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Diet selection of Nguni goats in relation to season, chemistry and physical properties of browse in sub-humid subtropical savanna

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ABSTRACT

This study was conducted to determine the influence of plant chemical, physical and phenology properties on diet selection of Nguni goats during the dry, early wet and late wet seasons in savanna in South Africa. Diet composition was estimated by direct observation of two different adult Nguni goats randomly selected from a herd each day for 7–8 days in each season. Observations were made during active foraging periods for 2 h in the morning and 1.5 h in the afternoon. The duration of each feeding bout and the species of woody plant from which bites were cropped at each feeding station were recorded. Diet selection was determined from the relative duration of feeding. Diet preference of each species was expressed as an index calculated using the selection and relative abundance of woody species. Browse species consumed by goats were sampled and analysed to determine crude protein, neutral detergent fibre, acid detergent fibre, acid detergent lignin, condensed tannins, cellulose and hemicellulose. Diet selection varied among the three seasons. The five species most selected (utilised) by goats were *Scutia myrtina*, *Acacia nilotica*, *Dichrostachys cinerea*, *Acacia natalitia* and *Chromolaena odorata*. *S. myrtina* was the most selected species during the dry season while *D. cinerea* was the most selected in the wet seasons. *S. myrtina* was the most preferred (highest utilisation relative to availability) in the dry and early wet seasons while *A. nilotica* was most preferred in the late wet season. Spinescent species were generally selected more than non-spinescent species in all seasons, while fine-leaf and deciduous species were selected more than broad-leaf and evergreen ones in the wet seasons. However, preference for broad-leaf and evergreen species increased in the early wet season. Although plant chemistry varied across seasons, it did not explain the preference of goats for various plant species in this study. Instead, effects of chemistry were species-specific. In conclusion, this study demonstrates the importance of evergreen browse species as a source of fodder when deciduous species are unavailable.

1. Introduction

Savannas occupy 65% of the total area of Africa, 60% of sub-Sahara Africa (Scholes and Archer, 1997) and 54% of KwaZulu-Natal province in South Africa (Breebaart et al., 2002). Savanna browse adds significantly to the total forage of livestock and wildlife in Africa (Bergström, 1992). Therefore, the savanna is important to support human populations in Africa through supporting livestock production (Scholes and Archer, 1997). A key to improving the management of savannas is the development of sound understanding of diet selection. Diet selection describes the decisions animals make with regard to the plant

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material (plant parts, plant species and patches) they choose (Newman et al., 1995; Morrison et al., 2002). However, the patterns of diet selection are not regular in space or time, which may be due to changes in forage availability (Edenius et al., 2002). Additionally, differences in chemical and physical defence influence the diet selection by herbivores (Illius et al., 1999; Dziba et al., 2003).

Chemicals such as tannins are assumed to function as defences against herbivores (Bergström, 1992). Besides changing the taste of feed, the negative feedback of tannins causes rumen microbial inhibition and decreased digestibility and animal performance (Silanikove et al., 2001; Min et al., 2003), but is advantageous in goats in dealing with tannin diet and that tolerate them without exhibiting toxic syndrome (Silanikove et al., 1996; Landau et al., 2000; Silanikove, 2000). However, tannins are not totally avoided by goats but are tolerated at a certain minimum level (Jansen et al., 2007). It has been suggested that the minimum level of tannin for ruminants to tolerate in forages is 55 g/kg DM (Min et al., 2003), but if this amount is exceeded and free tannins reach the rumen, tannins can form indigestible complexes with bacterial enzymes (Priolo et al., 2000), or cellulose and hemicelluloses (Haslam, 1989). Thus, tannins can protect plant cell walls against rumen organisms and reduce animal performance (Jachman, 1989; Priolo et al., 2000). In spite of negative effects, tannins may have positive effects on ruminants, such as increased nitrogen retention when protein–tannin complexes dissociate in the post-rumen (Nsahlai et al., 1998). This may provide additional amino acids and prevent excessive degradation of high-quality leaf protein in the rumen (Mehansho et al., 1987; Min et al., 2003).

Ruminants need sufficient dietary fibre for standard rumen functions by maintaining enough saliva and optimal pH (Church, 1988). Fibre has a significant role in goats because it limits intake and maintains normal fermentation in the rumen (Lu et al., 2005; Ndlovu and Nherera, 1997). Minimizing acid detergent fibre is a way to explain preferences in the case of *Acacia* species (Jansen et al., 2007), while lignin reduces the digestibility of browse (Moore and Jung, 2001).

