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Botanical Composition and Selective Feeding by Goats in the Semi-Arid Lands of Central-Eastern Kenya

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Abstract: ***Botanical composition of University of Nairobi's Machang'a Field Station, Mbeere, in the Semi-arid Central-Eastern rangelands of Kenya was inventoried by reconnaissance survey. Relative abundance of the various plant species and ground cover were then established for three seasons: long rains, short rains and dry season. Small East African goats were allowed to graze freely on the range and their selective grazing behavior used to identify the relative preference of plant species. Over one hundred and eighty (180) plant species were identified and recorded. The herbaceous ground cover varied with season and was highest during the long rains study (40.8%) followed by short rains (19.2%) and lowest for dry season (12.6%). Goats showed strong preference for species which were relatively scarce (r<-0.86). Promotion and conservation of the preferred plants was recommended.***

Keywords: Botanical composition, goats, semi-arid lands, preferred plants.

1. Introduction

Pastoralism is a grazing strategy in marginal areas having marked seasonal variation in pasture availability and general scarcity of water. Mobility of humans and livestock has for a long time been a sure way of coping with highly variable and uncertain environments [12]. Livestock production systems in the range areas traditionally emphasized the welfare and numbers of animals at the expense of ecological welfare of the vegetation and soil resources [5]. Consequently excessive environmental pressures, such as prolonged droughts have often led to catastrophic losses of large numbers of livestock or serious deterioration of body condition and productivity of the animals in marginal areas.

Settlements in marginal areas along infra-structural service lines are usually on more favorable cultivatable areas which were formerly important grazing reserves during drought which may call for sedentarization of pastoralists [12]. Earlier research have shown that it was important to make feed resource inventory in order to identify tree and shrub resources that were valuable [3]. Furthermore encouraging propagation of select feed resources for improvement of small ruminants has been recommended [8].

It has been emphasised in earlier studies that without an inventory of what was available, it was difficult to decide if animals fed on a forage species due to its preference or due to the absence of an alternative [6]. Plant composition and density must be determined since availability may influence consumption [2]. It is also important to have a proper inventory of the trees and shrubs found in rangelands so that research into their possible use in plantations or integration into farming systems can be conducted [1].

Goats select material higher in nitrogen compared to material offered [10]. Whereas this attribute benefits the goat, it poses a danger as it can modify the species composition of the pasture in the long run at the expense of the preferred species [4]. Continuous clipping keeps surviving plants small, thus enabling more individuals of the non-preferred species to be accommodated per unit area causing stiff competition for sunlight, water and soil nutrients with the preferred species [12].

This study was therefore conducted to establish the plant species abundance at the beginning of the research activities at the Machang'a field station to form a baseline reference against which any future trends and management decisions may be compared.

Objectives of the Study Were

1. To make an inventory of plant species in Machang'a Field Station, Central Eastern Kenya;
2. To determine the relative preference of plant species by free ranging goats during different seasons.

Site of Study

The study was conducted at The University of Nairobi's Machang'a Field Station in Mbeere, Embu County). The station is situated at an elevation of 1005 m above sea level, about 150 km North-east of Nairobi in Kenya. The field station covers an area of 500 hectares. The pattern of rainfall in this area is bimodal occurring in February/May and October/December with peak readings in April and November respectively.

2. Materials and Methods

Vegetation Inventory

Vegetation inventory was done using ocular survey or reconnaissance method [9]. This involved walking through the field station and taking a tally of all species of plants encountered. A representative area of 20 hectares was chosen for more intensive study of **species abundance** and **cover**. Ten permanent transects of 100 m long, were established approximately 200 m apart, along which detailed study was conducted.

Ground Cover and Herbaceous Layer Studies

Percentage ground cover study was conducted using Line Intercept Method [7]. A line intercept is a line representing one edge of a vertical *plane* that is perpendicular to the ground. All plant canopies projecting through that plane, over the line were tallied. The total decimal fraction of the line covered by each species multiplied by 100 equals to its percent cover. Holes in the canopy were treated as non-existent because such space was still under the influence of the shoot or root of the plant in question. A 100 m measuring tape was laid out along the transect and the overlap, intercept or projection of each species with the tape was measured. Summing up all the intercepts or projections, the percent, total cover and species composition were calculated:

% Total cover = (Total of Intercepts ÷ Length of Transect) × 100
% Composition for species **A** = (Total intercept for sp. **A** ÷ Total of intercepts.) × 100
% Cover for sp. **A** = % Total Cover × % Composition of sp. **A**.

Relative species density of trees and shrubs

Point centered quarter (PCQ) method was used to determine the relative density of trees and shrubs [7]; [9].

Calculations from PCQ

Sum up all distances, **D = Total distances.**

Mean distance,
d = D ÷ Total No. of measurements.

Where: number of measurements = to the number of sampling points x 4.

