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Correlation of Plant Condensed Tannin and Nitrogen Concentrations to White-Tailed Deer Browse Preferences in the Cross Timbers

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ABSTRACT

Chemical plant defenses such as condensed tannins (CT) have the potential to reduce insect herbivory. Condensed tannins sometimes also reduce ruminant herbivory as a result of decreased palatability and nutrient availability in gastro-intestinal systems. However, when consumed as 1-3% of diets, CT can be beneficial to ruminants as anthelminthics and by binding to plant proteins to enhance rumen-bypass protein. Given that plant nitrogen and CT are important ruminant nutritional factors, this study was designed to investigate correlations between deer browse preference and crude protein (CP) and/or CT concentration. In this study we collected 56 preferred warm-season white-tailed deer browse species within the cross-timbers region of Texas and analyzed for CT and CP concentrations. Plant CT varied from 78.4% to 0.5% (dry matter basis, *Schinopsis balansae* CT standard) and CP ranged from 23.8% to 5.0%. However, there was no correlation between plant CT or CP concentrations and published deer preference. Our study suggests that, while CT and CP may be important components of the white-tailed deer diet, preference is not based solely on CT or CP concentrations. Further research is needed to determine if plant maturity or surrounding vegetation confound correlations between white-tailed deer feed preferences and CT or CP in those selectively browsed plants. Use of a self-standard from each plant species to measure CT of that species may also change correlations.

KEY WORDS: condensed tannins, crude protein, forage preferences, white-tailed deer

INTRODUCTION

Condensed tannins (CT), which consist of polyphenolic compounds, are studied mainly because of their known anti-nutritional effects on both ruminants and monogastrics (Waghorn, 1996). Ruminants can, however, benefit from CT by protection of dietary protein from microbial degradation and helminthiasis (Iqbal et al., 2007). An increase in available protein has been reported to improve resistance to gastrointestinal nematodes (GIN) in sheep (Van and Skyes, 1996). Intestinal nematodes such as *Haemonchus contortus* can cause an increase in susceptibility to infections, poor growth rates, and overall decreased performance (Max et al., 2005).

Excessive herbivory resulting from high densities of white-tailed deer causes a decline in palatable forage occurrence (Eve et al., 1977). Concentrate eaters like white-

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tailed deer might have a depressed resistance to gastrointestinal nematodes when there is a decrease in available digestible protein (Iqbal et al., 2007). However, development of a relationship between plant CT and specific white-tailed deer browse preferences has not been identified. A better understanding of white-tailed deer preference for plant CT could be used to improve white-tailed deer herd health. Evaluating the CT concentrations in common deer browse species will also provide insight in developing feeds for livestock and the growing exotic wildlife industry.

Understanding metabolic compounds such as CT can be a useful tool when assessing forage quality. Condensed tannins decrease ruminal protein degradation and have antihelminthic effects at low concentrations in ruminant diets (Iqbal et al., 2007). Reduced rumen forage protein degradation is also a benefit of low CT concentrations, up to 5% using a self-standard, in the diet (Min et al., 2003). Plant nutritive values which may impact forage selection may also have anthelminthic properties and therefore should not be overlooked when assessing forages for nutritive value (Butter et al., 2001).

The objective of this study was to determine the correlation between CT or protein concentrations to published forage preference in white-tailed deer.

MATERIALS AND METHODS

Plants Used in Study. During the months of June, July, and August 2006 and 2007, 56 plant species were collected in Brown, Palo Pinto, and Erath Counties in central Texas. Plant collection sites ranged from heavily grazed to no livestock present within the last 10 years. Plant species were chosen based on published white-tailed deer plant preferences (Dillard et al., 2005). Condition, maturity, and location of hand-collected plants were recorded. Plants were identified at the sample site using Shinners and Mahler’s Illustrated Flora of North Central Texas (Diggs et al., 1999). Several samples were taken from each species within each county. Only leaf and shoot material was collected. All plants were collected in triplicate and immediately upon harvesting, sealed in a labeled 16.5 by 13.6 cm plastic bag and, stored on dry ice while in the field. Samples were subsequently stored at -20 ºC until further use.

Tannin and Crude Protein Assays. The plants were oven dried at 55ºC for a minimum of four days and ground, using a Wiley Mill, through a 1-mm screen. Material from each species was evaluated for total CT based on methods described by Terrill et al., (1992). A quebracho extract (*Schinopsis balansae)* standard (Traditional Tanners, Cave Junction, OR) was used for each plant sample rather than using a self-standard due to the large number of assayed species. Standard preparation was conducted by methods described by Wolfe et al. (2008); reported CT concentrations are relative to quebracho CT and should not be interpreted as absolute to that species (Wolfe et al., 2008). Nitrogen concentrations were estimated by combustion using a Vario Macro C-N Analyzer (Elementar, Mt. Laurel, NJ) and converted to CP concentrations by multiplying by 6.25 (Van Soest, 1994).

