https://doi.org/10.22319/rmcp.v14i1.5123

Technical note

Preference for eight plants among captive white-tailed deer *Odocoileus virginianus* in Veracruz, Mexico

Hannia Yaret Cueyactle-Cano [a]

Ricardo Serna-Lagunes [a]*

Norma Mora-Collado [a]

Pedro Zetina-Córdoba [b]

Gerardo Benjamín Torres-Cantú [a]

[a] Universidad Veracruzana. Facultad de Ciencias Biológicas y Agropecuarias región Orizaba-Córdoba, Calle Josefa Ortiz de Domínguez s/n Peñuela. Amatlán de Los Reyes, Veracruz, México.

[b] Universidad Politécnica de Huatusco. México.

*Corresponding author: rserna@uv.mx

Abstract:

Wild white-tailed deer *Odocoileus virginianus* consume a diversity of high energy plants. Captive deer, however, do not have access to this diversity, which may affect their productive capacity. A cafeteria test was used to evaluate intake of and preference for eight plant species among captive deer in Veracruz, Mexico. Three replicates were done of five consecutive days of feeding with the selected plants followed by a 15-d evaluation period. One kilogram of material from each plant species was offered each day and intake recorded. Physicochemical analyses were done of all eight species. Intake results were evaluated with an analysis of variance and a Tukey test, and a partial least squares regression analysis was applied to relate intake to plant characteristics. Intake was highest for four plants: *Zapoteca acuelata*, *Bidens pilosa*, *Pennisetum purpureum* and *Parthenium hysterophorus*. Preference for these species was determined by their fiber and protein contents, and °Brix and pH levels.

Diversifying the diet of captive deer could provide additional feed options for producers and increase animal productivity parameters.

Key words: Proximate analysis, Diet, Cervidae, Intake.

Received: 23/10/2019

Accepted: 20/08/2021

White-tailed deer (*Odocoileus virginianus*; Artiodactyla: Cervidae) is distributed throughout the Americas, from Canadian forests, to coniferous and xerophytic forests in the US, in most forests in Mexico and even in portions of South America[1]. It is widely hunted in Mexico[2], and is raised in Wildlife Conservation Management Units (Unidades de Manejo para la Conservación de la Vida Silvestre - UMA) to produce trophies, meat, skin, brood stock, and ornaments, among other products[3].

In the wild, *O. virginianus* is an opportunistic selective herbivore, foraging a selection of plant parts (e.g. shoots, fruits, leaves, bark, and seeds), especially those with high nutritional value[4]. When the dry season occurs in deciduous tropical forests plant abundance decreases and their nutritional quality diminishes[5]. Under these circumstances, *O. virginianus* can experience deficiencies in development, such as a lower than standard weight, become prone to disease and limit its reproduction[4]. These same responses are often observed in captive *O. virginianus*. Captive deer, fed diets based on sheep and commercial deer feeds as well as alfalfa[6], produce single rather than twin births, have low birth weight offspring, and longer intervals between births[7].

Adult deer require 5.5 to 9 % crude dietary protein for adequate physiological development[8,9]. Protein requirements may be related to ontogeny[9], since captive fawns require between 13 and 20 % protein for adequate development, while, for optimal antler development, 15 to 18 % protein is required[9]. Females require from 11 to 18 % protein in pre-breeding, mating, pregnancy, lactation, and to increase offspring count[10]. Diet diversification in *O. virginianus* UMAs is imperative to complement basic feed nutritional value and improve productive characteristics[11]. If animal feed preferences, nutrients contained in preferred plants and the nutritional requirements of animals at given weights can be interrelated, then animal productive behavior can be estimated[11].

Estimates of the nutritional content of plants consumed by wild deer have been done using various methodologies[12,13], but none have been done for captive deer. Cafeteria tests allow quantification and analysis of how animals modify dietary behavior to balance their nutritional needs. Essentially a multiple choice test, animals are offered one or several plants

and their nutritional preferences documented[14]. The present study objective was to use a cafeteria test to quantify the dietary preferences of captive *O. virginianus* offered eight plants as feed.

