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SHORT COMMUNICATION

DISTRIBUTION, ANIMAL PREFERENCE AND NUTRITIVE VALUE OF BROWSE SPECIES IN THE RANGELANDS OF AFAR, NORTHERN ETHIOPIA

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ABSTRACT: Browse species serve as the main feed sources for pastoralists' livestock especially during the dry season when herbaceous feed sources are exhausted. The study was conducted in Aba'ala District, Afar Regional State of Ethiopia to assess the indigenous knowledge on browse ecology and use and to investigate the browse selection by animals. Local pastoralists are knowledgeable about the ecology and use, and the change in vegetation structure of browse species. Browse species ranking, according to local criteria of use of vegetation species, indicated that *Acacia oerfota* was ranked first (3.77) followed by *A. etbaica* (3.88), *Balanites aegyptiaca* (4.55) and *A. mellifera* (4.88). The dominant species in the area were *A. oerfota*, *A. mellifera* and *A. tortilis*. The three most preferred browse species according to the browsing time spent on each of the species were *A. oerfota*, *B. aegyptiaca* and *A. mellifera* for camels; *A. mellifera*, *A. oerfota* and *A. etbaica* for goats and; *A. etbaica*, *Grewia ferruginea* and *G. tenax* for sheep. Analysis of nutritive value of two of the most dominant species, *A. mellifera* and *A. oerfota*, revealed that these species have nutritive values by far higher than the minimum requirement of ruminant animals and may be considered for use as a supplement to poor quality feed during the dry season.

Key words/phrases: *Acacia* species, Browse preference, Diet selection, Nutritive value.

INTRODUCTION

Low quality and quantity of feed has long been identified as the most important problem constraining the livestock sector in Ethiopia. Cognizant of the feed challenges and constraints, some strategies have been adopted and launched to alleviate the problems. Common strategies include: introduction of improved forage plants and supplementing with high nutritive value agro-industrial by-products. These options, however, did not bring the envisaged change especially to the targeted small-scale farmers and pastoralists. There has been limited spontaneous introduction of improved pasture and forage plants under smallholder farmer's conditions

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(Abebe Mekoya *et al*., 2008). Higher cost and unavailability of highly nutritive industrially prepared commercial concentrate feeds and industrial by-products like molasses, oil cakes, bran middling and cereals have also obliterated the possibility of supplementation feeding in many developing countries (Anbarasu *et al*., 2004). The main causes of low level of adoption of improved forage species include lack of adaptation to local environment (Roothaert and Franzel, 2001; Abebe Mekoya *et al*., 2008) and, lack of proper technical and agronomic practices (Roothaert and Franzel, 2001; Sullivan, 2001; Abebe Mekoya *et al*., 2008). The logical implication is therefore, that an alternative and workable solution must be sought. As a result, there has been an increased interest in the use of locally available feed resources.

Indigenous browse species contribute to a significant proportion of animal feed and agro-biodiversity in developing countries. Attempts made to increase knowledge and exploitation of indigenous forage species have proved that indigenous browse species play significant role in animal production, primarily by providing animals with feed resources rich in protein, energy, vitamins and minerals at a time when feed is scarce or is of low quality (Le Houérou, 1980; Bamikole *et al*., 2004; Salem *et al*., 2006). In addition to their value as sources of green fodder, most indigenous browse species are multipurpose and provide benefits and services such as food, fiber, shade, soil improvement and conservation, timber, fuel wood and live fences across all of the agro-ecological zones of Africa (Le Houérou, 1980; Osakwe and Drochner, 2006).

Despite their higher and intriguing potential for use as forage and other benefits, there is still very low concern and recognition given to indigenous browse species, and their level of utilization is very low as compared to their potential nutritive value, availability and diversity. For instance, Rosales and Margaret (1997) indicated that out of more than 300 species of trees with potential use as fodder, research has concentrated on a few (< 10) number of species. According to Le Houérou (1980), out of more than 5000 trees and shrubs listed as being suitable for feeding livestock in Africa, only 80 are of real fodder value while five may be recorded as good. This probably underscores the lack of information on the values of many of these local trees and shrubs.

