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Diet selection by Nguni goats in the Zululand Thornveld

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Abstract

The aim was to determine diet selection of goats grazing/browsing in Zululand Thornveld. An experiment was done in spring (November 2007) and autumn (March/April 2008) at Owen Sitole College of Agriculture, KwaZulu-Natal. Diet selection was estimated using direct observation of animals and an indirect plant-based method. The browse species observed in the plant-based methods were: *Gymnosporia senegalensis* (Gs), *Acacia nilotica* (An), *Acacia karroo* (Ak), *Scutia myrtina* (Sm) and *Dichrostachys cinerea* (Dc). Selection was determined by observing at regular intervals 40 marked branches on 10 plants of each browse species. Direct observation of diet selection was done by observing two goats in a base herd of 24 castrated males when they were allowed to forage together in a paddock of 1 ha. Observations were made every minute for three hours in the morning and 1.5 hours in the afternoon. The relative abundance of the browse species in the veld was determined and used to estimate the selection index (utilization relative to availability). In both seasons, the three most selected species according to the plant-based observations were Sm, Ak and Dc. Consistently, An experienced moderate defoliation and Gs the least. However, on the basis of the selection index the species followed the order: An>Dc>Ak>Sm>Gs in spring and An>Sm>Dc>Ak>Gs in autumn. The selection index was negatively correlated to all fibre attributes although the correlation attained significance only for NDF, ADF and lignin but not for tannins and cellulose. Both methods did not rank species in the same order, thus suggesting the need for further methodological refinement.

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Introduction

In Africa, natural vegetation makes up a major part of the diet of ruminant livestock. Thus, in order to enhance livestock production, it is imperative to improve pastures, comprising of grass and browse species. The improvement of such pastures is impossible to achieve without adequate understanding of browse-browser interaction and feeding behaviour. Bergström (1992) suggested active interaction between browsers and woody plants, in that woody plants respond to browsing and impact on feeding behaviour. Browsers have been shown to choose plants with high growth rates over plants with slow growth rates (Danell *et al.*, 1985). Animals have been shown to be able to distinguish between plant types and their parts (Hodgson 1986). Biochemical and nutritive characteristics of feed provide the option to select the diet which satisfies the goats' requirements (Fedele *et al*., 2002). Digestibility is influenced by plant fibre (Jung & Allen, 1995) whilst tannin may control diet selection and food intake since it creates unacceptable taste or reduces nutrient (protein) availability in the gastrointestinal tract (Arnold *et al.* 1980; Robbins *et al*., 1987). In a study by Montossi *et al.* (1997) in New Zealand, a low content of condensed tannin (<0.2%) did not influence lamb performance. Goats' feeding behaviour depends on the associative effects of diet items rather than their specific nutritive value, since goats maximize and balance intake without incurring digestive disorders (Fedele *et al*., 2002). The aim of this study was to determine the diet selection of goats grazing/browsing in Zululand Thornveld.

Materials and Methods

Two experiments were conducted using two paddocks (1 ha each) during the spring (November 2007) and autumn (March/April 2008) seasons at the Owen Sitole College of Agriculture (OSCA), Empangeni, South Africa. OSCA is located at 28˚57'45"-28˚57'22"S latitude and 31˚55'31"-31˚57'22"E longitude within the Coastal Forest and Thornveld (Van der Linden *et al*., 2005). The mean annual rainfall of OSCA is

1022 mm, with a third of it falling in mid to late summer (Van der Linden *et al*., 2005). The study area was located north of the main gate of OSCA. The paddocks were fenced and a pen (9 m x 6 m) was erected in one corner of the paddock for holding animals at night, which was equipped with one water trough.

Twenty-four castrated male Nguni goats were used. The study focused on five dominant browse species: *Gymnosporia senegalensis, Acacia nilotica, Acacia karroo, Scutia myrtina* and *Dichrostachys cinera*. The browse species were randomly sampled by collecting leaves 1.0 - 1.5 m above ground from three trees per species. Samples were kept in paper bags and air-dried prior to oven-drying at 60 °C for 48 hours. The leaves were ground through a 1-mm mesh sieve and stored in plastic bottles.