The study was carried out at the El Pochote UMA (Secretaría de Medio Ambiente y Recursos Naturales registry: UMA-IN-CR-0122-VER/og), located in Ixtaczoquitlán municipality, in the state of Veracruz, Mexico (coordinates: 18°52'13.70" N; 97°02'59.97" W; 1,137 m asl). Regional climate is predominantly semi-warm humid (Cwa) with abundant summer rains, an average annual temperature of 18 to 24 °C, and average annual rainfall of 1,900 to 2,600 mm. Vegetation near the UMA consists of remnant semi-evergreen tropical forest and secondary vegetation.

Experimental animals were two-year-old deer (3 males and 3 females, n = 6), all healthy and with similar body conditions. The cafeteria feeding trial was done over a 60-d period, that is, three replicates of 5 d feeding with the eight selected plants, followed by a 15-d evaluation. Feeding with the selected plants was done for five consecutive days at 0900 h. Independent feeders were randomly distributed within the pen, and 1 kg fresh material (leaves, shoots and green branches) from each of the tested plants placed in separate feeders (Table 1). To reduce animal subjectivity (deer tend to repeat feeding behaviors), feeder positions were changed daily. After 2 h, the feeders and the remaining plant material were removed from the pen. Intake was quantified with the equation consumption = grams material offered – grams material rejected.

Table 1: Intake (grams) of eight tested plants species by captive white-tailed deer *O. virginianus* during a cafeteria feeding trial

Plant species	Mean	Standard deviation	Standard error	Coefficient of variation	Min	Max
Bidens pilosa	999.6	0.69	0.4	0.07	998.8	1000
Bursera simaruba	516	112.93	65.2	21.89	393	615
Fetusca sp	594.4	44.39	25.63	7.47	559	644.2
Pennisetum purpureum	975.67	23.86	13.78	2.45	949	995
Phartenium hysterophorus	966.27	33.00	19.05	3.45	928.8	991
Saccharum officinarum	797.47	10.71	6.18	1.34	787	808
Vachelia farnesiana	616.4	43.99	25.4	7.14	587.2	667
Zapoteca acuelata	1000	0	0	0	1000	1000

Proximate analyses were done of the eight tested plant species. Three samples of 100 g of mixed material were collected from each plant and incinerated for 2 h at 600 °C. Organic matter, ash, °Brix, pH and acidity were estimated; crude protein was quantified with the Kjeldahl method (N x 6.25) and ether extract in a Soxhtel extractor[15]. The intake and physicochemical analysis data were analyzed with descriptive statistics using a central tendency. Intake levels by animal were analyzed with an analysis of variance (ANOVA) and a Tukey means test (α=0.05). A partial least squares (PLS) regression analysis was applied in which the dependent variable was intake per plant species, the categorical variables were the eight plants, and the predictor variables were each plant's physicochemical characteristics. All analyses were run with the Infostat ver. 2017 software.

The average intake results (Table 1) showed *Bursera simaruba* to have the highest coefficient of variation and the lowest average intake. The ANOVA identified *Zapoteca aculeata*, *Bidens pilosa*, *Parthenium hysterophorus* and *Pennisetum purpureum* as having the highest intake (correlation coefficient: R^2= 0.96, coefficient of variation= 5.94; P<0.05; Table 2). These levels exceeded those of the other evaluated plants (Tukey: minimum significant difference = 135.68 g, error= 2204.01, gl= 16; Figure 1). This is supported by the coefficients of variation, since only these four plants were clearly preferred by the animals. The tested plant species varied in terms of protein, fiber and °Brix (Table 3). The PLS regression analysis explained 61.7 % of the correlation for intake preference of *V. farnesiana*, *B. pilosa*, *Z. acuelata* and *S. officinarum*, which was related to fiber and protein contents and °Brix level (Figure 2).

Table 2: ANOVA results for plant intake by captive *O. virginianus*

Source of variation	Sum of squares	Degrees of freedom	Mean square	F	*P*-value
Plant species	883335.23	7	126190.75	54.77	<0.0001
Error	36864.08	16	2304.01		
Total	920199.31	23			

Figure 1: Tukey means test results identifying plants with highest intake by *O. virginianus*

