Original Research Article

Camel Feed Characterization of Ethiopian Somali Region Rangelands through Traditional Knowledge

ABSTRACT

The study was conducted in five administrative zones of the Ethiopian Somali Regional State, with the objectives of characterizing the major camel browse and grazed plant species and their seasonal availability in pastoral and agro-pastoral areas. A semi-structured questionnaire, group discussions, field observations, and key informant interviews were used as the primary data collection tools, while different secondary data sources were also used. A total of 150 household heads were selected purposively for formal interview. The results showed that most (90.7%) of the respondents were male and 85.3% of the sampled households were illiterate. It was revealed that browsing trees and shrubs were the major camel feed resources in pastoral and agro-pastoral areas. Although the quality and quantity of camel feed vary in dry (66%) and wet (88%) seasons; trees and shrubs were the major feed resources at all seasons, while the herbaceous species cover only 34% in both pastoral and agro-pastoral areas. The identified camel feed species in the study districts comprise 38 tree species, 20 herbaceous species, 12 shrub, 7 bush, and 17 grass species. The study revealed that there is a need to raise awareness among the pastoralist and agro-pastoral communities on the importance of browse plant species management and sustainable utilization.

Keywords: Biodiversity, Herbs, indigenous species, Pastoralists, Shrubs, Trees

1. INTRODUCTION

Camels are known for dry condition tolerance, and long distance mobility in search of food. Feral camels (*Camelus dromedarius*) sometimes cover 70 kilometers in a day, and can utilize most habitats in arid and semi-arid areas, depending on availability of food and summer shade [1]. The Australian Government report also indicated that camels prefer to browse on woody vegetation types including trees, shrubs and bushes to a height of 3.5 meters tall than they utilize grass. Most of the browse resources are found in the rangelands of pastoral and agro-pastoral systems, where camel production remains the dominant livelihood option. In the arid and semi-arid zones of the world, it is necessary for livestock to be adapted to the harsh grazing conditions. Camels through their unique morphology and physiology are able to survive in environments with harsh climatic conditions, and seasonal variation in feed quality, quantity and spatial distribution. This enables camels to survive on very fibrous and low protein diets because their height allows them to utilize feed resources inaccessible to other livestock species [2] and their cleft upper lip better able them to select diets. Camels are more drought-tolerant than cattle, performing well in adverse conditions, and have lower energy requirements [3].

Camels are an extremely important livestock species in arid and semiarid zones of Asia and Africa that significantly contribute to livelihood of the pastoralists and agro-pastoralists living in these fragile environments [4, 5]. In the drier parts of the Eastern and North Eastern provinces of Somali, camels support pastoralists' livelihood through provision of meat and milk, while playing an important role as a means of transport in the traditional rural sector [6]. Camel production is highly associated with the availability and quality of feed resources in all seasons.

Crop residues, improved pasture and agro-industrial byproducts are used in Ethiopia as livestock feed resources, and are used via communal land grazing and browsing, cut-and-carry feeding, hay and crop residues [7, 8, 9]. During the dry season in the mid Rift Valley of Ethiopia, pastoralists and farmers collect pods of tree species and retain them to feed calves and sick animals that cannot walk long distances in search of feed and water [10]. For small ruminants (especially goats), herders lead the animals to *Acacia* trees and shake the pods from the trees to feed the animals. Animal feed from a trees are considered as effective insurance against seasonal feed shortages for animals in some areas [11, 12, 2].

Study conducted by Shenkute et al. (2012) in the mid Rift Valley of Ethiopia [10] identified a large reserve of local plant species potentially useful for livestock feeding that could increase regional livestock production and productivity and reported that woody browse species has exhibited far higher nutritive value compared with herbs and grasses. Generally browse species are richer in crude protein, minerals and digestible nutrients than grasses [13].

For various reasons, plant species present in rangelands used as camel feed are facing degradation, that affects camel production in Ethiopian Somali Region. To cope with dwindling feed resources, planning for the herd size to be compatible with rangeland, carrying capacity should be a priority [14]. More importantly, to perpetuate the current production system, planning for appropriate utilization of the existing camel browse vegetation types and conservation of the plant species for socio-economic and ecological benefits is an important issue . The rangeland management activities have brought the increased woody species density score under enclosed grazing areas in Metema district of North Gondar Zone, Ethiopia compared to communal and the riverside grazing areas at P=0.05 [14].

Since camel production in the Ethiopian Somali region mainly depends on rangeland feed resources, vegetation management is required for sustainable camel production. Planning for sustainable utilization and conservation of browse species needs a description of potential rangeland species. Furthermore, understanding the seasonal gaps in the feed resources is also essential for implementing appropriate supplementation strategies. Therefore, characterization of plant species used for camel browse is critical.