In addition to plant fibre, diet selection in mammalian herbivores can be influenced by physical plant factors. Spines, thorns and other physical traits may limit leaf accessibility and intake rates resulting in lower preference of species that have these traits (Shipley et al., 1998; Dziba et al., 2003; Wilson and Kerley, 2003b).

Because savannas are seasonal environments, the challenge is to understand the relationships between chemical or physical factors and diet selection by goats at different time of the year. The objectives of this study were (i) to explore the diet selection of goats foraging in different seasons in a sub-humid subtropical savanna, and (ii) to investigate the possible relationships between diet selection and various physical, chemical and phenological features, such as condensed tannins, crude protein, fibre fractions, spinescence, leaf type and deciduousness. To achieve these objectives, we tested the following hypotheses. Firstly, seasonal variations in availability and quality of forage in sub-humid subtropical savanna may alter diet selection (Abate, 1996). Second, inherent differences in leaf chemistry among different plant species could affect diet selection (Scogings et al., 2004). Thirdly, variations of different plant species in leaf morphology (Shipley et al., 1998; Dziba et al., 2003; Wilson and Kerley, 2003a), spinescence (Cooper and Owen-Smith, 1986) and leaf phenology (Shipley et al., 1998; Watson and Owen-Smith, 2002) might influence diet selection.

2. Materials and methods

2.1. Study area

The study was conducted at the Owen Sitole College of Agriculture (OSCA) in northern KwaZulu-Natal, South Africa. OSCA is placed within the Zululand Coastal Thornveld (Mucina and Rutherford, 2006) and is located at 28°57′45″–28°57′22″S latitude and 31°55′31″–31°57′22″E longitude (Van der Linden et al., 2005). The mean annual rainfall of OSCA is 995 mm, with 75% of it falling in the wet season (October–April). The experimental paddocks (2–2.5 ha each) were fenced and a pen was erected in one corner of each paddock to keep the animals at night. Confining livestock in enclosures at night is commonly practiced in the area to prevent theft and predation. Ad lib water was provided in a trough. Fieldwork was carried out during the dry season (late June/early July, 2008), early wet season (late November/early December, 2008) and late wet season (late February/early March, 2009).

2.2. The relative abundance of woody species

For estimating the relative abundance of woody species, the vegetation was recorded by means of 2-m wide belt transects oriented north–south. Each transect started and ended 10 m from the edges of the paddocks. Impenetrable thickets of *Chromolaena odorata* were avoided. Because each paddock was not quadrangular, transect lengths varied between 20 and 120 m, but ultimately 5% of each paddock area was sampled. In each transect, the height (cm) of each woody plant was measured and identified to species level (according to Coates Palgrave, 2002). When there was no foliage below 1.5 m the plant was recorded as unbrowseable. The data from all transects in a paddock were used to calculate the relative abundance of each species, which was calculated as the total number of browseable plants of each species divided by the total number of browseable plants of all species.

2.3. Species samples and chemicals analysis

Browse species and grass which were accepted by goats were sampled. Species that were avoided by goats were not sampled because the study focused only on species utilized by goats during the three seasons of the study. Browse samples were taken from three unbrowsed trees (below 1.5 m above ground) per species and grasses were cut from three different ungrazed areas. Plant samples were collected in the last 2 days of each period, kept in paper bags and air dried prior to oven drying at 60 °C for 48 h. Samples were ground through 1 mm mesh and analysed for chemical composition on a dry matter basis. Crude protein (CP) was calculated using nitrogen concentration which was determined by AOAC method 990.03 (AOAC, 1997) using a LECO, FP2000, nitrogen analyzer. Nitrogen was converted to CP using 6.25 as a conversion factor. Neutral detergent fibre (NDF), acid detergent fibre (ADF) and acid detergent lignin (ADL) were determined according to Van Soest et al. (1991) using the ANKOM Technology Technique. Cellulose was calculated as the difference between ADF and ADL, while hemicellulose was derived from the difference between NDF and ADF. The acid-butanol proanthocyanidin assay (Porter et al., 1986) was used to determine condensed tannins (CT) (Makkar, 1995).

2.4. Diet selection and selection index

Previous browsing influence on chemical traits (protein and tannin) for the main species (*Scutia myrtina*, *Acacia nilotica*, *Dichrostachys cinerea*, *Acacia natalitia*) was tested because one paddock was used twice. Samples from ten trees per species per area were sampled and analysed for protein and condensed tannin. Control samples were taken from an area