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Acacia Species as Browse forGoats in Arid and Semi-Arid Regions in Kenya

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Abstract

The study evaluated the preference of specific Acacia spp, by goats in Chemeron, Baringo County, Kenya using natural browsing method. Pastoralism in arid and semi-arid lands(ASALs), face significant constraints due to insufficient and inadequate nutritious feeds. However, the region holds several fodder trees and shrubs which are important feed sources. The study area is part of the ASAL where the major browse plants including Acacia species are situated. The study used natural browsing method as a form of randomized experimental design in a natural setting where goats are left unconstrained to browse on any type of shrub or tree and in particular their preferred Acacia spp. This design was preferred because of the randomness of the choice of the Acacia trees species, the flexibility of choice of replicates and treatments and lastly, the method allows for natural preference within the contextual setting. Browsing data was obtained ophthalmologically after every 5 minutes for a period of 160 minutes. Once the data, had been transcribed and processes, preference statistic was estimated through Kruskal-Wallis test, ($\chi 2$ (4) = 182.6, $p < 0.05$) which indicated statistically significant differences in browsing preferences among the Acacia spps. The findings showed that certain Acacia spp. were highly preferred over other species by goats with A. brevispica, A. tortilis and A. nilotica being ranked highly while A. senegal having the lowest rank. In conclusion the most preffered browse species in ASAL include A. brevispica, A. nilotica and A. Tortilis, while acacia Senegal is the least preferred by the indeginous goats. The preferred species may be considered as supplements or as alternative livestock feeds depending on the agro-climatology and topography of the region. Therefore, there is need to propagate certain Acacia spps which include A. brevispica, A. nilotica and A. tortilis as alternative fodder crops of ASAL. These browses can be grown as fodder banks, live fences, alleys or silvopastoral systems and managed to provide fodder on a continuous basis or for harvest and processing for use in droughts as good source of nutrients for use in livestock production in ASAL regions. Lastly, the study focused on the identification of preferred Acacia spp. in a particular region in Kenya, whereas other studies may focus on development of a database containing favourable fodder tree crops.

Keywords: *Acacia spp*, browse plants, goats,

INTRODUCTION

In the African continent, about 70% of livestock is found in dry tropical countries. Livestock provides livelihoods for over 80% of the families in the ASAL. Indigenous forages that are well adapted to high ambient temperature and erratic rainfall patterns form major nutrient sources for domestic livestock. Moreover, there is limited knowledge available to the agricultural extension agents. This has worsened the situation in the ASAL area because palatable plant species are overlooked due to low feed value placed on them. Goats are natural browsers and move from one tree to another as they pick the browse able parts. Attraction

to these tree species is based on palatability factors that enhance more or less browsing on them. The challenges relating to livestock feeds in arid and semi-arid regions requires the review and exploitation of potential livestock feed resources (Melaku et al., 2010; Ngwa et al., 2004).

Livestock is a key component and an important pathway for rural households to escape poverty in Africa (Hemme and Otte, 2010). However, the challenges of livestock productivity in ASALs is aggravated by unreliable and erratic rainfall patterns which constrain the growth and biomass yield of the most consumed plant species (Melaku, Aregawi & Nigatu, 2010). Several types of browse species between and within localities whose distribution tend to vary (Aregawi, Melaku & Nigatu, 2008), feeds become plenty in wet seasons and diminish during dry seasons (Abusuwar and Ahmed, 2010). Due to this variation, the major constraint to increasing livestock production in ASAL regions is the scarcity, fluctuating quantity and quality of feed supplies the year-round (Ayantunde et al., 2005). It has been shown that insufficient information by the agricultural extension agents has curtailed the transfer of knowledge in the ASALs for the promotion of palatable plant species as feed for goats (Teklu et al., 2011).

Further, uncontrolled utilization of scarce communal grazing lands in dry rangelands contributes to degradation, further reducing the availability for livestock feed resources. In order to resolve to problem, new forage species have to be considered and as such browse plants such as *Acacia spp* have good protein and mineral sources for ruminants and therefore may be used as feed supplements. Therefore, the need to identify and develop specific Acacia species as fodder crops capable of growing in ASALs poor soils and dry conditions are important. Such fodder crop trees should bring economic benefits to pastoralists, reduce conflicts over resources, enhance biodiversity, create jobs and bridge the cruelty gap of supply and demand of livestock feeds in ASAL regions.