Little information is available in the study area except for some research findings covering only a spatial / limited part of the region. Lack of such information could have far-reaching consequences on the sustainability of camel productivity in Ethiopia [15]. However, if information available to local people

through indigenous knowledge is organized in usable form, it may bring positive change to the community.

People in pastoral and agro-pastoral areas are much familiar about their environment and animal's behavior. They apply their indigenous knowledge for feeding; breed management and health management of their animals along with traditional medicine practice and predicting the season in terms of feed and water availability. Indigenous knowledge is a very important tool to identify and describe the feed resources based on traditionally accumulated wisdom. Marius et al. (2016) indicated the power of indigenous knowledge on the identification of local woody plant species that used for animal feed in the communal farming areas [16]. This study was therefore conducted with the objective of characterizing the major camel browse and grazed plant species and their seasonal availability in pastoral and agro-pastoral areas by using indigenous knowledge approach.

2. MATERIALS AND METHODS

2.1. Study site description

The study was conducted in the Ethiopian Somali Region, located in east and south-eastern Ethiopia between 4^{o} to 11^{o} N latitude and 40^{o} to 48^{o} E longitude. It is the second largest Regional State of the Federal Democratic Republic of Ethiopia, with an estimated area of 281,900 km^2, while 80% the topography of the region is dominated by lowland plains, with an altitudinal range of 900 to 1600 meters above sea level.

Almost 80% of the region has an arid and semi-arid climate; rainfall is extremely variable and low having bi-modal distribution with an average annual rainfall from 200 to 700mm. The mean annual temperature ranges from 20^{o} to 45^{o}C. Strong wind circulation further causes moisture loss from soil and plants. Vegetation is sparse and mainly composed of grass, bushes and scrub. Natural vegetation contains a high proportion of endemic plants of Ethiopia, that are a large variety of *Acacia*, *Boswellia* and *Chomiphera* species; medicinal plants and gum while incense and myrrh producing plants are abundant. As a result of dry climatic condition and scarce surface water, the proportion of better adapted animal species such as camels and goats are higher compared to other animals in the region.

2.2. Sampling Design and Data Collection methods

The study was conducted in five zones (Jarar, Nogob, Qorahey, Dollo, Liban) of Ethiopian Somali regional state, from each zone one district (Degehabur, Hamaro, Kabridahar, Warder, and Dhakasuftu) was selected based on accessibility, security situation and having potential camel population. A subjective sampling procedure was used since strictly random sampling procedure was less feasible because of the mobility, scattered and less accessible nature of pastoral communities. From each district,

30 household heads of dominant camel producers were selected, making a total of 150 households from five districts for household survey.

From September up to Mid-November of 2016, primary data was collected by using key informant's interviews, household surveys, field observation and focus group discussions with pastoralists and agro-pastoralist camel herders, while secondary data was collected from published and unpublished data of district and regional Bureau of Agriculture and NGO's reports on the Ethiopian Somali region.

A semi-structured questionnaire was designed to collect both qualitative and quantitative data on types of camel feed and plants species with their diet values, as well as the seasonality of camel feed resources in pastoral and agro-pastoral areas. The questionnaire data collection was carried out by an experienced Somali language speaker with close researcher supervisions. Along with other data collection, field observation was conducted to provide an overall insight on the issue. Eight individuals of camel herders were selected from each district, and key informant interviews conducted with the help of a checklist to collect qualitative data. As part of the exploratory survey, one focus group discussion (composed of ten individuals) was conducted at each district to capture wider qualitative information. For this purpose, elder pastoralists and socially respected individuals (*Ugas*) owning camels were selected and discussion held with the help of a checklist.

After checking for errors and consistency, data were analyzed using SPSS software (version 20.0). Quantitative data were analyzed with the help of descriptive statistics such as percentage and frequency, while qualitative data were narrated, and explained logically based on the existing situation and literature. Vegetation species identification was made with the help of indigenous knowledge of local people, and reference books. Botanical names are according to [17, 18 and 19].

3. RESULTS

3.1. Household characteristics

The average age of camel herder respondents was ranged from 20 to 65 years while, 73% of the respondents were between the ages of 35-60 years. Regarding gender distribution, 91% of the respondents were from male households. Of the sampled respondents, 85% were illiterate, 13.3% were able to read and write only, and the rest were attending primary school. The degree of illiteracy may have a meaningful impact and hinder the adoption of new technologies in camel feed resource management in the study area (Table 1). However, regardless of educational level, pastoral and agro-pastoral communities were able to identify the different camel feed types.