For estimating relative abundance of woody species, the belt transect method was used. Transects of 2 m width, oriented north-south, were systematically placed 20 m apart. Each transect started and ended 10 m from the sides of the paddock. Transects were surveyed in 20-m lengths. About 5% of the paddock area was sampled. In sampled transects, woody plants were identified, the height of all woody plants was measured and the proportion with browseable material below 1.5 m height estimated. The relative abundance of each species was calculated as the number of plants of a species divided by the total number of plants of all species x 100. The density of each species (plants/m^2) was calculated as the number of plants of a species divided by the area of paddock.

An indirect plant-based method of diet selection involved marking 40 branches (on 10 plants) per species. Every two days, all branches were inspected and scored as browsed or not browsed. The cumulative proportion of marked branches was calculated and plotted against days. An animal-based method (direct method) was also used to determine diet selection. During foraging, two goats were selected randomly from the herd during each day of recording (different goats for each day) and closely observed continuously by two people. The selected browse species under study were recorded every minute. Browsing activity on species not being studied, and grazing activity, was recorded as ‘other browse’ and ‘grazing’, respectively. Observations were made for 3 h in the morning and 1.5 h in the afternoon on alternate days for a total of six days. Selection index (SI; utilization relative to availability) was estimated as: $SI_y = (C_y/D)/RA_y$, where SI_y is the selection index for species ‘y’, C_y is the number of times species ‘y’ was consumed, D is the sum of all observations of all species in the diet, and RA_y is the relative abundance of species ‘y’.

Crude protein was determined using the AOAC (16^{th} edition) method 990.03 (LECO. FP2000, Nitrogen analyzer). Neutral detergent fibre (NDF), acid detergent fibre (ADF) and acid detergent lignin (ADL) were determined using the methods of Van Soest *et al.* (1991) applied to ANKOM Technology Technique. Condensed tannin (CT) was determined according to the method described by Makkar (1995).

The diet proportion, diet selection index and relative abundance were analyzed using the GLM procedure of SAS programme (2000). Correlations between selection index and chemical properties were determined.

Results & Discussion

In both seasons, the three most selected species according to the plant-based observations were *S. myrtina*, *A. karroo* and *D. cinerea*. Consistently, *A. nilotica* experienced moderate defoliation and *G. senegalensis* the least (Figure 1). Dziba *et al*. (2003) in the Eastern Cape obtained the same order of preference for *S. myrtina* and *A. karroo*. Yayneshet (2008) showed that goats preferred *D. cinerea*. Sanon (2007) mentioned that the lowest intake was of *G. senegalensis*.

However, on the basis of the selection index the species followed the order: *A. nilotica*, *D. cinerea*, *A. karroo*, *S. myrtina*, *G. senegalensis* in spring and *A. nilotica*, *S. myrtina*, *D. cinerea*, *A. karroo*, *G. senegalensis* in autumn (Table1). *A. karroo* and *D. cinerea* had similar indices in spring and autumn (1.18 and 1.4; 1.19 and 1.36, respectively) perhaps because both plants had green leaves in both seasons. *A. nilotica* and *S. myrtina* registered different indices in both season, but differences were much wider in spring than in autumn. This suggests that preference ranking might be affected by season (Dziba *et al*., 2003). Milne *et al.* (1979) found that the intake rate of grazing sheep differed between summer and autumn. Goats might avoid a season’s twigs as a result of their high tannin contents and their location within the plant canopy (Provenza & Malechek, 1984).

The chemical composition is shown in Table 2. The selection index was negatively correlated to all fibre attributes although the correlation attained significance ($P < 0.05$) only for NDF, ADF and lignin (Table 2). Selection of diet items may sometimes be a function of quality and other times a function of quantity

(Shipley *et al*., 1999). Arnold (1981) suggested that herbivores select diets based on the concentration of nutrients relative to toxins rather than on availability.