Mean area = d^2
Density (N/ha) = $(1 \div d^2) \times 10{,}000\ m^2$

Relative density for sp**. A**
= No. of measurements for **sp. A** ÷ Total No. of measurements.

Absolute density for sp**. A**
= Total density × Relative density for sp**. A.**

Forage Selection

Direct observation method was used as described by earlier authors [2]. Ten goats were randomly selected from the herd and identified by their ear tag numbers. Grazing observation done on two of the randomly selected goats between nine and ten o'clock (9.00 a.m.-10.00 a.m.) daily.

During these observations the following information was recorded,
1. Time spent on individual plant species without walking one full step;
2. The plant species and part of the plant eaten; and
3. The number of bites.

A bite was taken as being the act of picking up (in the case of seed and other litter) the forage1or when the animal breaks off the I plant part. Time spent on individual plant species was used to calculate dietary preference according to time spent feeding on different plants.

Relative species preference was then calculated by use of a modified form of the formula recommended by Taylor [13] taking into account the relative forage availability.

Diet Preference

Diet preference was calculated by the formula recommended by Taylor [13] as shown below:

Preference Index (PI) for plant species.
PI = (Weighted proportion in diet - relative availability %) ÷ (Weighted proportion in diet + relative availability %) × 10.

Where weighted proportion in diet is calculated as (Mean No. of bites × Mean time spent) $^{1/2}$

Relative availability represents the proportion of a given forage species in the forage on offer; that is the relative abundance in the field. The index has a scale from -10 to +10 indicating relative preference. A value about zero would indicate consumption in proportion to availability.

Statistical Analysis

Analysis of variance was done for plant species preference to check the effect of season, goat, transect (or grazing location) and plant species on bites and biting time on individual plant species.

The model used was as shown below:
Model: $Y_{ijklm} = \mu + X_i + E_j + F_k + I_l + W_m + C_{ijklm}$
Where Y represents mean bite or mean time spent biting forage.
μ = overall mean;
X_i = effect of the i^{th} season (i = 1, 2, 3);
E_j = effect of the j^{th} transect (j = 1, 2… 5);
F_k =effect of the k^{th} goat (k = 1, 2… 10);
I_l = effect of the l^{th} plant species (l = 1, 2… 71);
W_m = effect of the m^{th} week within experimental season (m = 1, 2, 3); and
C_{ijklm} = random error term associated with $ijklm^{th}$ observation whose mean = 0 variance σ^2_e

3. Results and Discussion

Botanical Composition of Machang'a

A total of 180 plant species were recorded, 90 of which were found to be palatable to goats. There was a wide range of trees and shrubs as well as herbs occurring in varying proportions (Table 1). The predominant grass species during the rainy season were *Eragrostis caespitosa* (11%), *Latipes senegalense* (10.3%), *Aristida kenyensis* (10%), *Macrochloa kunthi* (7.7%), *Enteropogon macrostachys (6.3%)*, *Aristida spp.* (6.0%) *Fimbristylis dichotoma* (5.8%), *Eragrostis superba* (3.1%) and *Dactyloctenium aegyptica* (2.4%).

During the dry season, when most of the grasses and other vegetation had dried out, the following grasses were still standing (although dry) and therefore available to the goats: *Eragrostis caespitosa* (19.9%), *Aristida kenyensis* (15.5%), *Digitaria macroblephera* (14.0%)/ *Enteropogon macrostachys* (10.8%), *Latipes senegalense* (9.1%), *Eragrostis superba* (6.8%) and *Bracharia leersoides* (2.2%).

The overall ground cover was highest during the long rains (40.8%) followed by short rains (19.2%) and finally dry season (12.6%). Most of the ground surface was bare during the dry season as a result of prolonged dry weather and the fact that termites ate away much of the dry litter that had dropped on the ground.

The quantity of edible parts of vegetation was extremely scarce during the dry season, reducing the foraging options to goats. Strategies such as varying the stocking rate, supplementation with conserved forage and improving pastures based on forage plants that are well adapted to the edaphic and climatic conditions prevailing in Machang'a were therefore recommended.

Goats should not just be raised for their own value, but also as agents of slackening bush invasion into grassland. However, care must therefore be taken not to eliminate any vegetation type even if it seemed less preferred by goats.

Relative Preference Indices

During the long rains, the trees which were frequently eaten included *A. mellifera* (PI=9.9) and *Dalbergia melanoxylon* (PI=9.0), *Acacia hockii* (PI=8.7) and *Boswelia hildebrandtii* (PI=4.6).

Grass showed low preference indices for all the three seasons, having PI of -7 during the short rains, -6 during the long rains and -5.5 during the dry season.

Despite being the most abundant tree and therefore within reach, C. *molle* registered the poorest PI (-7.5 and -5.7) during both short rains and dry season. During the long rains C. *molle* had a low PI (-4.7) which was only slightly better than that for grass. The fact that goats showed dislike for *Combretum molle* could probably be because of some undesirable physical or chemical attribute of the tree detectable by the goats.