Table 1: The household characteristics of the study areas. Numbers in parenthesis indicate the percentage of respondents (%)

Districts	Age Groups by years			Respondents by gender		Educational level (%)		
	20-35	35-60	>61	Male	Female	Illiterate	Read & write	Primary School
Degehabur (n=30)	2(6.7)	23(76.7)	5(16.7)	26(86.7)	4(13.3)	23(76.7)	6(20.0)	1(3.3)
Kebridahar (n=30)	5(16.7)	21(70.0)	4(13.3)	30(100)	0(0.0)	28(93.3)	1(3.3)	1(3.3)
Warder (n=30)	6(20.0)	21(70.0)	3(10.0)	30(100)	0(0.0)	30(100)	0(0.0)	0(0.0)
Hamaro (n=30)	12(40)	16(53.3)	2(6.7)	25(83.3)	5(16.7)	19(63.3)	11(36.7)	0(0.0)
Dhekasuftu (n=30)	2(6.7)	28(93.3)	0(0.0)	25(83.3)	5(16.7)	28(93.3)	2(6.7)	0(0.0)
Overall (n=150)	27(18.0)	109(72.7)	14(9.3)	136(90.7)	14(9.3)	128(85.3)	20(13.3)	2(1.3)

*Illiterate: Not read and write

3.2. Major types of camel feed resources and seasonal availability in the sites

In the study districts, browse plant species were the major feed sources utilized by camels. Although crop residue availability was very low while maize and sorghum straw was fed mainly in agro-pastoralists during the dry season. Except for some discrepancies in the dry season, trees and shrubs are important sources of camel feed throughout the year in the region As 88% of the respondents indicated that, during the wet season, browse trees and shrubs are the major feed sources, followed by herbaceous species (Table 2). In the dry season, trees and shrubs remained as the main source of camel feed (66.0%), followed by herbaceous species (34.0%). Grass forage and crop residues were the least common camel feed resources utilized in both the dry and wet seasons (Table 2).

Table 2: Types of camel feed sources used at different seasons of the year as ranked by the percentage of responses (n= 150; 1= most common; 4= least common). Numbers in parenthesis indicate the percentage of respondents (%)

Types of feed	At wet season				At dry season			
	1st	2nd	3rd	4th	1st	2nd	3rd	4th
Herbaceous species	18(12)	52(34.7)	-	-	51(34)	68(45.3)	21(14)	-
Browsing trees and shrubs and bushes	132(88)	98(65.3)	-	-	99(66)	40(26.7)	20(13.3)	-
Grass forage	-	-	-	12(8)	-	42(28)	88(58.7)	
Sorghum Stover	-	-	-	-	-		-	2(1.3)
Maize Stover	-	-	-	-	-		-	3(2)

3.2.1. Major tree species utilized by camels in different seasons

The data show that 38 indigenous tree species were identified as locally important for camel feed in different seasons. The tree species most widely utilized by camels in the wet season were *Sonneratia*

alba (89.3%), *Cordia sinensis* (85.3%), *Acacia ogadensis* (83.3%), *Acacia mellifera* (82.7), *Acacia bussei* (80%), *Commiphora agar* (79.3%), *Commiphora allophylla* (74.7%), *Commiphora campestris* (71.7%), *Acacia senegal* (71.3%), *Acacia reficiens* (68%), *Commiphora incise* (67.3%), *and Carphalea glaucescens* (66.7%) in the decreasing order (Table 3). However, *Dobera glabra* (100%), *Boscia minimifolia (88%), Acacia tortils* (86.7%), *Commiphora campestris* (60%), *Commiphora erlangeriana* (59.3%), and others were identified as common camel brows species at dry season (Table 3) (All botanical names according to: [17,18;19].

Table 3: Tree based camel feed sources at different season in the study areas, while numbers along each column of the two seasons indicate the percentage of respondents towards the importance of each plant species at wet and dry seasons.

Tree species			Responses on the extent of shrub based camel feed sources utilization at different seasons	
Somali Name	**Scientific Name**	**Family Name**	**At wet season (%)**	**At dry season (%)**
Maanyo	*Sonneratia alba*	*Lythraceae*	89.3	27.3
Madheedh	*Cordia sinensis*	*Boragginaceae*	85.3	30
Dhamaajo	*Commiphora incise*	*Burseaceae*	67.3	34.7
Mal-mal	*Commiphora molmol*	*Burseaceae*	72.7	42
Midha-fur	*Boswellia neglecta*	*Burseraceae*	58.7	25.3
Xagar madow	*Commiphora allophylla*	*Burseraceae*	74.7	36
Hadi	*Commiphora erlangeriana*	*Burseraceae*	38.7	59.3
Hagar	*Commiphora agar*	*Burseraceae*	79.3	34
Quraar	*Commiphora campestris*	*Burseraceae*	71.7	60
Jaleefaan	*Caesalpinia erianthera*	*Caesalpinaceae*	45.3	30
Labi	*Delonix elata*	*Caesalpinaceae*	64	34
Mey-gaag	*Boscia minimifolia*	*Capparidaceae*	37.3	88
Aobol	*Combretum Sp.*	*Combretaceae*	47.3	19.3
Hareeri	*Terminalla polycarpa*	*Combretaceae*	65.3	28
Gaheydh	*Blepharispermum fruticosum*	*Composite*	56.7	14
Feedho-qandhol	*Hildebrandtia linearifolia*	*Convolvulaceae*	43.3	18.7
Geed-hamar	*Cucumis halabrada*	*Cucurbitaceae*	38	21.3
Einjir	*Euphorbia balsamifera Ait*	*Euphorbiacea*	45.3	16.7
Yo'ob	*Gyrocarpus hababensis*	*Hernandiaceae*	64.7	21.3
Galool	*Acacia bussei*	*Fabaceae*	80	32.7
Sarman	*Acacia hoodia*	*Fabaceae*	59.3	19.3
Sogsog	*Acacia etbiaca*	*Fabaceae*	58	33.3
Gumar	*Acacia nubica*	*Fabaceae*	66	30
Cadaad- geri	*Acacia ogadensis*	*Fabaceae*	83.3	54

