The Influence Of Plant Chemistry On Browse Choice In Angolan Colobus Monkeys (*Colobus angolensis palliatus*)

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INTRODUCTION

Browse is included in the diets of many primate species, especially those that consume large portions of leaf material under free-ranging conditions. The challenge of providing a reliable source of browse is complicated by the limited availability of plant species that are nutritionally adequate, palatable, and available in suitable quantities to meet the demands of the animal collection.

Palatability studies can provide important insight into the factors that influence preference and acceptance of new foods, including browse, by primates and other animals species.

The information compiled in the present study provides further data on composition of plant materials commonly used as browse by the Zoological Society of San Diego (ZSSD). Determining palatability and preference of browse species offered to leaf-eating primates is also an essential component of selecting trees to be grown for future exhibits.

The objectives of the project were to: 1) Evaluate the palatability of a new browse species (*Tipuana tipu*) as compared to two other species (*Ficus benjamina, Ficus rubiginosa*); 2) Accumulate additional data on the nutrient content of browse plants used in ZSSD feeding programs; and 3) Assess the influence of specific nutrients (e.g., cellulose, lignin) on browse preference across these three plant species.

MATERIALS AND METHODS

Animals

The feeding trials were conducted with a social group of Angolan colobus monkeys (*Colobus a. palliatus*), 4 ♂♂, 4♀♀ and 1 neonate. (Table 1). There was no alteration in the regular diet or routine husbandry of the group for the duration of the study.

Browse species

Three browse species, *Ficus benjamina*, *Ficus rubiginosa*, and *Tipuana tipu*, were rotated through designated feeding locations within the exhibit, with the position of each plant species being randomly predetermined (Fig. 1). This random rotation was to eliminate the potential for any location-based bias that may influence food choice. Five, 1-m pieces of each type of browse were offered at each observed feeding. Prior to this study, the browse portion of the diet consisted predominantly of *Hibiscus* sp., *Ficus* sp., *Eugenia* sp., and *Morus alba*. The group had not been exposed to *T. tipu* prior to this study.

Observations

There were a total of 12 observation sessions conducted between 04-Feb-00 and 01-Apr-00. The beginning of each 60-minute observation session coincided with the release of the animals into the browse-provisioned exhibit. Keepers notified the observer prior to releasing the animals into the enclosure. The scan sample method was used throughout the session. The number of animals consuming each type of browse was recorded at the beginning of each 60-second interval.

Laboratory Analysis

Leaf, or leaflet, samples were collected from each browse species once weekly for laboratory analysis. Fresh samples were weighed, oven dried at 50°C to a constant weight, and ground to pass through a 1 mm screen using a laboratory mill (Thomas-Wiley). Sub-samples were dried in a vacuum oven overnight (100°C) to determine final dry matter content and then subsequently placed in a muffle furnace (600°C) for a minimum of 5 h to determine total mineral (ash) content (AOAC, 1995)

Fiber components, including neutral detergent fiber (NDF), acid detergent fiber (ADF), and acid detergent lignin (ADL) were determined by using sequential detergent fiber analysis as described by Goering and Van Soest (1970). NDF, ADF, and ADL were calculated as a percent of dry matter. Hemicellulose (HC) and cellulose (C) were determined by the differences between NDF and ADF, and ADF and ADL, respectively.

Statistical analysis

Chi square analysis, based on total number of observed feeding bouts, was used to determine the differences in preference of browse species offered.

RESULTS

The values summarized in Table 2, indicate that the *Colobus a. palliatus* housed at Gorilla Tropics exhibited specific preferences among the three browse species offered. The group consumed *T. tipu* at a significantly higher frequency ($P < 0.01$) than *F. rubiginosa* and *F. benjamina*. The animals also chose *F. rubiginosa* for a significantly higher number of feeding bouts than ($P < 0.01$) than *F. benjamina*.

Mean concentrations of ash, moisture, and fiber components of leaves collected from the three browse species studied are provided in Table 3. *Tipuana tipu* contained the lowest levels of NDF (32.4%), ADF (21.7%), and ADL (9.7%), and was also preferred when fed concurrently with *F. rubiginosa* and *F. benjamina*. Although higher levels of fiber can indicate decreased digestibility in some species, colobine primates are highly adapted to utilize fibrous foods (Edwards and Ullrey, 1999). It must also be noted that *F. rubiginosa,* containing higher levels of NDF (50.0%), ADF (40.6%), and ADL (24.5%), was preferred over *F. benjamina*. This finding is somewhat contrary to what was anticipated, as species will typically avoid high lignin levels, when lower levels are available.