Dalbergia melanoxylon('Mpingo' or African Blackwood) has been described as the most valuable timber by weight and volume([14]). Its population has been greatly reduced because of the high demand for its timber among the Akamba wood carvers and European instrument makers. It was preferred by goats (PI=+9.8 during short rains and +9.0 during long rains). This implies additional pressure on the plant. This pressure, coupled by its poor regeneration and deciduous behaviour, makes *Dalbergia melanoxylon* an endangered tree species which may require legislative and agronomic intervention and protection.

While relative abundance of a given forage species may indicate the degree of adaptability of that plant species, it may not necessarily imply its availability to goats throughout the year. Certain plants are deciduous or may occur in less palatable forms during the dry season. It was therefore deemed necessary to take into account a plant's availability to goats in various seasons in making judgment on its relative suitability as a feed resource at Machang'a.

4. Conclusions

Machang'a field station was endowed with a wealth of (180) indigenous forage species which showed wide seasonal fluctuation in abundance and ground cover. Dry season was characterized by low ground cover with scarce and dry (dead) forage. Promoting growth of plants through controlled grazing, re-establishment and forestation would probably stabilize feed supply to goats throughout the year at Machang' a.

Table 1: Relative abundance (%) and preference indices of preferred plant species across three seasons

Plant species	Short rains		Long rains		Dry season	
	RA%	P1	RA%	P1	RA%	P1
Premna hildebrandtii (s)	3.5	+7.3	3.5	+8.1	--	na
Grass (bulked) (G)	49.7	-7.0	49.6	-6.0	51.7	-5.5
Indigofera spicate (s)	1.6	+6.5	0.5	+9.7	--	na
Boswelia hildebrandtii (T)	1.4	+7.8	4.3	+4.6	--	na
Aspilia misambicensis (S)	0.05	+9.9	0.05	+9.9	1.4	+7.4
Maytenus putterlickoides (S)	3.6	+6.6	3.6	+7.9	3.6	+6.6
Combretem molle (T)	30.5	-7.5	30.5	-4.7	28.9	-5.7
Crotolaria goodformis (H)	0.05	+9.9	0.05	+9.9	na	na
Acacia hockii (T)	1.2	+7.6	1.2	+8.7	1.4	+2.6
Tephrosia villosa (S)	1.6	+7.0	1.6	+7.9	na	na
Ochina innermis (S)	0.05	+9.9	--	--	na	na
Dichrostachys cinerea (S)	1.0	+8.6	1.3	+9.0	na	na
Grewia bicolor (S)	1.3	+8.2	1.3	+8.4	1.3	+5.6
Stephania abysinica (S)	0.05	+9.9	--	--	na	na
Lantana camara (S)	0.3	+9.9	0.05	+9.9	0.3	+9.8
Acacia milifera (T)	0.5	+9.5	0.5	+9.7	na	na
Combretum aculeatum (T)	2.6	+7.1	2.3	+7.7	2.4	+7.9
Ocimum ssp. (S)	0.2	+9.3	0.2	+9.8	0.2	+8.8
Barleria proxima (S)	0.7	+8.7	0.7	+9.1	0.2	+8.8
Dalbegia melanoxylon (T)	0.7	+9.8	0.7	+9.0	na	na
Hoslundia opposite (S)	--	--	2.2	+7.5	1.9	+7.9
Thunbergia holpstii (S)	--	--	1.3	+8.7	1.4	+7.2
Acalypha fruticosa (S)	--	--	2.4	+7.6	na	na
Acacia brevispica (S)	--	--	2.9	+7.6	--	--
Indigofera lupatana (S)	--	--	0.05	+9.9	--	--
Cordia gharef (S)	--	--	0.05	+9.9	na	na
Rubia ssp. (H)	--	--	0.2	+9.8	na	na
Solanum incanum (fruit) (S)	--	--	2.5	+7.2	5.2	+1.3
Hermamia alhiensis (S)	--	--	--	--	1.3	+7.7
Commiphora ssp. (fruit) (T)	--	--	--	--	2.7	+9.6
Ipomoea kituensis (S)	--	--	--	--	0.05	+9.6

-- =present but not eaten; na =not available to goats (plants are deciduous); T=tree; H= herbs; G=grass.

Table 2: ANOVA: Effect of season, goat, plant species and transect on number of bites and time spent on forages at Machang'a.

Source of variation	No. of bites	Time spent(sec.)			
	DF.	MS	F	MS	F
Season	2	6142.759	14.298***	11674.396	12.386***
Goat	9	989.641	2.303*	1708.258	1.812ns
Plant species	70	1554.645	3.619***	2772.797	2.942***
Transect	4	1697.452	3.951**	1834.357	1.946ns
Remainder	239	429.632		942.568	
TOTAL	2484				

ns = not significant ($p<0.05$)
*, **, *** =significant at $p<0.05$, $p<0.01$, and $p< 0.001$ respectively

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