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Evaluation of Feeding Management in Three White-tailed Deer Breeding-places (*Odocoileus virginianus yucatanensis*) in Yucatan, Mexico

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Abstract: White-tailed deer breeding in captivity is taking relevance in Mexico. However, few studies exist on the adequacy of the nutritional management used in most breeding places. The objective of the present study was to assess feeding practices employed in captivity and to relate this aspect with the reproductive success of three Breeding Places (BP). It was found that voluntary intake fluctuated between 0.64 - 2.16 kg DM/animal/day, the average was 1.24, 0.93 and 0.89 kg for BP1, BP2 and BP3, respectively. Dry Matter (DM) apparent digestibility was found to be 64.58% in BP1, 58.63% in the BP3 and 39.31% in BP. All diets covered the DM, Crude Protein and Neutral Detergent Fibre requirements, but not those of calcium and phosphorus. No apparent effects were found in the reproductive parameters due to differences in feeding management. The need to improve general management aspects has priority to nutritional aspects in all three BP.

Key words: Mexico, feeding management, intake, proximate analysis, apparent digestibility

Introduction

Mexico is considered a country of great biodiversity, within its indigenous fauna, cervids like the white-tailed deer has demonstrated to be more economic and ecologically productive than some domestic species since ancestral times (Hopcraft, 1975; Ehnis, 1996). The yucatecan native white tailed deer (*Odocoileus virginianus yucatanensis*) has been considered an endangered sub specie due to severe hunting practices, a situation that has made necessary to design alternatives for its conservation (Carrillo, 1987; Ehnis, 1994).

The establishment of farms (governmentally approved) has been encouraged in recent years (Almaraz and Navarrete, 1996; Navarrete, 1998) in order to alleviate the pressure upon its numbers in the wild. However, most of the incipient farms are been set without adequate knowledge of deer biology. In order to establish proper management practices it is necessary to gather information on all aspect of deer biology including the behavior and performance of this specie in captivity. It is required to clearly state management practices in order to obtain authorization for such type of farms (Ocampo and Cid, 1982; Remolina, 1996; Lafon, 1998). Information of this kind could serve as quick baseline to improve practices.

The objective of this study was to evaluate the nutritional management and identify problems in three white-tailed deer breeding-places in the state of Yucatan, México.

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Materials and Methods

Description of the Breeding-places

The climate of the state of Yucatan is warm, with rains in summer and annual mean temperature of 26°C (Duch, 1991). During the year 2000, the breeding-places were visited once by week during eight months, which included four months of both dry and rainy season.

Breeding Place 1 (BP1) has a population of 22 animals divided in female and males. It has three enclosures with wild vegetation, water trough (80 L) and three plastic feeders with 498 lineal cm in both sides: ramon (*Brosimum alicastrum*) is used as forage in the dry season while grazing takes place during rainy the season. A mixture of cereals and commercial feed is offered on a daily basis (500 g/animal/day). Vitamins and minerals blocks are also provided. The animals are treated for external and internal parasites, antlers are cut and weighed annually.

BP2 has a population of 13 animals housed in 2080 m². It has water trough (39 L) and a feeder with 332 lineal cm in both sides. The animals are not subjected to any kind of management. Animals had free access to ramon, in addition 200 g/animal/day of maize grain are also offered.

BP3 has 23 animals housed in 1,326 m². It has water trough (22 L), maize is provided directly into the ground as it has no feeders. The animals are not subjected to any kind of management. Twice a week ramon is offered and 500 g/animal of maize grain is supplied everyday.

Voluntary Intake

Total voluntary intake was registered weekly by groups and then averaged for individuals due to the lack of facilities to monitor individual intakes. In BP1, the determination of the intake in the enclosure was made based in the number of bites per minute, bite average weigh (Wallis, 1995) and time spent feeding during the day. In order to carry out this determination, ingestive behaviour was monitored during grazing up to totaling 24 h grazing; bite size was simulated after careful observation of the deer feeding habits (Verme and Ullrey, 1974; Nagy and Haufler, 1980). Detailed procedure was as follows; An adult male was followed in 4 h periods for 5 days (including night hours) and behaviour recorded at 1 min intervals. The activities were classified as a) feeding, b) ruminating, c) spatial movement (walking, running), d) resting, e) comfort (defecating, urination, self grooming, scratching) and e) social interaction (licking another deer, communication, physical contact). The number of bites per minute was recorded in 2 males and 4 females during 3 h in the morning and 3 h in the afternoon until a total of 90 observations for both males and females were achieved. Biting rate was compared between males and females using a t-test. Samples (n = 112) were taken by the hand-plucking technique (Wallis, 1995) simulating bite size and used to estimate DM intake.