Indigenous browse plant species including *Acacia spp*s serve as potential livestock feed resources during the dry season, because they remain green and have better nutritive value when all other herbaceous species and annual grass have dried out (Aregawi et al., 2008). Other varieties of tree species that can be used as browse foliage and these include the following trees species; *Acacia spp*. *Boswellia papyrifera*, *Balanites aegyptiaca*, *Terminalia brownii*, *Sterculia africana*, and *Ziziphus spina-christi* because of their nutritive value as animal feed resources (Melaku, Aregawi & Nigatu, (2010). Aregawi et al., (2008) identified Dichrostachys cinereal as an important feed source for goats during dry season with other species being *Terminalia brownii*, *Boswellia papyrifera* and *Sterculia africana*. Other identifiable tress species that can pass as browse foliage for goats include *Desmanthus virgathus*, *Leucophyllum texanum*, *Prosopis glandulosa*, *Leucaena leucocephala* and *Cercidium macrum* (Ramirez et al., 2001). These species can be considered to serve as browse foliage because of their high mineral content.

Generally, more than two thirds of the *Acacia spp*s are native to Australia with the remaining being found in tropical and sub-tropical regions (Zia-Ul-Haq et al., 2013). *Acacia nilotica* is the most common acacia throughout Africa (Bond, Smythe & Balfour, 2001). Various forms Acacia plant species including trees and shrubs have several applications and uses; good sources of shade, wind shelter, live fence, improved fallow, improved pasture, mulch, bee forage, human food, fuel wood, timber, fibre, resins, dyes, tannins, human and veterinary medicine, food, fertility enhancements, soil stabilization, beauty, oxygen, wildlife habitat, wild life feed, bird habitat, increased self-sufficiency, nutrient cycling and farm diversity (Luseba et al., 2006; Jamala et al., 2013). Acacia trees also aid in environmental protection through prevention of soil erosion; soil fertility through addition of organic matter and creation of good microclimate for crop production and helps mitigate against climate change and desertification through carbon sequestering (Abdalla et al., 2014).

Livestock consumes the different parts of *Acacia spp*s such as barks, flowers, leaves,twigs and pods (Gebeyew et al., 2015; Jamala et al., 2013). For instance, the A. senegal is a feed supplement in Ethiopia (Mengistu, Kefelegn, & Gebretnsae, 2016). In general, pods have lower crude protein concentration and higher organic matter digestibility than foliage (Dynes & Schlink, 2002). Goats and camels depend on the Acacia trees as the main browse plants and the use of *Acacia spp* as browse foliage in Ethiopia is widespread. However, the use of the *Acacia spp*. foliage is not with

challenges, for instance, Acacia oerfota emits a bad odour while *Acacia asak* also causes digestive disorder to cattle, while Acacia lahai and Acacia tortilis is thornier (Aregawi, Melaku & Nigatu, 2008).

The feed resoruce value of the *Acacia spp* depends on nutrient availability, essential minerals and secondary compounds such as tannins etc., found in foliage, pods or seeds (Dynes & Schlink, 2002). Several *Acacia spp*. That have been evaluated and considered to have adequate levels of crude protein for animal production but with considerable differences in the CP content between the different species, but with a range of 5.0% to 29.3% (Tibbo, 2000). Since there has been a little focus on these trees as forages and therefore their development and use is limited (Gebeyew et al., 2015; Khan et al., 2014). Thus, the study sought to examine the preference ranking of the *Acacia spp* by goats using natural browsing in a natural setting.

MATERIALS AND METHODS

The study was situated in Marigat Sub – county, Baringo County, Kenya because it forms part of the ASAL region where the major vegetation and browse plants of Acacia species are located. Although there are perennial forage scarcities especially during dry seasons, the study site holds a significant presence of livestock especially large flocks of goats.

The study employed a random experimental design in that the goats were given an equal probability of receiving a treatment, that is in the choice of their favourite Acacia tree species in their natural setting. This design was appropriate because of randomness of the choice of the Acacia tress species, the flexibility of choice of use of treatments and replicates d lastly, the method allows for natural preference within the contextual setting.

The selection of the study blocks was purposive with the help from local pastoralists, the staff from Kenya Forest Service (KFS) and Kenya Forest Research Institute (KEFRI) in the Marigat field stations. The locations identified and visited by the study included Parkera, Ng'ambo, Chemeron and Sirinyo. Each visit involved frequent random stopovers and walks into the bushes to view, identify and collect identification samples that included twigs and leaves, pods and barks. The identification of the *Acacia spp*., was done with the help of the local pastoralist, the staff from KFS and KEFRI at Marigat field stations and staff from Egerton University at Chemeron field station. Photographs of the trees and their identifying features were also taken.

