Tropical and Subtropical Agroecosystems

SHORT NOTE [NOTA CORTA]

SIMILARITY INDICES OF A SARCOCAULESCENTE SCRUBLAND AND BROWSING GOATS DIET IN NORTHWEST MEXICO

[ÍNDICES DE SIMILITUD DE UN MATORRAL SARCOCAULESCENTE Y DIETA DE CABRAS RAMONEADORAS EN EL NORESTE DE MÉXICO]

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SUMMARY

The extent of vegetation used by free browsing goats on a rangeland is a practical measure to determine rangeland productivity and may be measured by the similarity indices between the botanical composition of diet and the rangeland. The aims of this study were to evaluate and compare, seasonally the similarity indices of forage species and goats diets under the Sonorant desert conditions. Samplings were carried out in summer and autumn of 2006, and winter 2007 in a 200-ha rangeland with an animal density of 0.13 to 0.36 individuals/ha. Twenty two fixed transects (30 m long) distributed randomly were used to measure the botanical composition and importance value (IV) for plant types by the line-intercept method. Identified species were classified as non legumes trees and shrubs (NLTS), legumes trees and shrubs (LTS), cacti, forbs, agaves and grasses. Five castrated Creole-Nubio goats (29 kg of BW) provided with esophageal fistula were used to obtain diet samples and determine botanical composition of diets by microhistological analyses. Botanical composition of diet (A) and IV values (B) were used to calculate the similarity indices (SI) according to S = 2(W)(100)/A+B, being W the lower value between A and B. Sixty plant species were founded in the study area, but only 23 species were in diet of goats. Similarity indices indicated that NLTS were more utilized in all seasons than other plant types. The SI between seasons indicated a gradient of forage utilization in the following order (P<.05): In summer; forbs (87.3) > NLTS (70.2) > LTS (39.1) > cactus (0.0) = grasses (0.0), in autumn; cactus (85.9) > NLTS (85.6) > forbs (77.1) > LTS (73.3) > grasses (6.9) and in winter LNTS (88.8) > LTS (88.0) > grasses (87.4) > forbs (70.8) > cactus (53.3). Goats utilized only 30% of the vegetation on rangeland in all seasons and showed light change in their forage utilization pattern because of the opportunistic feeding behavior of these animals; however they maintain a high utilization on shrubs and trees.

Key words: Range goats; forage utilization, similarity indices, sarcocaulescent; northwest Mexico

INTRODUCTION

The need to study range ecological association on a quantitative basis has long been recognized (Bonham, 1982). The diet of livestock is a result from the complex interaction between available forage and animal species (Ramírez, 1999). However, in some parts of the world, grazing is applied in most regions without established principles of proper utilization (Papachristou et al., 2005). Baja California Sur, Mexico is part of the Sonoran Desert, considered as an extremely arid zone (FAO, 1987), about 92% of its flora is composed of shrubs and 23% of these are endemic species (Wiggins, 1980). The vegetation is characterized by trees with trunks of exaggerated diameter, including *Bursera* and *Jatropha* genera, although these striking tree are, in their abundance, distinctive of the area, they are actually outnumbered by *Olneya*, *Cercidium*, *Fouquieria* and *Prosopis* genera and by small-leaved shrubs Most of the farmers of the region are traditional smallholder. This system is characterized by a very low animal density (0.13-0.39 individual/ha), severe and prolonged drought period, continuing low per-animal

performance and uneconomical production. Farmers are unlikely to build fences for handling livestock or to buy supplementary feed to increase animal production, they have traditionally used shrub and tree fodders to feed their animals on the basis experience and convenience as a practical means of rearing animals (Monroy et al., 2003). However, information of species utilized by range ruminants on these sarcocaulescent scrublands throughout the year is spare. The objective of this study was to determine and compare seasonally the use of plant species and plant types by range goats.

MATERIALS AND METHODS

The study was conducted on the ranch "Palmar de en Medio" (200 ha) located in La Paz, Baja California Sur, Mexico at 23º38'03" north and 110º17'07" west longitude (DGETENAL, 1980), 146 m over sea level. Vegetation is composed mainly of shrubs from 1 to 3 m, and trees from 4 to 10 m of height (León de Luz y Coria, 1992). The climate of the region (BWhw) is extremely arid with annual mean temperature of 21.6ºC. Annual precipitation is about 168.6 mm, occurring mainly from July through October. Rainfall and temperature patterns were taken from the Todos Santos meteorological station from 1961-2003 (INIFAP, 2006). The main soils are of the type alkaline, regosol, eutric and calcareous which are very permeable (Flores, 1998).