Chemical Analysis

Monthly samples were obtained for ramon (*B. alicastrum*) or the enclosure vegetation and analyzed for: Dry Matter (DM), Crude Protein (CP), Neutral Detergent Fiber (NDF), Calcium (Ca) and Phosphorus (P) content (AOAC, 1980). The concentrated feed and cereals were analyzed three times (beginning, middle and end of monitoring period).

Diet Digestibility

Four fecal samples were taken by breeding-place and by season; together with samples of the feeds and analyzed for Acid Insoluble Ash (AIA) (silica). The result were employed in order to

calculate diet DM apparent digestibility (DMD) according to the following formula (Owens and Hanson, 1991):

$$\text{DMD} = 100 - (100 \times \text{feed concentration AIA}) / \text{digesta concentration AIA}$$

Statistical Analysis

Births, fawns by litter, fawns weaned and nutrients supplied by the diets were compared between BP and literature. Analyses of variance and Duncan multiple comparison test were carried out. For the analyses of the forage quality the breeding-place and season effects were included; while for concentrate quality and DM intake only the BP effect was included. DMD was compared between BP, season and interaction season *BP.

Results and Discussion

Feeds and Feeding Management

Table 1 presents the average and standard deviation of the proximate analysis of the forage and concentrated by BP and nutrient analyzed. From May onwards, the BP1 natural vegetation was grazed and this caused a reduction in DM and CP content of the forage but increased NDF and phosphorus. In spite of the oscillations on vegetation quality, only NDF was significantly different.

The feeding schedule in the breeding-places is considered convenient. The diurnal temperature did not seem to affect the intake in BP1 and BP2, since in both cases the animals had enough shade. However in BP3, animals might require provision of additional shade (Wallach, 1974). BP3 did not have feeders and in BP2 the number was insufficient, since each animal had 25 cm linear. In both cases the water supply was also inadequate. The feeders of BP1 were considered adequate in number, material and distribution (Wallach, 1974; Ffolliot and Galina, 1981). A general problem detected was related with the uncertainty of obtaining enough forage for feeding the animals, due to availability, transportation, or labor. To avoid such situation it would be convenient for each BP to secure its own source of forage.

Feed Intake

The behavior of white tailed deer in BP1 is presented in Table 2, it present a peak of feeding activity around 12 and 16 h associated with provision of supplemental feeding which probably encourages the beginning of a feeding bout. An additional peak of feeding was observed during the night. Resting was the main activity and comprised 51% of total time. Rumia was only observed during the morning as was not observed thereafter. In order to establish adequate management practices it will be necessary to assess whether this was a normal behaviour or caused by the captivity conditions.

The estimated bite size was $1.05 \pm \text{SD } 0.18$ g DM ($n=112$). Males having a higher biting rate than females (10.3 ± 2.54 vs $7.1 \pm \text{SD } 2.80$ pooled SD 2.68) ($p>0.001$). It was difficult to assess if the difference was due to males bigger body size which might drive to a potential higher intake (3.85 vs 2.63 kg DM). A total of 356 min were devoted to feeding during the day. Intake estimates for BP1 were similar to those reported by Remolina (1996) from 1.2 to 3.2 kg DM/animal/day as group averages (same deer subspecies in a neighboring state).

Table 3 presents the averaged individual voluntary intake of DM, CP, NDF, Ca and P by nutrient and BP. Significant differences were found in the intake of all nutrients except in calcium intake. In

Table 1: Forage (F) and Concentrated (C) mean chemical composition in three breeding places in South East Mexico

	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
	MS	MS	MS	PC	PC	PC	NDF	NDF	NDF	Ca	Ca	Ca	P	P	P
F	35.6a	35.8a	38.2a	13.6a	16.6a	16.1a	50.9a	39.0b	41.6ab	1.03 ^a	1.05a	1.09a	0.45a	0.25a	0.27a
Sd	11.3	3.99	7.01	2.53	1.60	1.59	14.7	2.56	6.88	0.48	0.34	0.51	0.36	0.11	0.11
C	91.8a	93.1a	90.5a	16.1b	8.38a	8.69a	-----	-----	-----	1.24 ^a	0.23a	0.62a	0.51a	0.31a	0.22a
Sd	1.78	1.90	2.46	2.09	0.56	0.75	-----	-----	-----	0.60	0.09	0.76	0.27	0.11	0.10