The experimental testing was done with the aid of 3 flocks of goats from 3 different sites as identified by the local pastoralists in Marigat. The process involved the releasing the goats at the field at 9.00 AM, and then following them up with the help of the local herdsman and the expert from Egerton University.

The method allows goats to browse naturally in the field with browsing ophthalmologic observation being carried out after every 5 minutes for a period of 160 minutes. The study recorded the visible number of goats browsing on specific Acacia tree species. This method was considered appropriate to the cafeteria method under controlled housing as it allows for natural preference. This process involved optical observations, identification of the Acacia tree species being browsed on and concurrently counting and recording the number of goats that are browsing on each one of them.

Once the data had been collected in a transcription form, the data was compiled in Microsoft Excel and analysed using one-way Kruskal-Wallis H test. The Kruskal-Wallis test is a rank – based non-parametric test that is used to examine the statistically significant differences between two or more groups of an independent variable on a continuous or ordinal dependent variable. It is used when the assumption of one -way ANOVA are not met and is able to segregate differences in at least two groups through ranking.

$$H = \frac{12}{N(N+1)} + \sum_{i=1}^{k} \frac{R_i^2}{n_i} - 3(N+1)$$

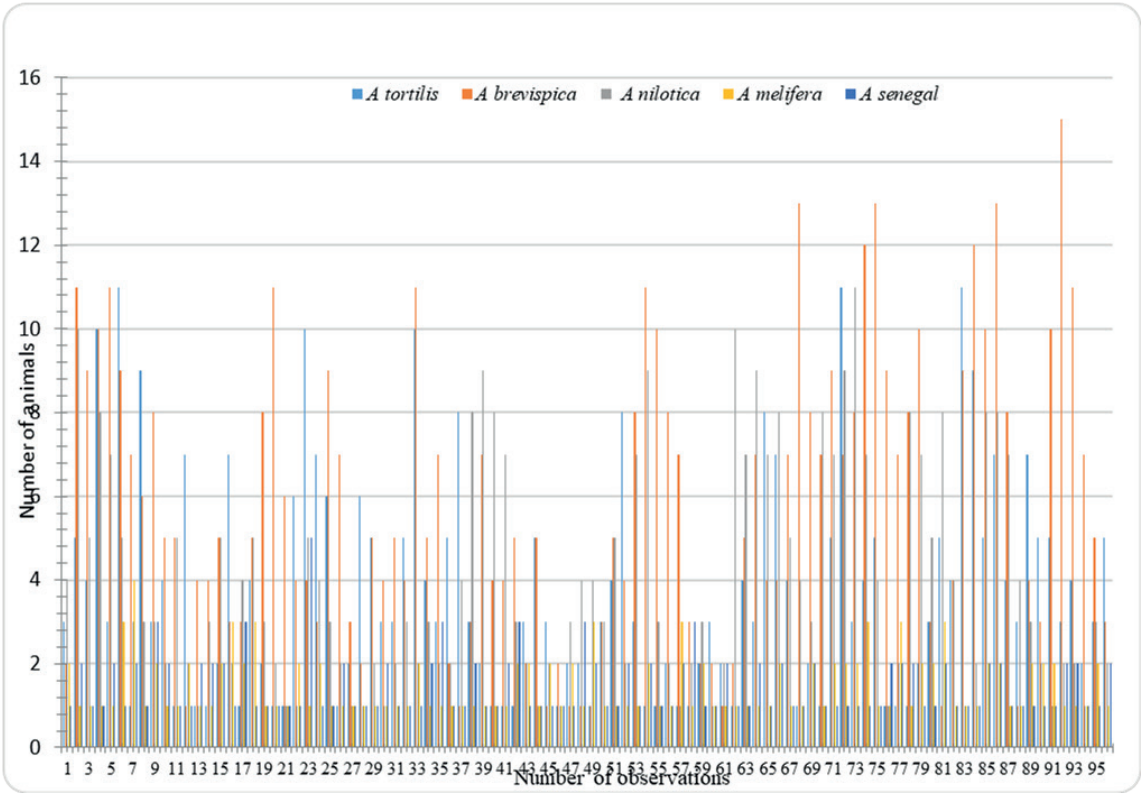
RESULTS

The local community and experts were able to identify the 14 Acacia species used in the current study as shown in Table1. The researcher himself followed up to identify their using local names and provided information on the uses of each *Acacia spp* locally.

