waaccuu	91.499	11.983	88.017	8.817	25.424	23.092	16.12	71.497
<i>Sarcostemmaviminale</i>	Hangayyaa	90.44	8.369	91.63	5.70	48.99	44.402	10.42	59.07
<i>Dalbergiamicrophylla</i>	Walchaamala	91.46	10.168	89.83	18.94	22.09	26.385	8.76	82.19
<i>Vechilla etbaica</i>	Alqabeessa	91.40	11.690	88.31	15.283	29.76	19.901	15.41	77.53
<i>Grewia tembensis</i>	Dheekkaa	90.95	16.396	83.60	19.094	44.36	43.524	5.258	77.37
<i>Premna schimperi</i>	Xaaxessaa	89.08	12.494	87.50	25.6	50.95	39.582	9.74	86.39
<i>Phyllanthusepialis</i>	Dhirriwarseea	90.36	10.982	89.01	19.196	24.75	23.277	9.41	83.71
<i>Baleria spinisepalo</i>	Qilxipheegaalaa	90.24	15.730	84.27	13.754	57.53	52.581	12.90	58.58
<i>Vechillabrevispica</i>	Hammarreessa	93.58	3.114	96.88	9.184	38.08	27.152	19.49	71.30
<i>Harmsiasidoides</i>	Qaxxee	88.87	13.457	86.54	15.877	49.62	43.411	7.76	84.58
<i>Rhus natalensis</i>	Daboobessa	90.31	9.576	90.42	19.9	51.12	35.42	15.79	77.65

ADF= acid detergent fiber; ADL= acid detergent lignin; CP= crude protein; DM= dry matter; NDF= neutral detergent fiber

The Acid detergent fiber (ADF) content of *Baleriaspinisepalo* was also significantly higher ($P < 0.05$) than the other species. *Phyllanthusepialis*, *Dalbergiamicrophylla* *Vechillaetbaica*, *Vechillabrevispica* and *VechillaSeyal* had significant ($P < 0.05$) lower than other browsers species. Lower values of ADF in these leaves of browse species indicate good potential as ruminant feed (Bakshi MPS, 2007). Those browse species with higher ADF content may have lower digestibility since digestibility of feeds and ADF content are negatively correlated (McDonald P et al.,2002). However, the NDF and ADF content of the current study are within the range 22.09-

57.53% neutral detergent fiber and 19.9-52.6% for acid detergent fiber which agree with the finding of (24-61% and 17-61%) respectively documented for forages used in ruminant feeding [Topps JH . 1992, Budi T, Wina E.1995].

Premnaschimperi, Harmsiasidoides, Phyllanthussepiasis and Dalbergiamicrophylla has high total invitro organic matter digestibility among the browses species which located in area. Baleriaspinisepalo has the lowest total invitro organic matter digestibility as compared to the those of annual grasses species. This may be due to the nature of plants (growth form) and eating/frequency of cutting. The fiber content of those browses species has very good which is almost content less than 50%. Only Baleriaspinisepalo has the highest neutral detergent fiber and acid detergent fiber. Among feed resource identified for camel as feed resource 10 are annual grass and 2 are perennials. The dry matter content of perennial and annual of this browses plants varies from 88.9 to 93.6%. the highest dry matter was recorded in *Vechillabrevispica* and the lowest in *Harmsiasidoides* perennial browses species. Among of optimum nutritive value content of browses *Rhusnatalensis*, *Phyllanthussepiasis*, *Dalbergiamicrophylla* mostly found in areas due to that reason the result of well managed as compared to the communal area.

According to the result of laboratory analysis all the annual ligneous plants has good crude protein content. Among the browses species collected *Premna schimperi* browse species has highest contents of the crude protein. This indicates that the browses species has the potential to satisfy the daily nutrient requirements of camel. Even though, the ash contents of this browses indicated that there is a contamination of collected feed during the collection of feed it may be improperly collected/handled. Some browses species of browses species contain crude protein which below the daily nutrient requirement in such case supplementation is important for reproductive performance improvement and production. *Vechilla brevispica* is one of the browses species which contain 9.18 crude protein which disagree with the finding of Sisay 2017. This may be due to soil contents of the area, stage of collecting and collecting methods. The ash content of this *Vechilla brevispica* very low which indicated that there is no contamination. The nutritive value of this browses species has the potential to survive the production and reproductive performance of the camels of this browses. The ash content of *Boscia mossambicensis* 14.1 which indicated that the collected feed has contaminated with different factor due to this reason crude protein content is very low. Properly harvesting and preservation until analyzed is very vital to any collected feed.

	DM	Ash	OM	CP	NDF	ADF	TIVOMD
Tree	91.4±0.75	12.57±2.03	87.43±2.02	12.67±3.38	31.15±6.28	29.29±7.85	73.03±4.7
Forbs	90.24±1.3	15.73±15.73	84.27±3.51	13.75±5.84	57.53±10.88	57.53±10.88	58.58±8.2
Shrubs	90.63±0.45	10.60±10.57	89.43±1.24	16.69±2.06	41.24±41.25	41.25±3.85	77.78±2.9

This study confirms that fodder trees and shrubs have potential for increased livestock production but has shown that the magnitude of the contribution to the productivity of grazing animals greatly depends upon accessibility of the browse. However, high accessibility is not often achieved in the grazing situation prevailing in the dry tropics which carry the majority of domestic ruminants. Among domestic ruminants, the most effective browsers are camels. Increasing accessibility of browse entails human interventions which may be detrimental to woody plants. There is therefore, a need to develop appropriate woodland management systems which will ensure optimum utilization concomitant with persistence of browse production in grazing systems.

4. CONCLUSION

It is concluded that the browse species used in this study could be good protein supplements to low quality basal diets. Throughout the year Browse species in the study area contributes cheapest source of protein for

camels and source of protein for other species of animals and they greatly contribute to the nutritional need of livestock camels and to the livelihood of pastoralists in the area at large. Therefore, awareness creation strategies and developing means should be targeted to maintain those valuable plants to have a sustainable livestock production in the area to prevent their deterioration. Browse species had also other traditional uses such as their role in medicinal value.

5. RECOMMENDATION

In order to enhance the utilization of browses trees and shrubs as camel feed resources, there is a need to

- Further studies to evaluate more Ant nutritional factors of this browses species will be need further study in future were recommended
- Animal feeding experiments are also necessary to determine the nutritive value of the promising species in terms of palatability, intake, digestion and effect on production performance of the animals
- Carry out an exhaustive assessment of the deleterious substances browses plants should be suggested
- To bring sustainable and fruitful camel production managing those promising plants species very important.
- Study on the Diversity of plants, Ecological requirement of each plant, Morphological description of each plant, Density of plant and Seeds of each plant will be need further study.

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