DISCUSSION

Many factors can affect palatability and preference of browse species, although plant cell wall constituents and secondary plant metabolites are thought to be two primary feed intake regulators for herbivores. Feeding preference was indirectly related to only two measured nutrients, cellulose and ash.

Although this trial represented the first exposure of these animals to *T. tipu* as a browse plant, the sustained level of response observed across the study period and a favorable nutrient composition of the plant, indicates that this species has potential as an important food source for additional species within the collection. Further study is necessary to determine the overall application of this plant species.

CONCLUSIONS

1. Although all species of browse were readily consumed (i.e., palatable) by the animals in this study, *Tipuana tipu* was preferred when the opportunity to make a choice was available.
2. Lower fiber and lignin concentrations were present in the most preferred browse species, but concentrations of those nutrients did not appear to influence preference between the remaining two species offered.
3. Other chemical components not measured, such as secondary plant compounds, may be influencing preference, but did not appear to have a negative influence on palatability of the three species offered.

REFERENCES

[AOAC] Association of Official Analytical Chemists. 1995. Official Methods of Analysis, 16th ed., AOAC: Washington, DC.

Edwards MS, Ullrey DE. 1999. Effect of fiber concentration on apparent digestibility and digesta passage in nonhuman primates. II. Hindgut and foregut fermenting folivores. Zoo Biol 18:537-549.

Goering HK, Van Soest PJ. 1970. Forage fiber analysis (apparatus, reagents, procedures, and some applications). USDA Agricultural Research Service. Agriculture Handbook No. 379.

TABLE 1. Identification, gender, birth date, and ID of eight *Colobus angolensis palliatus* included in a browse preference study.

Accession No.	Gender	Birth Date	ID
M 0689505	M	01 Jan 1985	WAP01
M 0689506	F	01 Jan 1985	WAP02
M 0689546	F	01 Jan 1985	WAP04
M 0595385	F	09 Sep 1995	SDZ05
M 0597433	F	22 Nov 1997	SDZ10
M 0598070	M	23 Mar 1998	SDZ11
M 0599096	M	14 Apr 1999	SDZ12
M 0599210	M	12 Jun 1999	SDZ13
M 0500029	F	6 Feb 2000	SDZ14

TABLE 2. Total and mean number of feeding bouts by *Colobus angolensis palliatus* on each browse species during the 12 observation sessions.

	Tipuana tipu	*Ficus rubiginosa*	*Ficus benjamina*
Total	1586	889	438
Average (per session)	132	74	40

TABLE 3. Mean moisture, ash and fiber composition of mature leaves or leaflets from three species of offered to *Colobus angolensis palliatus*.

Species	%, Moisture	%, dry matter basis					
		Ash	NDF[1]	ADF	ADL	HC	C
Tipuana tipu	62.7	6.88	32.4	21.7	9.7	10.8	12.0
Ficus rubiginosa	71.7	7.82	50.0	40.6	24.5	8.8	16.7
Ficus. benjamina	66.2	9.33	46.5	33.3	15.1	13.2	18.2

[1]NDF=neutral detergent fiber; ADF=acid detergent fiber, ADL=acid detergent lignin, C=cellulose.

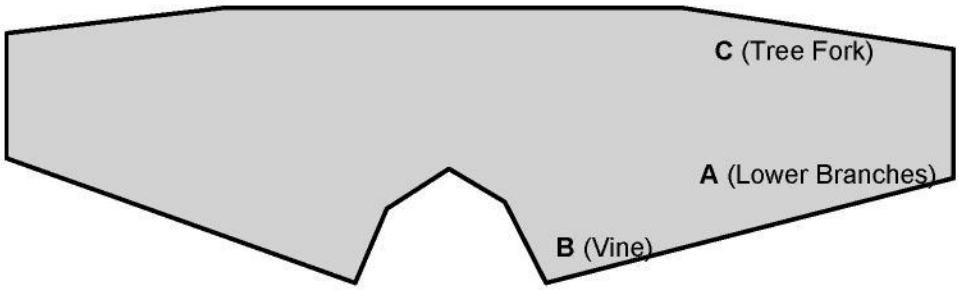

Fig. 1. Schematic of Gorilla Tropics *(Colobus a. palliatus*) exhibit and browse presentation.