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Notes and records

Feeding ecology of olive baboons (*Papio anubis*) in Kibale National Park, Uganda: preliminary results on diet and food selection

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Introduction

Essential to an understanding of the ecology of any organism is knowledge of nutritional aspects of their diet, as adequate nutrition is critical for successful reproduction (Barboza, Parker & Hume, 2009). While the feeding and nutritional ecology of baboons (*Papio*) has been widely documented (Norton *et al.*, 1987; Whiten *et al.*, 1991; Barton *et al.*, 1993; Byrne *et al.*, 1993; Altmann, 1998; Kunz & Linsenmair, 2008; Swedell, Hailemeskel & Schreier, 2008; Bentley-Condit, 2009), most research on olive baboons *(P. anubis*) has focused on savannah-dwelling populations, with comparatively little research in forested habitat (Rowell, 1966, 1969; Okecha & Newton-Fisher, 2006; Paterson, 2006; Ross *et al.*, 2011). Here, we report preliminary results on diet and nutritional ecology of forest-dwelling olive baboons in Kibale National Park, Uganda. Additionally, we report a preliminary assessment of the baboons' nutritional objectives by comparing the nutrient content of consumed foods with that of parts rejected in food preparation. Food selectivity in olive baboons has been previously studied by Barton & Whiten (1994), who compared the nutrient content of seven matched foods and discarded nonfoods in savannah-dwelling olive baboons, and found foods to be higher in protein and lower in both fibre and phenolics than nonfoods. Here, we report preliminary results on food choice in forest-dwelling olive baboons to further elucidate macronutrient properties governing diet selection in this species.

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Materials and methods

We studied a group of 64 olive baboons at Kanyawara, Kibale National Park, Uganda (0.13–0.41°N; 30.19–30.32°E). The group ranges entirely within the park and does not raid crops. As part of the habituation process, CAJ and two field assistants (Moses Musana and James Magaro) followed the group from dawn to dusk from 5 m for at least three consecutive days per month from July 2009 to July 2010. All foods consumed were identified and documented as feeding events on an all occurrences basis during this annual period. In July 2010, we followed the group for two consecutive weeks and collected plant parts eaten and those discarded in food preparation on an all occurrences basis. When possible, discarded parts were collected from baboon food refuse. Where additional samples were needed for analysis, we collected eaten and discarded parts in the same location as the feeding event. Samples were processed for nutritional analysis as per Rothman *et al.* (2008). We dried (<40°C out of sunlight) and milled samples at the field site. Samples were then exported to the Nutritional Ecology Laboratory at Hunter College in New York, USA, where we measured hemicellulose and cellulose via neutral (neutral detergent fibre, NDF) and acid detergent fibre (ADF), lignin, nonstructural carbohydrates, crude and available protein, metabolizable energy (not taking into account fibre digestibility) (Conklin-Brittain, Knott & Wrangham, 2006), condensed tannins (Rothman *et al.*, 2006a) and hydrolyzable tannins (Hartzfeld *et al.*, 2002).

We compared six paired eaten and discarded samples from the same species for nutrient content using Wilcoxon signed rank tests. The overall differences in the nine eaten versus twelve discarded foods were compared using Mann–Whitney tests. A chi-squared test was used to compare the presence of condensed tannins in eaten and discarded food parts. We used PASW Statistics 18.0 and an alpha-level of 0.05 for statistical analyses.

Results

We recorded 190 feeding events, during which baboons consumed 10 plant parts from 32 plant species. Observed foods comprised fruits (46%); stems (33%); tubers (7%); leaves (7%); seeds (4%); insects (1%); mushrooms (1%); and bark, gums and soil (1%). Additionally, baboons practiced postdispersal seed predation from elephant dung. A total of 21 samples from twelve species were analysed for macronutrients and tannins, including nine items consumed and twelve discarded in food preparation (Table 1). Food items analysed represent 77% of species consumed during recorded annual feeding events.

Foods and discards were similar in protein, energy and nonstructural carbohydrates. Fat content was extremely low in all food parts (<3%). Foods eaten were lower in hemicellulose than discarded counterparts ($Z = -2.313$, $P = 0.021$), while cellulose was similar between discarded and eaten parts. Consumed foods had higher lignin than paired discards ($Z = -2.521$, $P = 0.012$), but not when all consumed and discarded parts were compared (Fig. 1). No foods or discards contained hydrolyzable tannins. Condensed tannins were present in 83% of discarded parts, but only 56% eaten parts. There was not a significant difference in condensed tannins in eaten or discarded parts.

Discussion

While we followed this group uniformly across the year, our sample size is small and we did not record the majority of feeding events because the baboons were largely unhabituated. Additionally, we did not measure availability of food or harvest rate, which can influence food

Table 1 Nutritional composition of eaten and discarded plant parts processed by baboons in Kibale National Park, Uganda (%Dry Matter)