Vegetation measurements were carried out on a rangeland of 200 ha in summer and autumn of 2006, and in winter of 2007, Twenty two fixed transects (30 m long) permanently established and distributed randomly were used to measure the botanical composition of the study area by the line-intercept method (Whalley and Hardy, 2000; Franco-Lopez et al., 2001). With a line transects individuals and species touching the tape or string were recorded and the lengths of the intercept occupied by individuals touching the line were recorded (Whalley and Hardy, 2000; Franco-Lopez et al., 2001). Individuals of each species were identified and measured to classify them as non legumes trees and shrubs (NLTS), legumes trees and shrubs (LTS), cacti, forbs and grasses. Relative frequencies of occurrence, relative density, relative canopy cover were determined. The mean of these three values were considered as the importance value (IV) for each plant type in the area study (Whalley and Hardy, 2000; Franco-Lopez et al., 2001). Proportional IV (percent of each species from the total IV) for each specie was computed to be used in the determination of the similarity indices.

Five castrated creole-nubio goat (29 kg of BW) provided with esophageal cannulae were used to obtain esophageal extrusa samples and determine botanical composition of diet by microhistological analyses (Sparks and Malechek, 1968). As a separate data collections, leaves and fruit of all plants encountered within a 20 m perpendicular to transects but not on the transect were collected and slides prepared as a reference for plant identification in esophageal samples. Calculated relative frequency for each species was converted to relative density using the formulae $F = 1 - e^{-x}$ where F is frequency and x is the density, solving for x the percent for each species in the diet was calculated (Johnson, 1982), then plant were classified as one of the five types considered for the determination of the IV in the study area.

Botanical composition of diet (A) and proportional IV values (B) were used to calculate the similarity indices (SI) according to Kulczknski´s similarity index (Mannetje, 2000), using the formula SI = 2 (W) (100) / A + B, being W the lower value between A and B. Low SI indicate complete lack of similarity (there are no common species or values) and this may be due to a high preference or reject of a specie or plant type, whereas a high SI indicate complete similarity (all species or values are common) and that a plant type or specie is used according to their availability (Ratliff, 1993). To determine the effect of season on botanical composition of diet and similarity indices, an analysis of variance was performed. All test were performed with alfa = 0.05.

RESULTS AND DISCUSSION

Similarity indices between the botanical composition of the area and diet were different ($P<0.05$) among seasons being higher in winter than in other seasons (Table 1). In all seasons NLTS were constantly and represented the most important plant type in the area across seasons (Table 1). Moreover, NLTS were in a higher proportion of diet than other plant type in all seasons; their proportion in diet was higher in summer and their similarity indices were lower in this season because animals selected this plant type in a higher proportion than their availability (Table 1).

The LTS and cacti had a constant IV throughout the seasons. During winter LTS increased their proportion in diet of goats, and their SI was increased. Similarly cacti were included in a higher proportion in autumn and the SI was higher in this season, both plant types increased their SI because their consumption was closer to their availability (Table 1). Ramírez-Orduña *et al.* (2008) also reported that during autumn and winter cacti were utilized in lower proportions; whereas, Ramírez et al. (1993) reported that cacti were not utilized by goats on a rangeland at northeastern Mexico.

In autumn grasses had a higher IV and were not

included in the diet of goats in summer, but in autumn and winter were in a constant proportion of diet; however, their SI was low in autumn because of a high availability but low utilization; whereas, in winter the SI was of high availability and decrease without a significant variation in consumption (Table 1). Ramírez-Orduña et al. (2008) on a similar sarcocaulescent scrubland found that grasses were not preferred by goats. Ramírez et al. (1993) founded that only 5 species of grasses were used of a total of 12.

Table 1. Importance value, botanical composition and similarity indices of plant type on a sarcocaulescente shrubland.

	2006		2007
Item	Summer	Autumn	Winter
Importance Value			
Non legume trees and shrubs	31.7	26.7	30.4
Forbs	23.4	18.3	16.2
Legume trees and shrubs	17.5	16.3	17.7
Cacti	15.9	14.2	15.6
Grasses	10.7	23.8	19.2
Botanical composition			
Non legume trees and shrubs	84.2 ± 1.0^{b,}	51.4 ± 1.0^{a,y}	58.4 ± 1.5^{a,y}
Forbs	13.9 ± 1.0^{4a}	26.4 ± 1.0^{a,xy}	11.3 ± 1.2^{a,x}
Legume trees and shrubs	3.9 ± 0.3^{a}	6.9 ± 0.8^{ab,x}	17.0 ± 1.0^{b,x}
Cacti		13.0 ± 1.^{1x}	4.5 ± 1.4^{x}
Grasses		8.8 ± 1.4^{x}	9.8 ± 1.2^{x}
Similarity Indices			
General	62.6 ± 1.6^{a}	74.3 ± 0.9^{a}	83.5 ± 1.1^{a}
Non legume trees and shrubs	70.2 ± 1.1^{a,y}	85.6 ± 0.8^{b,y}	88.8 ± 1.8^{b,x}
Forbs	87.3 ± 1.2^{a,y}	77.1 ± 1.9^{a,y}	70.8 ± 1.4^{a,x}
Legume trees and shrubs	39.1 ± 1.9^{a,x}	73.3 ± 0.9^{ab,y}	88.0 ± 1.3^{b,x}
Cacti		85.9 ± 1.2^{b,y}	53.3 ± 1.0^{a,x}
Grasses		6.9 ± 1.1^{a,x}	87.4 ± 1.2^{b,x}