Surprisingly little is known about most of the traditionally utilized indigenous forage species. Kiptot (2007) indicated that there is very little scientific knowledge available about most indigenous fodder species

preferred by Massai pastoralists in Kenya. There is a general lack of information on the nutritive value and chemical composition of browse species used by local people in central Kenya (Roothaert and Franzel, 2001). Similarly, Abebe Mekoya *et al*. (2008) indicated that the existing scientific knowledge on indigenous fodder trees in the highlands of Ethiopia is too limited to support their promotion, even if they are preferred by locals. The lack of information on the nutritive value of indigenous browse species and their ultimate impact on animals makes it difficult to assess their potential contribution to animal production, and therefore, to plan different feeding schemes and strategies.

In order to design efficient feeding practices, and incorporate these invaluable resources to the feeding systems in developing countries, more has to be done on identification of best indigenous fodder species and accessions (Simbaya, 2000). Information is also needed on the nutritive value and fermentation profile (Okoli *et al*., 2003), actual impact on replacement of concentrate feed by browse, considering the high cost and unavailability of concentrates to small-scale farmers (Givens *et al*., 2000; Das and Ghosh, 2007), browse biomass production (Paton *et al*., 1999; Paton *et al*., 2002; Said *et al*., 2005) and agronomic requirements. In addition, understanding threats for natural tree recruitment because of failure of natural regeneration and recruitment, is one of the main current problems with many native browse species (Ward and Rohner, 1997; Oba, 1998; Wiegand *et al*., 1999; Diress Tsegaye *et al*., 2007; Diress Tsegaye *et al*., 2009). With the increasing trend of drought (the local manifestation of climate change), there is also a need to develop fodder options that will be capable of survival and production even under the severe drought conditions. Many of the preferred and higher quality species are under pressure, leading to changes in species composition (Chettri and Sharma, 2009).

Considering the large population of cattle and browsing animals in Ethiopia, on one hand and the acute shortage of conventional fodder resources on the other, one would suggest that there should be another supplementary feed resource, like the indigenous browse which is easily accessible. These large populations of browse animals must depend on the feed resource of their vicinity including the indigenous scattered tree and shrub species found all over the marginal grazing landscapes. There are similar situations in the present study area of Afar Region where there is a rich diversity of woody flora with potential browse value that must receive research emphasis in terms of identification, nutritive value analyses and agronomic evaluation

for adaptability and fodder yield under managed conditions. It is based on the above observations that this study was initiated with a specific aim to avail information on distribution, animal preference and nutritive value of browse species in Aba'ala District, northern Afar, for possibilities of their incorporation into animal feed packages which is a priority technology intervention for Afar Region.

Objectives

The overall objective of this study was to assess local uses/indigenous knowledge, distribution and fodder value of selected browse species. The specific objectives of this study were to:

- Assess the browse selection pattern and preference of different livestock species in the study area.
- Determine the chemical composition and nutritive value of *A. mellifera* and *A. oerfota*.
- Identify indigenous management practices and local peoples perception of change in the relative abundance of selected browse plants.

MATERIALS AND METHODS

Description of the study area

The study was conducted at Kala rangeland; a browse-dominated rangeland site, 10 km from Ab'ala town in Zone two of Afar Regional State, northeastern Ethiopia. It is situated at a distance of 83 km southeast of Mekelle town. The elevation ranges from 1000-1500 m above sea level. It has a semi-arid type of climate and receives a bimodal rainfall. The short rain occurs during March and April (sugum) while the main rain (karma) occurs between June and September. The rainfall is generally characterized by its erratic nature with an annual average of 422 mm (Diress Tsegaye and Mitiku Haile, 2004).

The study area consists of flat plains occasionally interrupted by undulating hills and series of ridges. The topography is a mix of flood plains, mountainous areas with moderate relief, and rugged areas with steep slopes. There are a few perennial rivers in the study area, which flow eastwards but sink into the sand within very few kilometres from their sources. In the study area, goats, sheep, cattle, camels and donkeys are the major livestock classes kept by the mixed Tigrian agro-pastoralists and the native Afar

pastoralists. Livestock production is the main livelihood of the Afar pastoralists.

Methodology

Browse-dominated rangeland site at about 10 km from Aba'ala town was identified and vegetation attributes of the browse species were measured. Measurements were made from twelve 10 m by 10 m plots located in each of three transects. Vegetation attributes, like species identity, number of individuals, height, and canopy diameter, stem diameter both at stump and breast height, were recorded to obtain information about the abundance of each browse species in terms of canopy cover, density and frequency. These parameters enable to depict the population structure of each browse species. The population structure informs whether the growth and dynamics of each browse species is healthy or not.