Table 1: Identified *Acacia spp*s, their common and local names and uses

SCIENTIFIC NAME	COMMON NAME (English)	LOCAL NAME (Kalenjin)	PASTORALISTS KNOWLEDGE ON USES
Acacia brevispica	Wait-a-bit thorn	Korness	Livestock feed, roofing materials for local huts, bee forage, firewood
Acacia nilotica	Nile thorn	Chebeiwa	Livestock forage, herbal medicine, timber, wood fuel, shade, vegetables, bee forage
Acacia tortilis	Umbrella thorn	Sesie/Kipkores/ Kibenwo	Livestock forage, shade, wood fuel, charcoal, fencing materials, bee forage
Acacia mellifera	Black thorn, Honey Acacia	Ng'orore	Bee forage, livestock forage, fencing materials, herbal medicine
Acacia Senegal	Gum-Arabica tree	Chemanga	Livestock forage, fencing materials, food as gum-Arabica, bee forage
Acacia hockii	White thorn acacia	Tilatil	Livestock forage, bee forage, firewood, charcoal, fencing materials, herbal medicine
Acacia seyal	Red acacia, Shittar tree	Len'gne	Livestock forage, wood fuel, fencing materials, honey production
Acacia elatior/ Acacia tiryon	River acacia	Tiryon	Timber materials, wood fuel, high quality charcoal, shade
Acacia drepanolobium	Whistling thorn	Ngowo	Wood fuel, bee forage, fencing materials
Acacia nubica	-	Sebeiwa	Herbal medicine
Acacia reficiens	False umbrella tree	Barsol	timber, fencing, firewood
Acacia mearnsii	Black wattle	-	Firewood, herbal medicine
Acacia gerrardii	Red thorn acacia	-	Shade, firewood, bee forage, herbal medicine
Acacia albida	Ana tree/ Faidherbia	-	Bee forage, pods as forage for goats

Figure 1: Number of goats observed browsing specific tree leaves during the study



The data in Figure 1 relates to the observational data made during the experimental period. The data relates to the number of animals observed during the entire period of study. As many as 15 animals were observed on a specific tree species at any one period of time.

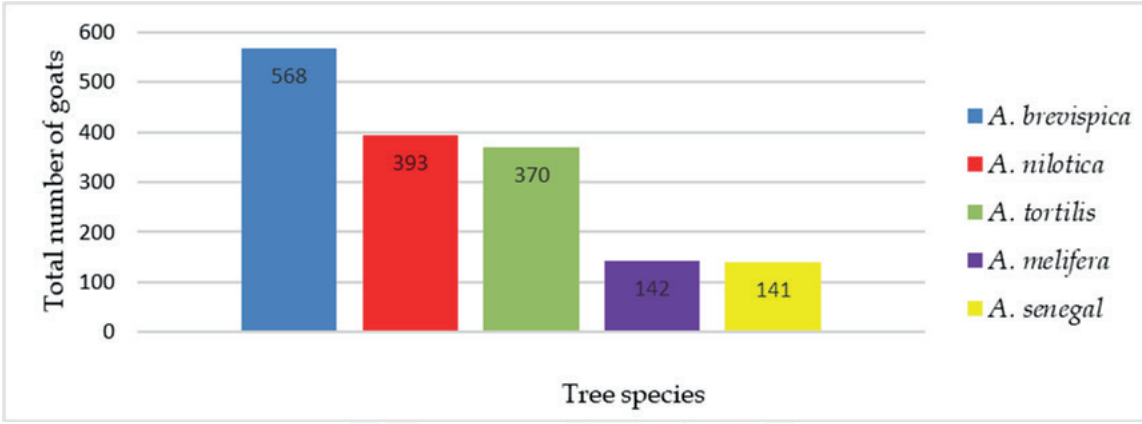


Figure 2: Preference Rating of *Acacia spp* by goats

Figure 2 shows the total number of goats browsing specific *Acacia spp*. during the study period.

