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ABSORPTION OF NON-PROTEIN NITROGEN IN GUAJILLO BY WHITE-TAILED DEER

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ABSTRACT

Guajillo (*Acacia berlandieri*) is an important forage for white-tailed deer (*Odocoileus virginianus*), but has high concentrations of non-protein nitrogen (N). To determine if non-protein N is absorbed by deer, 4 diets with different proportions of guajillo were assigned randomly to 4 male deer in a Latin square design and total balance trials were conducted. Urea and ammonium N were assayed and subtracted from total urinary N, resulting in a pool of N we called uncharacterized N. Our hypothesis was if non-protein N was absorbed but not used by the deer, the amount of uncharacterized N in urine would increase with increasing amounts of guajillo in the diet. Uncharacterized N did not differ among diets ($F_{3,6}$= 2.37, P = 0.169). Our data suggest non-protein N must have either not been absorbed in the digestive tract, or was converted to amino acids by rumen microbes prior to absorption.

KEYWORDS: ammonium, digestibility, guajillo, *Acacia berlandieri*, nitrogen, *Odocoileus virginianus*, urea, white-tailed deer

Guajillo is a leguminous, multi-stemmed shrub common in many habitats and soil types of southern Texas and northern Mexico, often associated with black brush (*Acacia rigidula*), cenizo (*Leucophyllum frutescens*), and prickly pear (*Opunita* sp.) (Taylor 1997). It is an important forage for livestock and deer during drought (Varner

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and Blankenship 1987, Barnes et al. 1991). Conventional nutritional analyses suggest guajillo is high in crude protein (Barnes et al. 1991). This, however, may be misleading because a considerable amount of N in guajillo is in non-protein forms (e.g. amines and alkaloids), not protein (Clement et al. 1997). Additionally, N in guajillo is poorly digested because of binding that occurs between protein and tannins and between and cell wall components during digestion (Barnes et al. 1991).

Ruminants may benefit from some forms of non-protein N because rumen microbes can use this N to produce amino acids, which can be absorbed by the animal (Van Soest 1982; Minson 1990). Alternatively, non-protein N may be absorbed, metabolized, and excreted without any benefit to the animal. For example, nitrogen-containing chemicals in guajillo cause toxicosis in livestock (Price and Hardy 1953). Furthermore, goats and deer fed increasing concentrations of guajillo excreted more detoxification conjugates, suggesting guajillo contains chemicals that are absorbed then metabolized through secondary pathways (Campbell 1999, Nantoumè et al. 2001). Most of the N in amino acids that are absorbed will be metabolized and excreted in the urine as urea or ammonium. However, a small portion of the N within amino acids will be excreted in the urine as other metabolic by-products (Van Soest 1992), which we define as uncharacterized N. Non-protein N that is not used by rumen microbes to produce amino acids and that is absorbed will be detoxified and excreted in the urine (Klaassen et al 1986) as uncharacterized N. Therefore, if significant amounts of non-protein N in guajillo are absorbed from the digestive tract, changes in the amount of dietary guajillo should result in changes in the amounts of uncharacterized N in the urine.

Our objective was to examine urinary N of deer consuming diets differing in guajillo concentration to determine if N is absorbed from the digestive tract in forms other than amino acids. We used uncharacterized N in urine as the response variable. If uncharacterized N increases with increased consumption of guajillo, then not all N digested by deer consuming guajillo will be available for protein metabolism. This information will help range managers more fully understand the role of guajillo in animal nutrition.

MATERIALS AND METHODS

Urine samples from Campbell and Hewitt (*In press*), in which we fed guajillo to white-tailed deer in feeding trials, were analyzed at the Texas A&M University-Kingsville Animal Nutrition Laboratory. Our feeding trials involved collecting herbaceous guajillo stems and leaves from plants in Webb and Duval counties of southern Texas. Dried guajillo and alfalfa were run through a 1 cm hammer mill screen and mixed into 4 diets containing guajillo: alfalfa ratios (dry mass: dry mass) of 0:100, 25:75, 50:50, and 75:25. We used alfalfa (*Medicago sativa*) as the control forage because its nutritive value is similar to native forbs. We completed *in vivo* metabolism trials with 4 adult male white-tailed deer in a 4x4 Latin square design. We randomly assigned diets and each successive trial randomization was limited to insure each deer received a diet it had not received previously. Urine was collected, quantified, and sampled daily during a 7-day collection phase. We analyzed urine for urea N with a 535-A Blood Urea Nitrogen Kit (Sigma-Aldrich Diagnostics, St. Louis, MO), without deproteinization. Urine samples were diluted 1:50 with deionized water. We assayed urinary ammonium N using the Kjeldahl procedure without the sulfuric acid digestion step. We analyzed nitrogen excretion for diet effects with a 3-way ANOVA without interaction effects using SAS (SAS Institute 1999). Diet, individual deer, and feeding trial period were main effects. We used Tukey's test for means separation. Results were considered significant at $P < 0.05$.

RESULTS

Total urinary N decreased as dietary guajillo increased ($F_{3,6} = 98.38$, $P < 0.001$; Table 1). Urea and ammonium urinary N also decreased as dietary guajillo increased ($F_{3,6} = 33.78$, $P < 0.001$), with diets containing 50 and 75% guajillo differing from the other two diets (Table 1). Uncharacterized N did not differ by diet ($F_{3,6} = 2.37$, $P = 0.169$), and the trend was opposite of that predicted if large amounts of non-protein N were being excreted in the urine.

Table 1. Urea, ammonium, uncharacterized and total nitrogen (N; $g \cdot day^{-1}$) for male white-tailed deer fed 4 diets containing guajillo in Kingsville, Texas.

Percent	Urea and ammonium		Uncharacterized N		Total N	
Guajillo[a]	Mean	SE	Mean	SE	Mean	SE
0	18.5 A[b]	1.2	8.5 A	1.7	27.0 A	0.8
25	17.3 A	0.7	5.6 A	1.0	22.9 B	0.4
50	11.7 B	1.1	5.9 A	0.6	17.5 C	1.5
75	8.0 B	1.1	4.6 A	0.3	12.7 D	1.2

[a] Percent guajillo in diets based on alfalfa hay to guajillo ration (dry mass: dry mass)
[b] Means in a column with different letters differ at the $P = 0.05$ level.

DISCUSSION

Declines in total urinary N and the sum of urea and ammonia N with increased dietary guajillo were expected because of the decline in dietary N from 4.1 to 3.1% in the 0% and 75% guajillo diets, respectively, and a decline in N digestibility from 75.9 to 40.5% in the 0% and 75% guajillo diets, respectively (Campbell 1999). Uncharacterized N, representing excretion of N containing secondary plant compounds as well as some products of normal metabolism, did not differ. This suggests that non-protein N in guajillo was not absorbed and excreted as uncharacterized N, at least not in large amounts. Instead, the non-protein N must have either not been absorbed, or was converted to amino acids by rumen microbes prior to absorption. Because digestible N was so low in guajillo containing diets (Campbell 1999), it seems most likely that most of the non-protein N was not absorbed.

Our results indicate that N absorbed from guajillo diets is predominantly in forms that can be converted to protein for use by deer. It does not appear that deer absorb large amounts of non-protein N that must be detoxified and excreted. Thus, even though the N in guajillo is not highly digestible, the N that is absorbed appears to be useful in protein synthesis. For this reason, and because guajillo is abundant in southern Texas and remains available during drought, it is beneficial in livestock and deer management.

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