Botanical Name	Part	%AP	%NDF	%ADF	%ADL	%Fat	%TNC	E	CT
Eaten									
Cucumis sp.	UF	15.0	42.9	31.9	11.1	1.4	32.9	203.6	–
Cyperus papyrus	LP	7.0	66.4	45.2	8.7	1.0	10.6	79.7	+
Cyperus sp.	P	11.1	59.3	33.4	7.5	1.0	13.1	105.8	+
Diospyros sp.	RF	10.5	56.0	40.8	8.7	2.2	27.2	170.4	+
Marantochloa sp.	Rt	14.1	43.6	36.0	14.5	1.0	10.9	50.3	+
Olea latifolia	P	7.5	67.0	39.0	2.4	1.5	8.4	71.3	–
Palisota sp.	P	25.8	45.8	30.2	15.1	1.1	6.2	137.7	+
Pennisetum purpureum	P	12.6	63.1	44.3	6.3	0.1	5.6	73.6	–
Seteria sp.	P	9.0	32.7	20.4	12.0	1.4	51.1	247.6	–
Discarded									
Aframomum sp. 1	R	9.8	52.6	35.8	7.1	0.2	23.7	135.9	+
Aframomum sp. 2	R	6.6	52.0	34.7	6.0	1.3	17.2	106.9	+
Cyperus papyrus	St	5.8	78.1	50.5	8.0	0.2	11.1	69.7	+
Cyperus papyrus	UP	4.1	73.7	43.4	6.4	1.7	12.6	75.5	+
Cyperus sp.	St	6.2	66.5	38.5	3.8	1.7	15.7	103.3	+
Dasylepis sp.	R	14.5	51.9	39.2	17.4	1.2	22.0	156.9	+
Marantochloa sp.	HL	20.4	62.2	30.9	8.0	2.9	1.5	113.2	+
Marantochloa sp.	St	9.5	65.4	45.1	7.4	1.4	8.3	84.1	+
Myrianthus sp.	R	13.8	47.0	39.8	21.6	1.6	27.7	173.7	+
Palisota sp.	St	27.3	43.3	27.2	10.9	0.3	5.9	135.5	+
Pennisetum purpureum	St	11.6	65.6	37.1	4.9	1.9	12.2	104.8	–
Setaria sp.	St	9.5	70.4	43.7	6.1	0.3	9.4	78.7	–

AP, available protein; NDF, neutral detergent fibre; ADF, acid detergent fibre; ADL, acid detergent lignin; TNC, total nonstructural carbohydrates; E, energy (kcal per 100 g); CT, condensed tannins; (+)/(−), presence/absence. Plant part: HL, herbaceous leaf; LP, lower pith; P, pith or inner stem core; R, rind or fruit exocarp; RF, ripe fruit; Rt, root; St, outer stem; UF, unripe fruit; UP, upper pith.

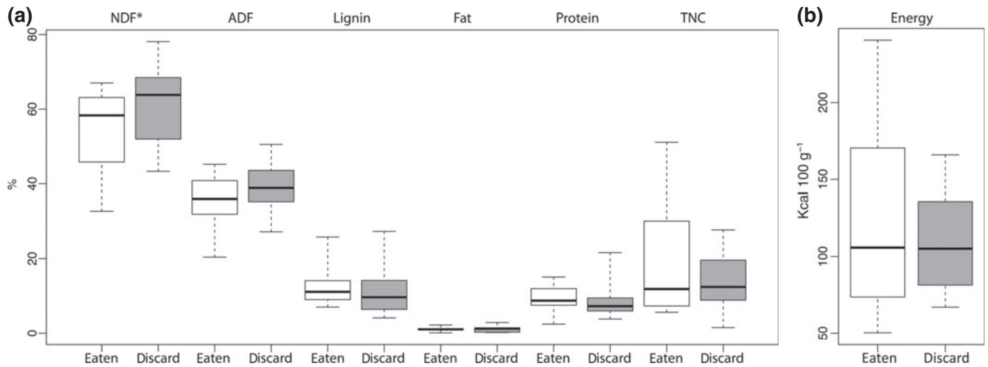

Fig 1 (a) Comparison of macronutrient content in all eaten and discarded food parts (NDF, neutral detergent fiber; ADF, acid detergent fiber; TNC, total non-structural carbohydrates, *Significant difference at $P < 0.05$) (b) Comparison of energy content in eaten and discarded food parts

choice (Barton & Whiten, 1994; Felton *et al.*, 2009). These results must thus be viewed as preliminary pending further research on this population.

Similar to the study of food choice in savannah olive baboons by Barton & Whiten (1994), Kibale baboons selected food parts that were lower in hemicellulose than discards. Unlike Barton & Whiten's (1994) study, Kibale baboons did not select for foods higher in protein or lower in phenolics. There was no overlap between food species analysed in this study and those by Barton & Whiten (1994).

The NDF content of foods eaten by Kibale baboons was high and similar to foods eaten by colobus monkeys in the same forest, which ferment fibre in a specialized foregut and eat leaves with 49% NDF (n = 1000; J. Rothman, unpublished data). More information is needed on fibre digestibility in baboons, but it is possible that they can digest portions of the hemicellulose in stems similarly to chimpanzees (cf. Wrangham *et al.*, 1991). Higher lignin content in eaten compared with discarded paired items was unexpected as lignin is indigestible (Van Soest, 1994). This result did not hold when all eaten and discarded items were compared, however, and may result from small sample sizes. We found no difference between eaten and discarded items for other major nutrients, including protein, energy, fat, and nonstructural carbohydrates.

These results differ from previous studies of baboon food selectivity, which found protein and tannin content to influence food choice (Barton & Whiten, 1994). We could not assess the effect of hydrolyzable tannins in food selection as this class of polyphenol was absent in both eaten and discarded foods. Interesting, but not unique, dietary behaviours in this group included the consumption of bark and soil, perhaps to obtain minerals or detoxify dietary toxins (Johns & Duquette, 1991; Rothman, Van Soest & Pell, 2006b), and predation on postdispersed seeds procured from elephant dung (Silk, 1987; Altmann, 1998).

Food selection studies are useful for revealing properties of food that influence their consumption; however, they do not address the underlying nutritional goals that govern nutrient intake nor reveal larger dietary patterns, such as how preferred foods fit into a broader nutritional framework (Raubenheimer, Simpson & Mayntz, 2009). Our future research will include a comprehensive examination of the nutritional goals of Kibale baboons. The study of olive baboon diet and food choice in forested habitat is important as it allows for comparisons across habitats to reveal intraspecific variation in feeding behaviour and species-wide patterns of diet selection.

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