Table 2: Browse Preference by goats

	Mean	STD Dev	Max	Range	Lower Quartile	Upper Quartile
A brevispica	5.917	3.454	15	14	3	8
A nilotica	4.094	2.684	11	10	2	7
A tortilis	3.854	2.718	11	10	2	5
A mellifera	1.479	0.696	4	3	1	2
A senegal	1.469	0.710	5	4	1	2

Table 2 highlights the mean statistic of browsing preference. A. brevispica had a mean preference of 5.917. The indicated that at least 6 goats at any given moment browsed on A. brevispica, followed by A. nilotica (Mean = 4.094) and A. tortilis (Mean = 3.854,). Least browsed were the A. mellifera (Mean = 1.479) and A. senegal (Mean = 1.469)

Table 3: Kruskal-Wallis test on Preference of the *Acacia spp*.

Sample	Size	Mean rank
A brevispica	96	351.54a
A nilotica	96	293.09b
A tortilis	96	277.54b
A mellifera	96	140.80c
A Senegal	96	139.53c
The χ^2 (4) = 182.6, p-value < 0.001		

Of the 14 species identified and based on browsing distribution, the study used five Acacia based on the browsing preference. Based on Kruskal-Wallis statistical test (χ2 (4) = 182.6, p-value < 0.001), there were significant differences in the distribution of browsing goats among the different Acacia species and their differences were ranked as follows from the most selected being A. brevispica, A. nilotica, A. tortilis, A. mellifera and lastly A. senegal.

DISCUSSION

The study findings indicated that there were statistically significant differences ($p<0.05$) in browsing preference with A. brevispica being highly preferred while A. senegal being least preferred. Other studies done on *Acacia spp*s in Kenya by Osuga et al., (2008), working with goats and sheep, using shrubs and trees from the semi-arid Egerton University's Chemeron Field station in Marigat Division, Baringo County in Kenya, indicated that Acacia brevispica was preferred over the other browse species.

The preference results under normal circuit grazing showed that Acacia brevispica was the most preferred browse and Acacia Senegal was least preferred. The order of preference was A. brevispica > A. nilotica > A. tortilis > A. mellifera > A. senegal with A. nilotica and A. tortilis showing moderately high preference while A. mellifera and A. senegal posting low preference. Research in palatability and preference of plants by animals in Tehsil Takht-e-Nasrati in Pakistan showed that *Acacia nilotica* was among the preferred browse (Khan et al., 2012) thus concurring with the study findings.

Bite size and ease-to-bite seemed to influence preference since A. brevispica leaves are bigger and easily available as compared to A. senegal which are smaller and are not accessed easily because of the sharp hooked spikes in their stems

that are many and prickly. Skarpe et al., (2012) found out that, bite rates were highest in plants without hooks and lowest in those that have. Ndjamba, (2014) revealed that spinescence significantly influenced browsing patterns with armed plants having smaller biting size, indicating low intake, as compared with unarmed (non-spiked) plants. This means that, browsers achieve greater bite size with minimum interruptions and more intake with less spiked plants hence the preference to A. brevispica.

Nutritive value held by the *Acacia spp*. also influences the preference and this has been supported by Abdulrazak et al., (2000) who confirm that certain *Acacia spp* that have moderate to high crude protein values are preferred. A. albida and A. tortilis have comparative higher crude protein content and thus were comparatively preferred (Tibbo, 2000). Further, the mineral composition of the *Acacia spp*s tend to vary from species to species but in comparison the different plant parts, pods tend to have lower crude protein concentration with commensurate higher organic matter digestibility than foliage (Tibbo, 2000).

On the converse, the presence of anti-nutritional factors such as cyanidin and phenolic compounds, affects preference by interfering with the digestive processes and metabolism (Dambe et al., 2015). For instance, A. sieberiana and A. nilotica have lowered preference and low feed intake because of the phenolic compounds and proacthocynidins which either toxic or inadequate for animal production (Tibbo, 2000).

RECOMMENDATIONS

The study concluded that A. brevispica and A. nilotica were highly preferred by the goats as the browse feed in their natural setting. Thus, certain *Acacia spp* which include but are not limited to A. brevispica, A. tortilis and A. nilotica were more preferred by the livestock during the study, thereby lending credence that *Acacia spp*s can be used as feeds or feed supplements for livestock depending on the agro-climatology and topography of the region. Based on the study findings, there is a need to propagate certain *Acacia spp*s which include; to A. brevispica, A. nilotica and A. tortilis as alternative fodder crops of choice in ASAL through fodder banks, live fences, alleys or silvopastoral systems.

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