Preference Factors. For each grass, forb, and browse species two tables summarize CP and CT values based on white-tailed preferences measured in 1996 and 1997 (Dillard et al., 2005; Tables 1-6). Preference values varied between these two years and are based on rumen analysis, frequency of plant material present in rumen, and availability of the forage (Dillard et al., 2005)

Statistical Model and Analyses. The relationship of CP and CT concentration to previously reported plant preference (Dillard et al., 2005) was determined using the REG procedure of SAS. Separate analyses were conducted for 2006 and 2007 plant samples for each type of plant sampled (browse, forbes, and grasses).

Table 1. Preference factor, crude protein (CP; *P* =0.16, R^2=0.19, SE=0.06), and condensed tannin (CT; *P* =0.28, R^2= 0.11, SE=0.03) levels for 1996 preferred browse species

Plant Species	Classification	Preference	CP%	CT%
Phoradendron tomentosum	Browse	3.68	23.8	1.2
Rhus aromatic	Browse	2.20	9.0	5.0
Quercus fusiformes	Browse	2.09	9.1	8.0
Smilax bona-nox	Browse	1.24	11.1	15.2
Ulmus crassifolia	Browse	1.18	10.0	11.4
Ilex deciduas	Browse	0.85	11.9	1.3
Berberis trifolia	Browse	0.71	7.2	4.4
Forestiera pubescens	Browse	0.60	11.8	1.5
Juniperus ashei	Browse	0.50	7.5	18.3
Prosopis glandulosa	Browse	0.41	18.9	1.5
Bumelia lanuginose	Browse	0.35	12.8	32.0
Celtis laevigata	Browse	0.29	11.9	8.8

Higher preference factor values denote greater preference by white-tailed deer according to Dillard et al., 2005.

Table 2. Preference factor, crude protein (CP; *P* =0.47, R^2=0.03, SE=0.024), and condensed tannin (CT; *P* =0.26, R^2= 0.08, SE=0.007) levels for 1997 preferred browse species

Plant Species	Classification	Preference	CP%	CT%
Quercus fusiformes	Browse	1.29	9.1	8.0
Rhus aromatica	Browse	1.21	9.0	5.0
Rhus lanceolata	Browse	1.08	12.8	5.7
Phoradendron tomentosum	Browse	0.94	23.8	1.2
Ilex decidua	Browse	0.83	11.9	1.3
Smilax bona-nox	Browse	0.75	11.1	15.2
Ulmus crassifolia	Browse	0.71	10.0	11.4
Cercis canadensis var. *texensis*	Browse	0.67	10.4	10.5
Zizphus obtusifolia	Browse	0.50	11.9	38.6
Celtis laevigata	Browse	0.41	11.9	8.8
Cornus drummondii	Browse	0.39	7.9	1.7
Ungnadia speciosa	Browse	0.39	12.7	30.4
Forestiera pubescens	Browse	0.35	11.8	1.5
Rhus toxicodendron	Browse	0.32	12.3	8.9
Juniperus ashei	Browse	0.31	7.5	18.3
Fraxinus texensis	Browse	0.28	12.1	1.6
Bumelia lanuginosa	Browse	0.21	12.8	32.0
Berberis trifolia	Browse	0.16	7.2	4.4

Higher preference factor values denote greater preference by white-tailed deer according to Dillard et al., 2005.

Table 3. Preference factor, crude protein (CP; *P* =0.03, R^2=0.37, SE=0.038), and condensed tannin (CT; *P* =0.03, R^2= 0.38, SE=0.007) levels for 1996 preferred forb species

Plant Species	Classification	Preference	CP%	CT%
Lespedeza repens	Forb	2.67	16.9	78.4
Chamaecrista fasciculata	Forb	1.94	19.8	4.8
Rhynchosia spp.	Forb	1.60	18.1	1.3
Coreopsis wrightii	Forb	0.98	8.0	1.9
Chamaesyce prostrata	Forb	0.95	9.5	1.9
Eryngo leavenworrthii	Forb	0.86	9.4	1.1
Verbena bipinnatifida	Forb	0.84	9.7	1.1
Oxalis dillenii	Forb	0.73	12.7	4.9
Plantago spp.	Forb	0.69	6.4	1.4
Bifora americana	Forb	0.66	7.1	19.5
Tragia ramosa	Forb	0.40	11.5	24.0
Stillingia texana	Forb	0.27	15.6	2.0

Higher preference factor values denote greater preference by white-tailed deer according to Dillard et al., 2005.