1) BP1 2) BP2 3) BP3, ab. Mean values without the same letter are significantly different ($p < 0.05$)Table 2: Time budget (min h⁻¹) of captive white tailed deer (*O. virginianus yucatanensis*) in an enclosure with grass and natural vegetation

Hour of the day	Resting	Feeding	Rumia	Comfort	Moving	Socializing
1	20	21	4	7	7	1
2	19	30	0	4	3	4
3	54	3	0	3	0	0
4	58	2	0	0	0	0
5	52	0	8	0	0	0
6	32	7	18	3	0	0
7	34	13	10	3	0	0
8	3	15	27	10	0	5
9	19	9	22	5	3	2
10	23	0	25	7	5	0
11	29	3	18	3	4	3
12	5	25	12	7	7	4
13	20	21	11	3	3	2
14	33	19	0	3	5	0
15	22	27	0	8	3	0
16	49	10	0	0	0	1
17	32	8	0	9	2	9
18	48	0	0	8	0	4
19	60	0	0	0	0	0
20	25	33	0	2	0	0
21	60	0	0	0	0	0
22	32	22	0	0	6	0
23	7	48	0	0	2	3
24	13	40	0	1	5	1
Total	749	356	155	86	55	39
%	51	25	11	6	4	3

Table 3: Individual daily Dry Matter (DM) Crude Protein (CP), Neutral Detergent Fibre (NDF) (kg d⁻¹) and mineral (g d⁻¹) intake per month and breeding-place

	1	2	3	1	2	3	1	2	3	1*	2	3	1*	2	3
	MS	MS	MS	PC	PC	PC	NDF	NDF	NDF	Ca	Ca	Ca	P	P	P
Jan	0.93	1.16	1.15	0.14	0.16	0.15	0.18	0.24	0.23	6.25	6.00	2.00	5.25	3.00	2.00
Feb	1.03	0.65	0.95	0.15	0.09	0.12	0.20	0.15	0.14	7.25	4.00	6.00	4.75	2.00	3.00
Mar	0.97	0.84	0.95	0.15	0.11	0.11	0.17	0.23	0.16	6.00	9.00	8.00	4.75	3.00	3.00
Apr	0.87	0.92	0.80	0.14	0.13	0.10	0.14	0.24	0.10	7.25	10.0	4.00	5.00	2.00	2.00
May	1.75	0.89	0.89	0.10	0.13	0.11	0.20	0.22	0.13	10.2	6.00	13.0	3.75	4.00	2.00
Jun	1.47	0.93	0.80	0.08	0.15	0.09	0.21	0.30	0.11	6.75	10.0	9.00	4.25	4.00	2.00
Jul	1.55	1.03	0.93	0.08	0.16	0.11	0.28	0.33	0.11	4.5	7.00	6.00	1.75	1.00	2.00
Aug	1.32	1.04	0.64	0.06	0.13	0.06	0.21	0.33	0.12	3.25	5.00	3.00	1.75	1.00	1.00
Mean	1.24a	0.93b	0.89b	0.11a	0.13a	0.11b	0.20b	0.25a	0.14c	6.44a	7.12a	6.37a	3.91a	2.50b	2.12b
SD		0.15	0.15		0.02	0.03		0.06	0.04		2.29	3.6		1.19	0.641

1) BP1 2) BP2 3) BP3, * mineral supplements were not included, abc. Mean values without the same letter (s) are significantly different ($p < 0.05$)

Table 4: Estimated daily requirements of dry matter, crude protein, neutral detergent fiber, calcium and phosphorus in white-tailed deer for the different categories (Wallach, 1974; Klós and Lang, 1982; NRC, 1984)

Live weigh (LW)	DM (kg) 2-4% LW	CP (kg) 13-20%	Fibre (kg) 7%	Ca (g) 1.2%	P (g) 0.7%
14.5	0.58	0.07-0.12	0.04	7	4
35.5	0.71	0.10-0.14	0.05	8	5
40.8	0.82	0.11-0.16	0.06	10	6

Table 5: Results of the apparent dry matter digestibility (%) of the diets in the three breeding-places

Season	BP1	BP2	BP3	Mean
Dry	75.18±2.93	29.06±5.08	60.19±4.18	54.81a
Rainy	53.98±23.38	49.57±22.80	57.08±6.69	53.54a
Mean	64.58a	39.31b	58.63a	

ab. Mean values without the same letter (s) are significantly different ($p < 0.05$)

order to evaluate the nutritional management, animal weights and average voluntary intake are needed. Thus, weights for the different categories of *O. virginianus yucatanensis* (Hernandez *et al.*, 1998) were taken from literature reports as: 14.5 kg in juvenile animals, 40.8 kg in males adult and 35.5 kg in females adult. Based on these weights, the estimated requirements of DM, CP, FDN, Ca and P are given in Table 4.