Adaad	*Acacia senegal*	*Fabaceae*	71.3	47.3
Garbi	*Acacia albida Del*	*Fabaceae*	60.7	26.7
Jeerin	*Acacia edgeworthii*	*Fabaceae*	58.3	35
Maraa	*Acacia nilotica*	*Fabaceae*	51.3	25.3
Qansax	*Acacia reficiens*	*Fabaceae*	68	39.3
Qudhac	*Acacia tortilis*	*Fabaceae*	57.3	86.7
Bil-il	*Acacia mellifera*	*Fabaceae*	82.7	31.3
Hammi	*Miring borziana Matti*	*Moringaceae*	40.7	14
Dhuya	*Balbergia commiphoroides*	*Papilionaceae*	45.3	18
Gob	*Ziziphus mauritiana*	*Rhaminaceae*	62.7	36
Bur-bur	*Carphalea glaucescens*	*Rubiacea*	66.7	26.7
Himir	*Gardenia fiorii*	*Rubiaceae*	37.3	17.3
Adey	*Salvadora persica*	*Salvadoraceae*	49.3	24
Garas	*Dobera glabra*	*Salvadoraceae*	0	100

3.2.2. Major shrub species utilized by camel in different seasons

, Totally 12 indigenous shrub species were identified as locally important camel browse species (Table 4). Shrub species were also identified as very important camel feed sources. The most widely utilized shrub species in wet season were *Cordia gharaf* (87.3%), *Grewia tenax* (76.0%), *Grewia bicolour* (74.7%) and *Boscia coriacea* (70.7%), and others. Whereas, *Cordia gharaf* (66.7%), *Grewia tenax* (55.3%), *Grewia bicolour* (54%), *Boscia coriacea* (50%) widely browsed as camel feed at dry season in the study districts (Table 4). From the shrub species identified by the respondents *Tiliaceae* family (33.3%) was ranked first followed by *Capparidaceae* (16.7%) (Table 4).

Table 4: Shrub based camel feed sources at different season in the study areas, while numbers along each column of the two seasons indicate the percentage of respondents towards the importance of each plant species at wet and dry seasons

Shrub species			Responses on the extent of shrub based camel feed sources utilization at different seasons	
Somali name	Scientific name	Family name	At wet season (%)	At dry season (%)
Madheedh	*Cordia gharaf*	*Boraginaceae*	87.3	66.7
Dhirindhir	*Euphorbia cuneata*	*Euphorbiaceae*	64.7	44.0
Dhebi	*Grewia bicolour*	*Tiliaceae*	74.7	54.0
Hob-hob	*Grewia penicillata*	*Tiliaceae*	65.3	44.7
Dhanfaruur	*Grewia tenax*	*Tiliaceae*	76.0	55.3
Gomosh	*Grewia villosa*	*Tiliaceae*	57.3	36.7
Geed-jini	*Stercula africana*	*Steraculiaceae*	50.0	29.3
Salalma	Sesamothamnus busseanus	*Pedaliaceae*	65.3	44.7
Hanjo-mukh	*Sarcostemma adongense*	*Asclepiadaceae*	50.0	29.3

Higlo	*Cadaba heterotricha*	*Capparidaceae*	49.3	28.7
Qalan-qal	*Boscia coriacea*	*Capparidaceae*	70.7	50.0
Tiire	*Clerodendrum Sp.*	*Verbenaceae*	63.3	42.7

3.2.3. Major Bush species utilized by camel in different seasons

A total of seven indigenous bush species categorized into six families were identified as camel feed resources in the study areas (Table 6). Although bushes are less preferable camel feed sources compared with trees and shrubs in the wet season, some of the species such as *Euphorbia longetuberculosa* (41.3%), *Abutilon anglosomaliae* (32.7%), *Sida ovata (26%)* and *Entada leptostachya (23.3%)* were still well known being camel brows bush species in decreasing order (Table, 5). Whereas the bushes including *Abutilon anglosomaliae (*47.3%*), Euphorbia longetuberculosa* (43.3%), *Cassia somalensis* (38), *and Entada leptostachya* (37.3%) continued to be used as a commonly browsed camel feed sourcein the dry season.. Survey results ranked the *Malvaceae* family of bush species first, followed by *Euphorbiaceae*, *Mimosaceae*, *Cucurbitaceae*, *Caesalpinaceae* and *Solanaceae* (Table 6).