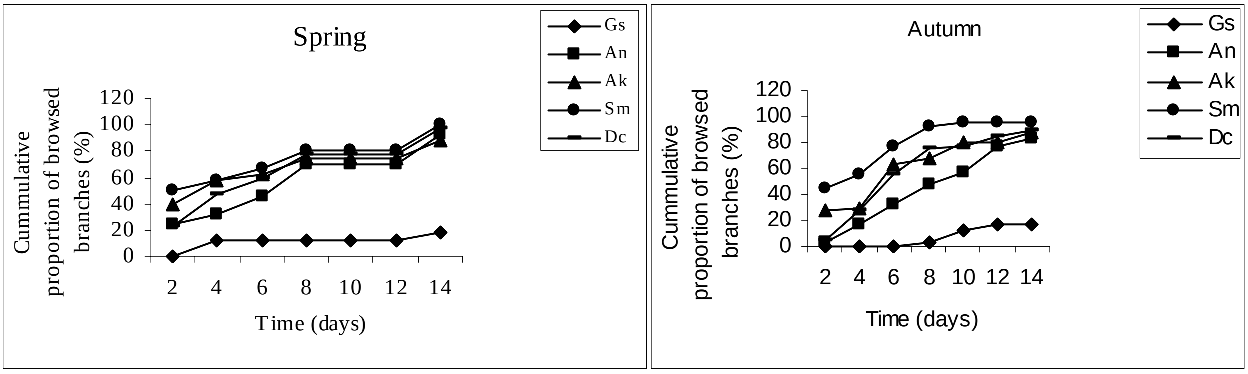

Figure 1 Defoliation rate of branches of browse species in spring and autumn (Gs = *G. senegalensis*, An = *A. nilotica*, Ak = *A. karroo*, Sm = *S. myrtina* and Dc = *D. cinera)*.

Table 1 Density of forage trees, browseable trees within species (BAS), relative abundance of browseable species (RAS), relative abundance of a browseable species in the diet (Diet), and diet selection index (Sindex)

Feed	Density (plants/ha)		BAS (plants/ha)		RAS		Diet		S index	
	S	A	S	A	S	A	S	A	S	A
G. senegalensis	949	1280	939	1248	0.077	0.090	0.005	0.014	0.10	0.27
A. nilotica	653	500	520	360	0.042	0.026	0.116	0.102	4.08	6.35
A. karroo	2439	1860	2224	1840	0.181	0.133	0.136	0.099	1.18	1.19
S. myrtina	1071	860	908	820	0.074	0.059	0.034	0.125	0.68	3.25
D. cinerea	898	1460	867	1361	0.071	0.099	0.065	0.083	1.40	1.36
Other browses	6936	8740	6804	8172	0.555	0.592	0.306	0.201	0.82	0.55
Grazing							0.338	0.374	-	-
RMSE							0.0607	0.027	0.55	1.13
P<							0.05	0.05	0.05	0.05

S = spring, A = Autumn; OB – other browse species; RMSE is the root mean square error.

Table 2 Chemical composition of experimental species and correlation coefficients with diet selection index

Species	CP (g/kg)	NDF (g/kg)	ADF (g/kg)	ADL (g/kg)	CT (g/kg)	Cell (g/kg)
G. senegalensis	73.8	486.4	304.8	205.3	77.5	99.5
A. nilotica	114.7	460.7	259.8	172.8	132.3	87.0
A. karroo	123.4	272.9	139.3	78.3	20.3	61.0
S. myrtina	125.7	431.4	288.0	213.2	100.0	74.8
D. cinerea	123.2	523.6	316.9	198.1	57.9	118.8
Correlation with selection index						
Spring	0.56^{NS}	-0.88^{*}	-0.88^{*}	-0.90*	-0.76^{NS}	0.62^{NS}
Autumn	0.48^{NS}	-0.87^{*}	-0.96*	-0.97*	-0.46^{NS}	0.69^{NS}

CP - crude protein; NDF - neutral detergent fibre; ADF - acid detergent fibre; CT - condensed tannin; Cell – cellulose. NS (P >0.05); * (P <0.05).

Conclusion

Indirect plant-based and direct animal-based methods did not rank browse species in the same order, thus suggesting the need for further methodological refinement. Diet selection appears to be influenced by the fibre constituents.

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