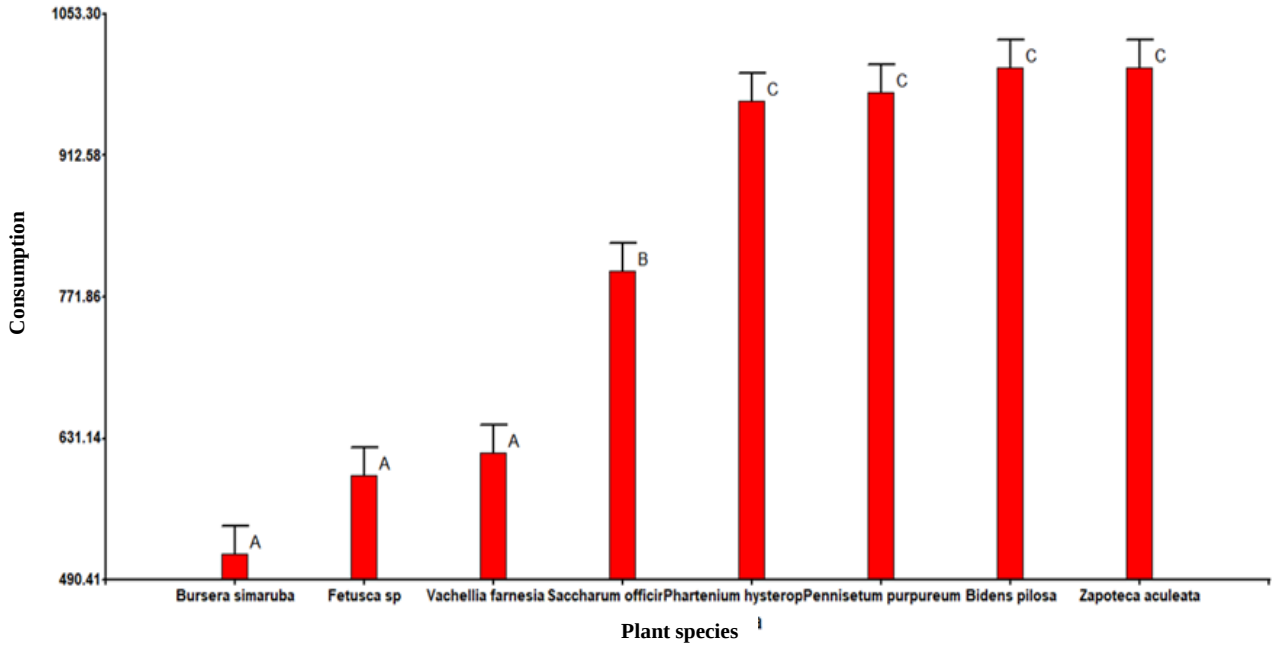
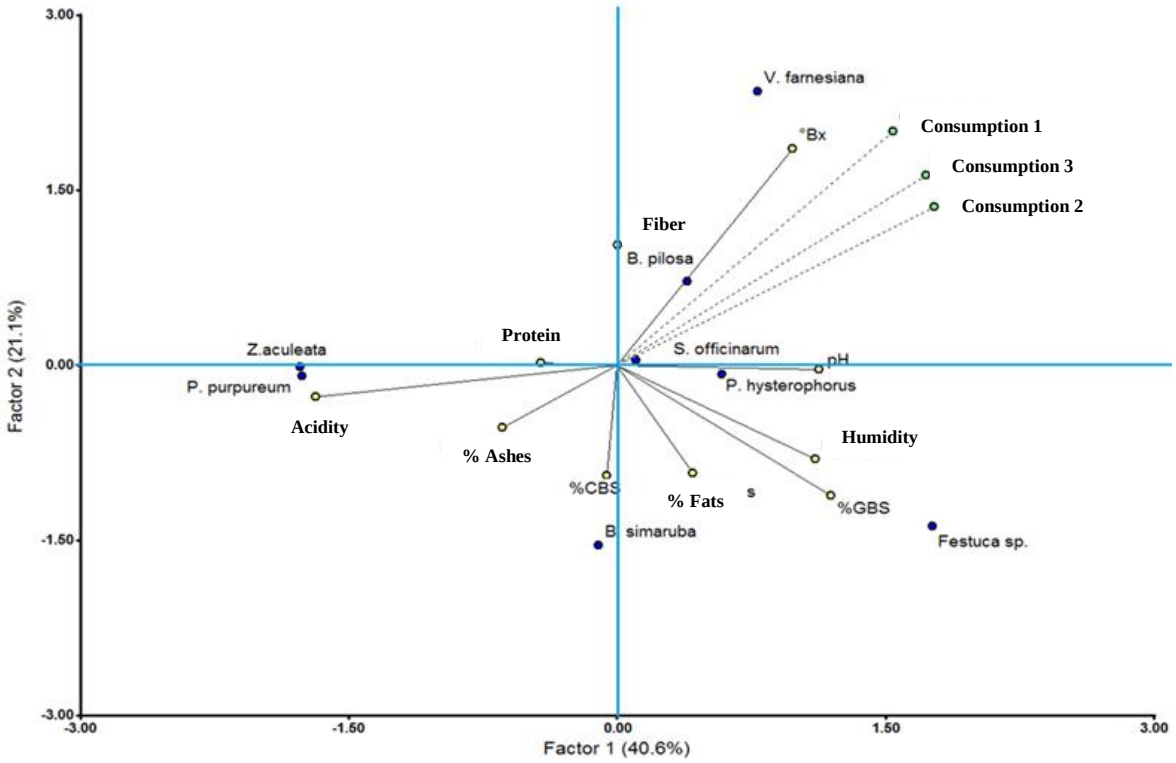