The diet preference of ten randomly selected mature free-ranging goats, sheep and camels were observed. The preferences of the different browse species by the three domestic animal species were assessed by observing each animal of the three species for 10 minutes at 10 minutes interval for 7 consecutive days between 14:00–16:00 hours. For each animal, the browse species visited and the time spent in browsing or nibbling of that species was recorded for ten minutes. For each animal species three trained observers were assigned. The first observer recorded species foraged upon by each animal species and counted the total bites; and the second observer collected plant specimens and measured height of browsed species while the third observer controlled the time using a stopwatch (Yayneshet Tesfay *et al*., 2008). Measurements included species selected, number of bites, total time spent, height of browsed plant, bite rate (Yayneshet Tesfay *et al*., 2008) and species preference index (Bryant *et al*., 1981). The result was then analyzed to identify the most preferred and favoured browse species by each of the animal species.

Structured and semi-structured questionnaire was administered to 30 representative pastoral households. Discussions were also made with pastoralists, development agents, and administrators. These questionnaire and discussions helped to reveal the existing indigenous knowledge on the ecology and feed value of common browse species. Besides, threats and opportunities associated with each of the browse species were identified and ranked.

Nutritive value of two of the most dominant browse species (*A. mellifera* and *A. oerfota*) were analyzed by taking leaf samples of two age groups for each browse species. Samples of leaves of browse species were collected from at least 15 phenologically similar individuals of the two species (Yayneshet Tesfay *et al*., 2009a), by handpicking. Plants were randomly sampled as they were encountered in each plot and sampling continued until about 1 kg fresh weight of each species was obtained. The harvested browsed leaves were transported to the laboratory and oven dried at 50°C until constant weight was obtained. Samples were ground and sieved with 1 mm sieve and stored in airtight container until they were analyzed. The chemical analysis were undertaken according to AOAC (1990) for dry matter (DM), ether extract (EE), crude protein (CP), acid detergent fiber (ADF) and crude fiber (CF). Phosphorus (P) and Magnesium (Mg) were estimated using acid Absorption Spectrophotometer.

Descriptive statistics was used for organizing data collected from the questionnaire survey. One way ANOVA was employed for analysis of data on the vegetation attributes and browsing time spent by each of the browsing animals on the different browse species. JMP-version 7 statistical software was used for data analysis.

RESULTS AND DISCUSSION

Browse selection patterns of camels, goats and sheep in Aba'ala District

Goats browsed on a large number of species i.e., ten out of fifteen recorded species; camels browsed only on eight species, while sheep browsed on only six browse species within the recording time of ten minutes (Table 1). The observation that goats browsed large number of plant species is in line with the popular belief that the goat's diet is composed of different species. Goats forage upon diverse herbaceous and woody species (Yayneshet Tesfay *et al*., 2009b). Goats usually preferred to browse on low strata browse species, where most of the species in the study were preferred by the goats regardless of the difference in nutritional quality. Goats and sheep were observed to browse on the relatively short growing bushy and shrubby *Grewia* species. Camels browsed on the tall growing trees of *A. tortilis* and *A. etbaica*, *Balanites aegyptica*, and *Ziziphus spina-chrisiti*, as well as short and shrubby browse species such as *Calotropis procera* and *Lycium shawii*. Camels preferred to browse on the canopy of taller species to intensify their forage use by slowing down their movement. The ease of reach of the camels to the canopy of the taller trees increased their chance to forage on inaccessible browses for the small ruminants. This may be a trade-off

mechanism between the camels and small ruminants on the use of browse species. The difference in vertical feeding height stratum is believed to negatively influence the bite of ruminants (Dziba *et al*., 2003) and favours camels. The three most selected browse species for each of the animal species according to the browsing time spent on each of the species were *A. oerfota*, *Balanites aegyptiaca* and *A. mellifera* for camels; *A. mellifera*, *A. oerfota* and *A. etbaica* for goats; and *A. etbaica*, *Grewia ferruginea* and *G. tenax* for sheep (Fig. 1).

Fig. 1. Browsing niches of camels, goats and sheep in the study area.