Table 5: Bush based camel feed sources at different season in the study areas, while numbers along each column of the two seasons indicate the percentage of respondents towards the importance of each plant species at wet and dry seasons

Bush species			Responses on the extent of shrub based camel feed sources utilization at different seasons	
Somali Name	Scientific Name	Family Name	At wet season (%)	At dry season (%)
Adda-adeey	*Sida ovata*	*Malvaceae*	26.0	34.0
Balan-baal	*Abutilon anglosomaliae*	*Malvaceae*	32.7	47.3
Dhalaan-duuh	*Euphorbia longetuberculosa*	*Euphorbiaceae*	41.3	43.3
Gamo-dheere	*Entada leptostachya*	*Mimosaceae*	23.3	37.3
Geed-hamar	*Cucumis halabrada*	*Cucurbitaceae*	15.3	27.3
Jaleelo-geel	*Cassia somalensis*	*Caesalpinaceae*	16.0	38.0
Kariiri	*Solanum somalensis*	*Solanaceae*	0.0	30.0

3.2.4. Major herbaceous species utilized by camels in different seasons

During the wet season, herbaceous plants are preferred camel feed compared with trees and shrubs. Conversely, herbaceous plants are less abundant in the dry season. This reduces the chance of herbaceous plants being camel feed. However, these plant categories also play a role in diversifying wet season camel feed. Through questionnaires and group discussions, 20 herbaceous plant species were identified as camel feed in the study districts at different seasons (Table 6). The most widely utilized herbaceous plants in the rainy season were *Blepharis ciliaris* (93.3%), *Coccinia grandis* (90.7%), *Sesbania somalensis* (88.7%), *Cadaba longifolia* (86.7%), *Hyphaene benadirensis* (86.7%), *and Abutilon fruticosum* (84.7%) (Table 6).

Table 6: Herbaceous species based camel feed sources at different season in the study areas, while numbers at each column of the two seasons indicate the percentage of respondents towards the importance of each plant species at different season.

Herbaceous species			Responses on the extent of shrub based camel feed sources utilization at different seasons	
Somali Name	Scientific Name	Family Name	At wet season(%)	At dry season(%)
Yamaarug	*Blepharis Ciliaris*	*Acanthaceae*	93.3	53.3
Wancad	*Abutilon fruticosum*	*Acanthaceae*	84.7	43.3
Jid	*Actiniopteris radiata*	*Adiantaceae*	66.7	23.3
Sarin	*Cadaba Ruspolii*	*Capparidaceae*	43.3	16.7
Rugumbay	*Cadaba Longifolia*	*Capparidaceae*	86.7	26
Qodah-tol	*Maytenus Somalensis*	*Celstraceae*	39.3	8
Ga-gabood	*Vernonia Mogadoxensis*	*Compositae*	74.7	30
Maadathe	*Dicoma Somalensis*	*Compositae*	63.3	23.3
Fari-hood	*Sclerostephane Adenophora*	*Compppositae*	74.7	42.7
Hiil	*Vernonia Cinerascens*	*Compppositae*	74	24
Madooya	*Cadaba Longifolia*	*Convolvulacaeae*	76	42
Saar	*Coccinia Grandis*	*Cucurbitaceae*	90.7	46.7
Qarari	*Citrullus Lanatus*	*Cucurbitaceae*	80	22
Buuhiso	*Croton Gillettii*	*Euphorbiaceae*	80.7	38.7
Dhikri	*Acalypha Fruticosa*	*Euphorbiaceae*	60.7	30.7
Kab-gal	*Hibiscus Meyeri*	*Malvaceae*	56.7	15.3
Baar	*Hyphaene Benadirensis*	*Palmae*	86.7	33.3
Haqa-qaro	*Tephrosia Villosa*	*Papilionaceae*	59.3	16.7
Jilab	*Indigofera Ruspolii*	*Papilionaceae*	72	19.3
Labi-yar	*Sesbania Somalensis*	*Papilionaceae*	88.7	44.7

3.2.5. Major Grass species utilized by camels in different seasons

Similar to the herbaceous plants, grass was also not a camel's priority feed in wet season; although this plant category is abundant at that time. However, grasses enhance food choices diversity and, camels graze alternatively to the browse trees and shrubs species. Dry grass is also used as camel feed during the dry season period of food scarcity. A total of 17 indigenous grass species were identified as camel feed in the districts (Table 7). The most widely utilized grass species, as indicated by the respondents, were *Chrysopogon aucheri (65.3%), Sporobolus spicatus (60.7%), Panicum Sp.* (59.3%), *Cenchrus ciliaris* (58.0%), *Aristida magiurtina* (54.0%) and *Chioris somalensis* (49.3%). According to survey result, *Gramineae* family of grass species (88.2%) was ranked first followed by *Euphorbiaceae* family (5.8%), and *Amarahthaceae* (5.2%) as mentioned in Table 7.