^{a,b}Means and standard deviation within rows for each variable with different letters differ by season (P <0.05)
^{x,y,} Means and standard deviation within columns for each variable with different letters differ by type plant (P <0.05)

Forbs had a higher IV and SI in summer and decreased by winter even when they were in a higher proportion in diet during autumn, indicating that animals selected this plant type in proportion of their availability. Ramírez-Orduña *et al*. (2008) and Ramírez *et al*. (1993) reported that during summer, autumn and winter forbs were the second plant type utilized by goats on rangelands of northwestern and northeastern Mexico, respectively.

Thirty three plant species were identified in goat diets: 13 NLTS (out of 34), seven forbs (out of 16), seven LTS (out of 13), five grasses (out of 10) and only one cacti (out of 6); however, LTS, grasses and cacti were included in goat diets only in autumn and winter; whereas, NLTS and forbs were included in all seasons (Tabla 2). The NLTS species: *Adelia virgata* and *Ambrosia magdalena* and the forb *Amaranthus palmeri* represented at least 50 % of the diet in all seasons. The LTS: *Prosopis sp*, the grass: *Aristida californica* and the cacti: *Opuntia cholla* were in

higher proportion within their plant type and together represented at least 15% of the diet in autumn and winter. These results are in agreement with those reported by Ramírez-Orduña *et al*. (2008) and Ramírez *et al.* (1993), who found than only a small group of species was highly preferred throughout the seasons and this preference was more dependent on the specific species than the plant type. Consistently with Silanikove (2000) NLTS and LTS represented more than 50% of the diet selected by goats as a mean of preserve their acclimatization to a tannin rich food.

Table 2. Botanical composition of goat diets by species and plant type on a sarcocaulescente shrubland.

	2006		2007
Specie	Summer	Autumn	Winter
Non legume trees and shrubs			
Adelia virgata	48.1 ± 1.4[b]	5.8 ± 1.5[a]	12.4 ± 1.1[a]
Ambrosia magdalena	25.7 ± 1.1[a]	36.2 ± 1.6[a]	31.5 ± 1.4[a]
Ruellia peninsularis	8.2 ± 1.9	5.6 ± 0.9	na
Lysium torreyi	3.6 ± 1.3[a]	2 ± 1.0[a]	1.8 ± 1.3[a]
Hymenoclea monogyra	1.3 ± 0.03	1.5 ± 0.0	na
Colubrina glabra	1.3 ± 0.0	1.5 ± 1.0	na
Lippa palmeri	1.3 ± 0.0	na	na
Melochia tomentosa	na	2.5 ± 0.7	na
Erythea brandegeei	na	0.4 ± 0.0	na
Sapium biloculare	na	0.7 ± 0.0	na
Manguifera indica	na	na	12.7 ± 1.5
Bourreria sonorae	na	na	9.5 ± 0.0
Fouquieria diguetii	na	na	3.2 ± 0.2
Forbs			
Amaranthus palmeri	11.4 ± 0.2[a]	14.8 ± 0.7[a]	6.9 ± 1.5[a]
Solanum hindsianum	4.8 ± 0.9	7.3 ± 1.0	na
Antigonon leptopus	na	3.6 ± 0.7	na
Ambrosia psilostachya	na	2.0	na
Porophyllum gracile	na	0.7	na
Chenopodium murale	na	na	2.7
Euphorbia polycarpa	na	na	1.7
Legume trees and shrubs			
Prosopis articulata	3.9 ± 0.6[a]	2.5 ± 0.9[a]	4.7 ± 1.3[a]
Pithecellobium confine	na	1.4 ± 0.6	7.5 ± 0.6
Haematoxylon brasiletto	na	1.4 ± 0.7	1.3 ± 1.1
Acacia farnesiana	na	1.0 ± 0.4	2.8 ± 1.8
Cercidiun floridum	na	0.7 ± 0.02	2.3 ± 1.0
Mimosa xantii	na	1.1 ± 0.0	0.0
Acacia peninsularis	na	0	1.7 ± 0.4
Grasses			
Aristida californica	na	7.6 ± 1.4	6.5 ± 1.8
Eragrostis pilosa	na	5.9 ± 0.0	na
Chloris gayana	na	1.2 ± 0.4	1.6 ± 0.1
Cenchrus palmeri	na	1.5 ± 1.0	2.6 ± 0.4
Sporobolus airoide	na	na	1.1 ± 0.5
Cacti			
Opuntia cholla	na	12.9 ± 0.5	4.4 ± 0.7

[a,b] Means and standard error in rows for each variable with different letters differ by season ($P < 0.05$).

CONCLUSION

Results showed a change in selectivity by goats and the opportunistic feeding behavior of these animals. Only a small group of species was highly preferred but this preference was more dependent on specific species than plant type.

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