Except for the species *A. oerfota*, and *G. villosa*, the time spent by the different animal species on the different browse species did not vary significantly ($P>0.05$). In the case of *A. oerfota*, camels and goats spent significantly higher proportion of their ten minutes (341.31 and 33.81 seconds, respectively) in browsing the same species as compared to that of sheep (0 second). However, in the case of *G. villosa*, while goats and sheep spent significantly higher ($P<0.0001$) proportion of their ten minutes (23.52 and 4.1 seconds, respectively), camels totally rejected this same browse species.

Table 1. Browse selection by camels, goats and sheep in Aba'ala area.

Type of animal	*Acacia mellifera*	*Acacia oerfota*	*Acacia nilotica*	*Calotropis procera*	*Grewia tenax*	*Acacia etbaica*	*Grewia villosa*	*Grewia ferruginea*	*Acacia senegal*	*Cordia ovalis*	*Cordia sinensis*	*Lycium shawii*	*Acacia tortilis*	*Balanites aegyptiaca*	*Ziziphus spina-chrisiti*
Camel	16.2	341.31[a]	0	5.7	0	5.5	12:00	0	0	0	0	2.5	5.9	19.2	7.62
Goat	55.08	33.81[a]	5	6.4	11.3	33.6	23.52[ab]	22.5	3.6	0	0.145	0	0	0	0
Sheep	0	0	0	0	8.3	39.5	4.10[b]	9.8	1.7	0.9	0	0	0	0	0

Levels with different superscripts are significantly different (P<0.001)

Nutritive value of selected browse species

The chemical composition values of the browse species reported in this study are lower than those values reported for other species from similar study area (Yayneshet Tesfay *et al*., 2009a). The average crude protein (CP) content of both *A. mellifera* and *A. oerfota* species is higher than the critical level of 7% CP (Table 2) for temperate forages (McDonald, 2002) and 6% for tropical forages (Minson, 1990) after which the feed intake of the animal is depressed. Most of the times, indigenous fodder trees and shrubs are appreciated for the higher content of CP they provide (Le Houérou, 1980; Simbaya, 2000; Roothaert and Franzel, 2001; Yayneshet Tesfay *et al*., 2009a) which is by far higher than the minimum tolerable range for ruminant animals; 6% for tropical forages (Minson, 1990) and hence have been recommended as supplement and inclusion for low quality crop residues by many, for example, Abebe Mekoya *et al*. (2008), Yayneshet Tesfay *et al*. (2008) and Atta Elmnan *et al*. (2009).

Similarly, the nutritive values obtained for these browse species are comparable to the average values of browse species in Africa reported by Le Houérou (1980), Mandal (1997) and Abdulrazak *et al*. (2000). Indigenous browse species are also preferred over improved forage plants due to its low cost, availability and accessibility to local communities (Anbarasu *et al*., 2004; Salem *et al*., 2006), adaptability to local environmental conditions, requiring little or no management input (Simbaya, 2000; Roothaert and Franzel, 2001), and resistance to diseases and parasites (Rosales and Margaret, 1997). Moreover, indigenous browse species remain green at the critical period of the year and make a good source of dry season feed for ruminants in arid and semi-arid agro-ecologies where annual grasses and other herbaceous plants fail to produce year round. Therefore, incorporating these invaluable resources into the feeding systems of developing countries is necessary. The browse species considered in this study have shown considerable promise to be developed as cultivated fodder for eventual incorporation into fodder bank system - a highly advocated system to bridge the gap in feed deficit over the dry season.

Table 2. Nutritive value of two of the most dominant browse species (*A. mellifera* and *A. oerfota*) around Aba'ala District.

Species	Age group	Nutritional composition						
		DM	CP	ADF	CF	%Fat	P	Mg
A. mellifera	Young	35.52	10.79	27.67	20.14	5.16	0.17	0.39
	Old	52.26	11.56	17.20	16.81	5.77	0.14	0.47
A. oerfota	Young	28.51	17.91	20.85	17.58	11.22	0.63	0.41
	Old	30.39	23.12	21.22	17.44	13.15	0.31	0.42