Table 7: Grass species based camel feed sources at different season in the study areas, while numbers at each column of the two seasons indicate the percentage of respondents towards the importance of each plant species at different season.

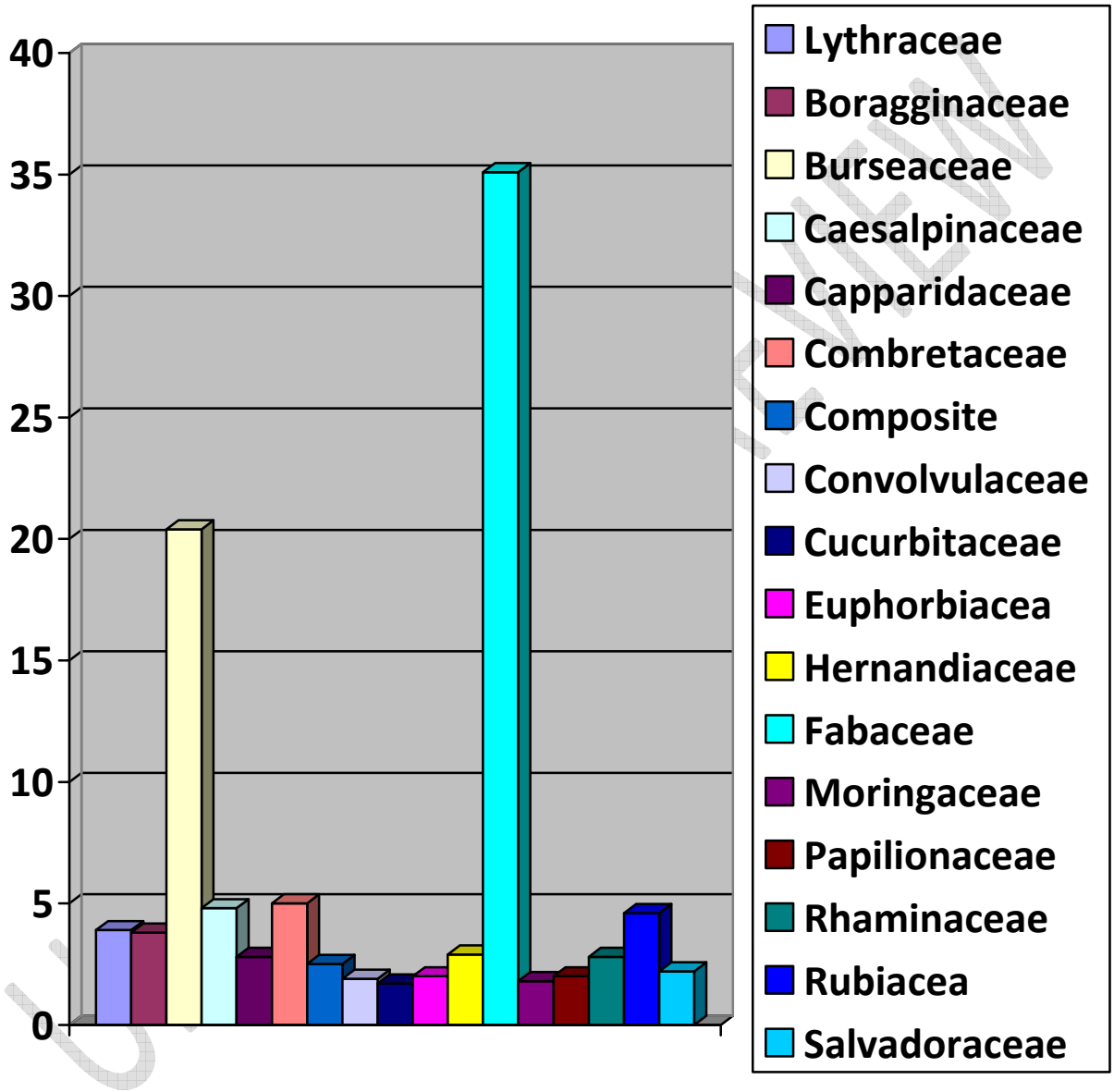
Grass species			Responses on the extent of shrub based camel feed sources utilization at different seasons	
Somali name	Scientific Name	Family name	**At wet season (%)**	**At dry season (%)**
Daba adde	*Aerva Sp*	*Amarahthaceae*	43.3	0.0
Biile	*Jatropha dichtar*	*Euphorbiaceae*	48.0	0.7
Weylo-qab	*Chioris somalensis*	*Gramineae*	49.3	1.3
Badhoole	*Afrotrichloris hyaloptera*	*Gramineae*	41.3	2.7
Birqin(bire)	*Aristida sieberiana*	*Gramineae*	50.0	0.7
Dareemo	*Chrysopogon aucheri*	*Gramineae*	65.3	14.0
Dhurbay	*Bothriochloa insculpta*	*Gramineae*	43.3	3.3
Dihi	*Paspalum vaginatum*	*Gramineae*	45.3	0.0
Dooyo	*Coelachyrum stoloniferum*	*Gramineae*	38.0	0.0
Duur	*Schizachyrium kelleri*	*Gramineae*	34.0	0.0
Eir-dhuq	*Cenchrus ciliaris*	*Gramineae*	58.0	15.3
Gargood	*Panicum Sp*	*Gramineae*	59.3	2.0
Harfo	*Digitaria ternate*	*Gramineae*	48.7	1.3
Maadh	*Aristida papposa*	*Gramineae*	47.3	2.0
Maajeen	*Aristida magiurtina*	*Gramineae*	54.0	3.3
Ramaas/Dhikil	*Sporobolus spicatus*	*Gramineae*	60.7	10.0
Timo gabdhoodle	*Letothrium senegalense*	*Gramineae*	43.3	4.7