The monthly variation in dry matter intake in all BP's was due to forage supply which was not constant. The average daily intake registered in the three BP ranged from 0.64 to 2.16 kg (0.75-2.16, 0.65-1.16, 0.64-1.15, for BP1, BP2 and BP3, respectively). The intake was higher in BP1 due to the higher contribution of concentrated feed. The estimates intakes agree with previous reports (Remolina, 1996) who found intakes of 1.2-3.2 kg DM/day.

Considering the maximum protein requirement (20%), in BP1, females had a potential deficit during the last months of observation when the ramon was not supplied, although this intake could be compensated due to the availability of native vegetation. In BP2, the protein content in the diet was within the recommended range, with the exception of February when the contribution of forage is reduced. In BP3 there was a deficit of this nutrient in May and August. In all BP's the diet covered the fiber requirement (Klos and Lang, 1982). However, it did not cover the Ca and P requirements. The deficit was large and lead to think on implementing mineral supplementation strategies (Remolina, 1996; Klos and Lang, 1982; Van soest, 1982; Robbins, 1993). However, more detailed studies have to be carried out on this aspect.

BP1 diet had a higher DMD which was no significantly different to the BP3 diet and were close to the 66% DMD recommended for deer (Klos and Lang, 1982) (Table 5). Ruggiero and Whelan (1976) reported 69.2 and 73.2% of *in vivo* (true) dry matter digestibility in two animals: female and male respectively. In that experiment the pelleted ration had a higher crude protein percentage than the diet offered in the three BP in the present study. Ruggiero and Whelan (1976) did not reported differences between sex and both animals were 17 month old, while in the present study, the animals were older and included both sexes. Nevertheless DMD was similar to the value reported in the literature. BP1 diet had an average of 39.31% DMD, lower ($p < 0.05$) than the other two BP. This result is lower than expected, as the diet composition was similar between BP and there were no apparent reason for such low values.

Table 6 compares does' behavior in the three BP with the literature parameters: 85% of litters, 1.5 fawns by female, 25% of mortality in the first month and 50% twin litter in 2nd and 3rd litter (Rogel and Lujan, 1982). BP1 reproductive performance was as expected. In BP2, the number of litters

Table 6: Comparison between expected and recorded reproductive parameters in the three breeding-places

	Litters*	Litters**	Fawns*	Fawns**	Mortality*	Mortality**
BP1	4	4	6	7.5	1.5	1
BP2	7	9	10.5	11	2	2
BP3	7	4	10.5	6	3	2

*Expected parameters, **Recorded parameters

was higher, since two precocious females gave birth. Taking out the precocious females the number of fawns was smaller by 1.5. This was an effect due to the lower percentage of twin litters (22.2%). Although it did not appear to be an effect due to undernourishment as the number of litters corresponds to the literature parameters (Halls, 1978; Ffolliot and Galina, 1981; Teer and Vaaughan, 1994) a mineral deficiency effect must not be ruled out. BP3 presented a different problem, as half of the females were considered to be in mating age (2 years old), 57% of fertility was obtained. This equals to 3 liter and 4.5 fawns less than expected from the literature parameters. This can be due to the improper female:male relationship found, alternatively infertility problems could be present and related to the mineral status of the animals. However, detailed studies would need to be conducted to clearly assess the causes.

Conclusions

Time budget can be used as a tool to assess nutritional status of white tailed deer. Additional studies are needed on diet quality of captive white tailed deer. Diets from the BP evaluated (Yucatán, México) covered the requirements of MS, CP, FDN, but not those of calcium and phosphorus, therefore more detailed analyses on the mineral status must be carried on. Current (traditional) feeding practices in Mexican (Yucatan) farms appears to be adequate in the BP's studied. However, close monitoring must be undertaken to avoid future nutritional problems as animal population increases.

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