RESULTS AND DISCUSSION

Evolutionary adaptations have allowed concentrate foragers such as white-tailed deer to thrive by consuming small quantities of highly nutritious plant material. For example, white-tailed deer avoid mature grasses because these require more rumination time and are typically less nutritious than forbs and legumes (Wilson, 1994). As a result, less than ten grass species appear on the preferred plant list (Dillard et al., 2005). This indicates a preference for more highly digestible plant material. Results from this study indicate that while CP may increase with increased preference values, CT levels have no apparent effect on preference.

Our results indicate that a correlation of preference to CP and CT does not exist for browse species (Tables 1 and 2). Forb and grass CP and CT did show a positive correlation to white-tailed deer preference although the R^2 values were low (Tables 3, 4, and 5). Although relationships between CT, CP, and preference factors did not support a strong correlation, it is important to note the presence of these factors in browse and forb species which make up the majority of white-tailed deer diets. Relationships between CT, CP, and preference factors may have resulted from limited plant species availability, plant maturity, and season of collection. Further studies looking at more species, locations, and a range of plant maturity should be conducted to better understand the correlation between plant quality and anti-quality factors with preference ratings. If funding allows, the use of self-standards for CT assay, as recommended by Wolfe et al. (2008), may also result in different levels of correlation between this plant component and other important factors such as CP and white-tailed deer preferences.

Table 4. Preference factor, crude protein (CP; *P* =0.4108, R^2=0.03, SE=0.45), and condensed tannin (CT; *P* =0.09, R^2= 0.13, SE=0.006) levels for 1997 preferred forb species

Plant Species	Classification	Preference	CP%	CT%
Chamaesyce prostrata	Forb	2.96	9.5	1.9
Lespedeza stuevei	Forb	1.95	12.5	78.4
Lespedeza repens	Forb	1.91	16.9	78.4
Dalea aurea	Forb	1.78	13.5	1.6
Erdodium texanum	Forb	1.64	11.6	5.2
Croton spp.	Forb	1.49	14.2	33.1
Erigeron strigosus	Forb	1.48	7.4	2.2
Chamaecrista fasciculata	Forb	1.40	19.8	4.8
Rhynchosia spp.	Forb	1.39	18.1	1.3
Desmanthus illinoensis	Forb	1.08	13.9	9.6
Dancus pusillus	Forb	1.01	7.9	1.6
Oxalis dillenii	Forb	0.86	12.7	4.9
Verbena bipinnatifida	Forb	0.83	9.7	1.1
Senna roemeriana	Forb	0.78	12.0	3.1
Crsium texanum	Forb	0.78	6.9	1.7
Ambrosia psilostachya	Forb	0.69	12.7	2.0
Coreopsis wrightii	Forb	0.62	8.0	1.9
Bifora americana	Forb	0.59	7.0	19.5
Verbena halei	Forb	0.59	9.5	1.6
Plantago spp.	Forb	0.52	6.4	1.4
Lactuca ludoviciana	Forb	0.50	17.1	1.8
Tragia ramosa	Forb	0.41	11.5	24.1
Stillingia texana	Forb	0.39	15.6	2.0

Higher preference factor values denote greater preference by white-tailed deer according to Dillard et al., 2005.

Table 5. Preference factor, crude protein (CP; *P* =0.18, R^2=0.40, SE=0.13), and condensed tannin (CT; *P* =0.70, R^2=0.04, SE=1.1) levels for 1996 preferred grass species

Plant Species	Classification	Preference	CP%	CT%
Dichanthelium oligosanthes	Grass	2.29	9.7	1.2
Elymus canadensis	Grass	1.68	6.5	1.2
Bouteloua hirsuta	Grass	1.14	10.0	1.3
Bouteloua curtipendula	Grass	1.06	5.9	1.2
Bouteloua rigidiseta	Grass	0.61	5.9	0.9
Schizachyrium scoparium	Grass	0.53	5.4	1.8

Higher preference factor values denote greater preference by white-tailed deer according to Dillard et al., 2005.

Table 6. Preference factor, crude protein (P =0.78, R^2=0.015, SE=0.07), and condensed tannin (P =0.84, R^2= 0.008, SE=0.36) levels for 1997 preferred grass species

Plant Species	Classification	Preference	CP%	CT%
Bouteloua curtipendula	Grass	1.00	5.9	1.2
Dichanthelium oligosanthes	Grass	0.88	9.7	1.2
Bouteloua rigidiseta	Grass	0.44	5.9	0.9
Elymus canadensis	Grass	0.39	6.5	1.0
Schizachyrium scoparium	Grass	0.16	5.4	0.5
Leptochloa dubia	Grass	0.16	5.0	0.7
Bothriochola saccharoides	Grass	0.15	5.8	1.8
Bouteloua hirsuta	Grass	0.08	10.0	1.3

Higher preference factor values denote greater preference by white-tailed deer according to Dillard et al., 2005.

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