4. DISCUSSION

4.1. Major tree species utilized by camels in different seasons

Camels browse more trees and shrubs during wet season compared with herbaceous and grass species. Although detailed species list is not available, the report in other parts of Ethiopia shows that camels browse on tree species [20, 21]. However, in the dry season, less palatable species are also browsed during the critical feed shortage period. In the dry season, some of the trees on which camels intensely browsed were shade the leaf due to its physiological adjustment. Key informants also indicated that camels eat less palatable species and/or some dried or wilted plants including dried grasses during critical feed shortage in the dry season. Selectivity of certain plants by animals is affected by circumstances such as availability of other plants in the vicinity [22]. For camels, browse preferences were similar in the Rift Valley of Ethiopia [20]. Due to feed preference, and the high biomass production compared with other vegetation categories, tree species are a very important camel feed resource in the Ethiopian Somali region. Comparison of the dominant browse trees at the family level indicated that

236 *Fabaceae* was ranked first (31.6%), followed by *Burseaceae*. The percentage of tree species family
237 available in the study areas is illustrated in Figure 1. Ethiopia's diverse climatic conditions and
238 topographic and edaphic variation enable a wide range of vegetation from tropical rain and cloud forests
239 to the desert scrub [23].



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241 Figure 1: Tree species family browsed by camel in the study districts: Y axis represents the level of camel
242 preference on browsed tree species (%), while X axis indicates the camel browsed tree species family.
243
244 The potential of the dominantly camel browsed tree species must be assessed in terms of their
245 abundance and distribution within the camel producers' rangeland ecosystem. Personal observations by

researchers found the tree species degraded, with tree stumps, dried trees, and fragmented forest patches common phenomena in the rangelands of the Ethiopian Somali region. Data from group discussions indicated charcoal production practices were common in the rangelands using harvest from Acacia species. These species are slow growing and the most preferred camel browsed tree species; yet it is also a quality charcoal yielding species. This implies that for regionally sustainable camel production, the data based management of these very important tree species is critical.

4.2. Major shrub species utilized by camels in different seasons

There were 12 indigenous shrub species identified as locally important camel browse species. According to the key informants and group discussions, camel browsed shrubs more than herbaceous and grass species during the wet season. Camels demand grass and herbaceous fodder only when there is severe scarcity of browse resources. Unless they were forced to consume herbaceous / grass plants when some of the preferable shrubs get in to leaf shedding at dry season, camels browse shrubs as an important feed source. Shrub browse is a camel feed source [20; 21], that the species must be managed to make the supply of this resources sustainable.

4.3. Major Bush species utilized by camels in different seasons

The quantitative data collected through the questionnaire process indicate that seven indigenous bush species that group in to six families were identified as camel browse species in the study areas. Data from the key informants and group discussions indicate camels show less preference browsing from bushes during the rainy time where trees and shrubs are abundantly green and palatable. Compared with trees and shrubs, bushes are highly utilized in the dry season since these camel browse species remain green, while browsed trees and shrubs shedding their leaves. At this, camels shift to consuming available bushes and less palatable feeds sources. Bushes are therefore considered a dry season safeguard for camels, and their importance may be significant during prolonged dry season when there is climate change. . This feed source is also supporting the livestock production in general as it was the case in Senegal as reported by [24].