Local peoples perception on ecological status and use of browse species

The common threats that affected the survival and development of browse species were poor seed germination (*Dobera glabra, Balanites aegyptiaca*), grazing or browsing pressure (*Cordia sinensis, Acacia nilotica, Salvadora persica*, *Balanites aegyptiaca*) and human exploitation for fuel, construction and other domestic purposes (*Cadaba rotundifolia, Commiphora* spp., *Ziziphus spina-chrisiti*). The main reason for the observed decrease in vegetation cover as perceived by the respondents was the increased occurrence of drought. Respondents indicated that in the past (50 years ago), the three rainy seasons dibaba, sugum, and karma described in Diress Tsegaye and Mitiku Haile (2004) occurred at regular intervals but nowadays their occurrence is irregular and the overall rainfall availability has decreased enormously. They also pointed out the increased cutting of big trees for construction purpose as the main reason for the disappearance of large browse trees. This is expected in view of the increasing rate of sedentary life style of pastoralists and the associated need for construction materials. On the other hand, respondents have noticed certain species with increasing composition in the vegetation and spelled out the possible reasons for the increasing trend.

Multipurpose values of browse species

Different browse species are used for diverse purposes including fodder, fuel, construction, shade and medicine. The browse species in particular are appreciated for various merits like providing shade, drought resistance and ever-green nature. The multiple values and benefits identified by pastoralists in the present study conform to farmers' selection criteria for fodder trees, as reported by Thorne *et al*. (1999). The common browse species in the study area are ranked (Table 3) based on the various uses and socio-ecological values as described by the respondents.

Table 3. Multiple values of different browse species according to the rank given by the pastoralists in the study area.

Scientific Name	Vernacular name	Fodder	Fuel	Shade	Drought resistance	Biomass production	Composite rank
Acacia mellifera	Merkaeto	3.25*	5.54	3.42	1.78	10.45	4.89
Acacia oerfota	Garmoita	7.24	6.08	2.32	2.00	1.24	3.78
Cadaba rotundifolia	Adan galeta	8.01	7.36	7.24	2.45	6.89	6.39
Acacia etbaica	Sekakto	3.83	1.00	1.24	10.11	3.24	3.88
Cordia sinensis	Mederto	1.02	2.08	4.25	10.25	12.70	6.06
Grewia erythraea	Hidaito	5.37	3.41	6.80	4.76	11.30	6.33
Commiphora spp.	Adwohadita	9.23	3.80	8.09	8.34	8.76	7.64
Acacia tortilis	Aepto	9.24	4.28	5.47	5.24	9.24	6.69
Acacia nilotica	Gessalto	7.26	9.87	5.42	1.25	2.12	5.18
Balanites aegyptiaca	Oodaito	3.24	6.70	8.24	1.45	3.12	4.55
Ziziphus spina-chrisiti	Kusraito	3.38	4.25	10.12	2.40	5.56	5.14
Grewia villosa	Hibelita	6.43	12.00	6.23	8.40	4.36	7.48

* The ranks are averages of ranks given to each quality by each of the 30 respondents, for instance the average rank for fodder value of *A. mellifera* is 3.25 which is the average of ranks given by each individual respondent to the fodder value of *A. mellifera*, and the composite rank is the average of all average ranks for each quality.

CONCLUSION

The study revealed that local pastoralists are aware of the enormous changes in the vegetation structure that is taking place in their community. The browse species that are perceived by local pastoralists as being declining in composition from the vegetation include *Dobera glabra*, *Balanites aegyptiaca*, *Cordia sinensis* and *A. nilotica*. The main reasons for the reduction of these species are the frequent drought, grazing/browsing pressure, cutting for fuel wood, overuse for medicine and construction, and decreasing ability of the species to produce viable seeds. However, as perceived by pastoralists, some species are increasing in the plant composition due to their observable attributes of drought tolerance and producing large number of viable seeds. These species include: *A. mellifera*, *Grewia villosa*, *A. oerfota*, *A. etbaica* and *G. erythraea*. Local criteria for selection of browse species identified by respondents include fodder, fuel, shade, drought resistance or ever-greenness, and biomass production. Nutritive analysis of the two most dominant *Acacia* species, *A. mellifera* and *A. oerfota*, revealed that these plants have high CP contents and other nutritional composition within optimum ranges of animal requirements, making them valuable source of supplementary fodder during dry season

when herbaceous cover declines. The three most selected browse species for each of the animal species according to the time spent browsing on each of the species were *A. oerfota*, *Balanites aegyptiaca* and *A. mellifera* for camels; *A. mellifera*, *A. oerfota* and *A. etbaica* for goats; and *A. etbaica*, *Grewia ferruginea* and *G. tenax* for sheep.

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