Table 3: Average physicochemical values of eight plants fed captive *O. virginianus*

Plant species	Moisture (%)	Protein (%)	Fat (%)	Fiber (%)	Ash (%)	pH	Brix (°)	Acidity
Bidens pilosa	48.937	18.15	4.728	23.94	1.505	5.5	7.8	0.224
Bursera simaruba	58.437	8.88	3.484	6.03	1.902	5.3	2.7	0.352
Phartenium hysterophorus	63.174	16.02	6.475	39.04	2.202	6.0	2.4	0.032
Saccharum officinarum	63.510	11.19	4.555	17.03	1.164	4.6	6.8	0.256
Vachellia farnesiana	48.016	18.1	0.474	29.04	2.245	5.0	4.5	0.192
Pennisetum purpureum	48.795	14.1	3.011	46.4	2.438	6.0	3.1	0.032
Zapoteca aculeata	41.771	20.5	5.224	22.06	0.352	4.5	9.3	0.64
Festuca sp.	32.375	15.02	6.873	48.02	1.432	4.3	7.8	0.16

Figure 2: Relationship of plant physicochemical characteristics to intake by *O. virginianus*



Of the tested plants, *Z. aculeata*, *B. pilosa*, *P. purpureum*, *P. hysterophorus* and *S. officinarum* were preferred by the captive *O. virginianus*. That these include two herbaceous plants and a grass is of note since wild deer consume mostly shrubs and trees, choose herbaceous species only seasonally, and consume few grasses throughout the year[16,17]. Voluntary consumption of bushy, herbaceous and grassy plants reflects nutritional need[18,19], and is focused on species with the best physicochemical characteristics[20], such as carbohydrates (°Brix) and fiber, both vital to digestibility[21].

All eight tested plant species meet deer protein requirements according to ontogenic stage. To reach above-average weight male deer require 15 % dietary protein[21], and females require 13 %[22]. In young males, optimal growth requires from 13 to 16 % protein, while 20 % will augment their reproductive activity[22].

These results suggest that at least five of the tested plant species could be used to diversify the diet of captive *O. virginianus*, which represents more dietary options for UMAs in this region. In addition, the tested plants have physicochemical characteristics that make them apt for use as deer feed while meeting the productive and reproductive requirements of *O. virginianus*.

Acknowledgements

The research reported here was financed by the project "Caracterización de recursos zoogenéticos de las altas montañas, Veracruz: aplicación de la filogeografía y modelación ecológica2 (PRODEP: 511-6/18-9245/PTC-896). The authors thank María del Rosario Dávila for carrying out the physicochemical analyses.

Literature cited:

1. Ortega S, Mandujano S, Villarreal J, Di Mare MI, López-Arévalo H, Molina M, Correa-Viana M. Managing White-tailed deer: Latín América. In: Hewitt DG editor. Biology and management of White-tailed deer. Boca Ratón, Fl, USA: CRC Press. 2011:565-585.

2. Mandujano S, Delfín-Alfonso CA, Gallina S. Comparison of geographic distribution models of white-tailed deer *Odocoileus virginianus* (Zimmermann, 1780) subspecies in Mexico: biological and management implications. Therya 2010;1:41-68.