During dry season most trees and shrubs are phonologically inter in to dormancy so that drop the leaf, and remain dormant. Herbaceous feeds become less abundant and are often more fibrous than they were before. In the dry season due to feed scarcity and quality deterioration of trees and shrub based feed sources; camels move long distance in search of feed. However, less palatable species like bushes are browsed by camels during the critical dry season. In the study districts from January to March, bushes are broadly utilized by camels since most of bushy species in the study area were perennials with evergreen phenology. Others such as [20] claimed that bush species were highly utilized by camel during the dry season when quality feed is absent; suggesting that the role of bush in supporting livestock production, and camel production more specifically is meaningfully great).

4.4. Major herbaceous and grass species utilized by camels in different seasons

Due to the highly selective feeding behavior of camels and the seasonal availability of herbaceous plants while tree and shrub species are also abundant, the use of herbaceous and grass feed sources as camel feed is very low. Wet season herbs and grasses are optionally utilized by camels since they are least preferred compared with browse trees and shrubs. However, these plant categories play a role in feed diversification for camels in the wet season. Along with the other species providing camel feed in the dry season, herbs and grasses contribute to the high level as camel feed during this season. The justification of [25] supports the current study by that the natural vegetation such as grasses, legumes, and herbs in the arid and semi-arid low lands are the main feed source of livestock.

The current study revealed how much this feed group is supporting camel production in the study districts. However, except for a general knowledge of these species' potential use as alternative camel feed in the pastoral and agropastoral districts of the Ethiopian Somali region, their management, current resource status, threat of degradation and their detailed nutritive value is not well known. Since pastoralists manage camels as a priority animal, and camels utilize the rangeland resources such as shrubs and grasses in the dry season, information from this study can be very important in emphasizing management of this vegetation category. The currently global climate change that is seriously affecting vegetation diversity worsened by inappropriate rangeland management of the feed resources makes the herbaceous and grass species vulnerable to degradation. Focus group discussion in the current study indicated that some of the herbaceous and grass species have been locally extinct, and some others are also rarely available to be grazed by camels. Long term over-utilization of feed resource has resulted in serious damage to grassland ecosystems and reduced livestock production at China [26]. Furthermore, the existing genetic potential of the herbaceous and grass species in the current study in the field level, so as to conserve and manage to sustain the livestock production.

5. CONCLUSION AND RECOMMENDATIONS

5.1. Conclusions

Camels are the main livelihood option in the Ethiopian Somali region since other animals are less adapted to the harsh and dry climate. For camel herder pastoral and agro-pastoral people in the study areas, camel feed resources are basic determinants of camel production. Along with other factors, feed resource scarcity due to the degradation of species is challenging camel producers in the Ethiopian Somali region.

Camel production system in the area is extensive, and there is no improved forage production. Rather, browse plants like tree and shrub species were the major camel feed resources in all seasons, albeit with some limitations. This is associated with camel feeding behavior as camels prefer browsing rather than utilizing wet season abundant herbaceous and grass feed. Nevertheless, different species such as bush

species, herbaceous species, and grass species were identified as camel feed in the wet season, while camels depend on these categories in the dry season in the study districts. Based on locally accepted pool of indigenous knowledge, 38 indigenous tree species, 12 indigenous shrub species, seven indigenous bush species, 20 herbaceous plants, and 17 indigenous grass species were identified as camel feed sources with a varying level of preference.

The traditional knowledge based species list in the current research does not guarantee the sufficiency and quality of feed supply for camels at in all season, and camels in the region continue to face feed shortage challenges. However, the data in this study indicates the diversified camel feed resource existence, and the deepest indigenous knowledge on camel feed source preference. The information on the species list with potential camel feed value can be applied as the base for vegetation genetic diversity conservation and management in the dryland for livestock production. At the same time, conservation of these species has a global implication as the trees, shrubs, and bushes in the rangelands combat desertification [27], and have a potential for carbon sequestration and, improving microclimate.

With regardless of incredible indigenous list of camel feed sources in the study district, there is limited special distribution and a rainy season dependent availability of camel feed in this drought prone area. In arid and semi-arid regions, climatic conditions (especially rainfall) are known to have a prominent impact on rangeland vegetation dynamics [22]. Most pastoralist camel herders responded that they faced difficulty in searching for feed for their camels especially following a long dry season. Consequently, they move long distances, sometimes cross regions and country in borders which in turn leads to resource right conflict and the potential loss of their life and that of their animals. Therefore, detailed data based sustainable utilization of these camel feed sources in rangelands is necessary to maintain the camel production based livelihood in pastoral and agropastoral districts.

5.2. Recommendations

The data from focus group discussions and researchers' observation indicated that camel feed resources are dwindling, and pastoralists and agro-pastoralists move long distance in search of feed resources. Hence, awareness creation among pastoralist and agro-pastoral communities on existing camel feed resource management and sustainable utilization is needed. In addition, there is a need to develop fodder options with species preferred by camels to reduce long distance movement in search of feed. On the other hand, species abundance and richness must be studied for evaluation of the status of camel preferred plant species.

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