3. Gallina S, Mandujano S, Bello J, López-Fernández H, Weber M. White-tailed deer *Odocoileus virginianus* (Zimmermann, 1780). In: Barbanti DJM, González S editors. Neotropical Cervidology: Biology and Medicine of Latin American Deer. FUNEP/IUCN. 2009:101-118.

4. Ramírez-Lozano RG. Nutrición del venado cola blanca. Universidad Autónoma de Nuevo León. Monterrey, Nuevo León, México. 2004.

5. Arceo G, Mandujano S, Gallina S, Pérez-Jiménez LA. Diet diversity of white-tailed deer (*Odocoileus virginianus*) in a tropical dry forest in México. Mamm 2005;69:159-168.

6. Fulbright TE, Ortega-Santos JA. Ecología y manejo de venado cola blanca. Texas A&M University Press. 2007.

7. Henke SE, Demaris S, Pfister JA. Digestive capacity and diets of White-tailed deer and exotic ruminants. J Wild Management 1998;52:595-598.

8. Holter JB, Hayes HH, Smith SH. Protein requirement of yearling white-tailed deer. J Wild Management 1979;1979:872-879.

9. Smith SH, Holder JB, Hayes HH, Silver H. Protein requirements of white tailed deer fawns. J Wild Management 1975;39:582-589.

10. Jones PD, Strickland BK, Demarais S, Wang G, Dacus DC. Nutrition and ontogeny influence weapon development in a long-lived mammal. Canad J Zool 2018;99:1-8.

11. Plata FX, Ebergeny S, Resendiz JL, Villarreal O, Bárcena R, Viccon JA, Mendoza GD. Palatabilidad y composición química de alimentos consumidos en cautiverio por el venado cola blanca de Yucatán (*Odocoileus virginianus yucatanensis*). Archiv Med Vet 2009;41:123-129.

12. Miller R, Kaneene JB, Fitzgerald SD, Schmitt SM. Evaluation of the influence of supplemental feeding of white-tailed deer (*Odocoileus virginianus*) on the prevalence of bovine tuberculosis in the Michigan wild deer population. J Wild Dis 2003;39:84-95.

13. Champagne E, Moore BD, Côté SD, Tremblay JP. Spatial correlations between browsing on balsam fir by white-tailed deer and the nutritional value of neighboring winter forage. Ecol Evol 2018;8(5):2812-2823.

14. Hartley A, Jones GE. Process oriented supplier development: building the capability for change. Inter J Purch Mat Management 1997;33:24-29.

15. AOAC. Official Methods of Analysis. Association of Official Analytical Chemists. 15th ed. Washington, DC, USA. 1990.

16. Gallina S. White-tailed deer and cattle diets in La Michilia, Durango, Mexico. J Range Management 1993;46:487-492.

17. Granados D, Tarango L, Olmos G, Palacio J, Clemente F, Mendoza G. Dieta y disponibilidad de forraje del venado cola blanca *Odocoileus virginianus thomasi* (Artiodactyla: Cervidae) en un campo experimental de Campeche, México. Rev Biol Trop 2014;62:699-710.

18. Ramírez GR, Quintanilla JB, Aranda J. White-tailed deer food habits in northeastern Mexico. Small Ruminant Res 1997;25:141-146.

19. López-Pérez E, Serrano-Aspeitia N, Aguilar-Valdés BC, Herrera-Corredor A. Composición nutricional de la dieta del venado cola blanca (*Odocoileous virginianus* ssp. *mexicanus*) en Pitzotlán, Morelos. Rev Chap serie Cienc Forest Amb 2012;18:219-229.

20. Aguilera-Reyes U, Sánchez-Cordero V, Ramírez-Pulido J, Monroy-Vilchis O, García-López GI, Janczur M. Hábitos alimentarios del venado cola blanca *Odocoileus virginianus* (Artiodactyla: Cervidae) en el Parque Natural Sierra Nanchititla, Estado de México. Rev Biol Trop 2013;61:243-253.

21. Clemente F, Riquelme E, Mendoza GD, Bárcena R, González S, Ricalde R. Digestibility of forage diets of white-tailed deer (*Odocoileous virginianus*, Hays) using different ruminal fluid inocula. J Appl Anim Res 2005;27:71-76.

22. Ullrey DE, Youatt WG, Johnson HE, Fay LD, Bradley BL. Protein requirement of white-tailed deer fawns. J Wild Management 1967;31:679-685.