Food preference of captive mona monkey (*Cercopithecus mona*) in University of Lagos, Nigeria

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Abstract

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*In the wild, nonhuman primates' preferences for some food may not be quite clear due to the seasonality and utilization of fallback foods during periods of scarcity. Understanding the most preferred foods could aid schedules of serving them to captive primates. Against this background, the study was carried out to determine the food preference of captive mona monkeys offered foods consumed by their counterparts in the degraded and fragmented urban forest, biodiversity rich rainforest, and in a zoo. The feeding trials were conducted in the service area of the University of Lagos. Four adult monkeys (two males and two females) were offered weighed amounts of 13 different foods served in batches of five, using the cafeteria method. Each food type was offered separately in a food trough at 10:00 hrs each day. Left over was withdrawn and measured after 24 hours. Position of the food trough was changed every day. Water was provided ad libitum in a water trough. The difference between offered and left-over weights was regarded as intake. Food preference was determined from the coefficient of preference (COP), and a unitary value was considered preferred. In decreasing order of preference, the preferred foods that had $COP \geq 1$ were *Musa sapientum*, *Zea mays*, and *Solanum melongena*. The mona monkey and other sympatric species held in captivity could be provided with these foods in addition to other foods that could meet their nutritional needs. Nutritional assays of these foods could provide clues to their being preferred above others.*

Keywords: Coefficient of preference, food preference, mona monkey, non-human primate.

La Préférence alimentaire du singe mona en captivité (*Cercopithecus mona*) à l'Université de Lagos, Nigéria

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Résumé

Dans la nature, les préférences des primates non humains pour certains aliments peuvent ne pas être tout à fait claires en raison de la saisonnalité et de l'utilisation des aliments de remplacement pendant les périodes de pénurie. Comprendre les aliments les plus préférés pourrait faciliter les horaires de les servir aux primates captifs. Dans ce contexte, l'étude a été menée pour estimer la préférence alimentaire des singes mona en captivité qui offraient des aliments consommés par leurs homologues dans la forêt urbaine dégradée et fragmentée, la forêt tropicale riche en biodiversité et dans un zoo. Les essais d'alimentation ont été menés dans l'aire de service de l'Université de Lagos. Quatre singes adultes (deux mâles et deux femelles) se sont vus offrir des quantités pesées de 13 aliments différents servis par lots de cinq, en utilisant la méthode de la cafétéria. Chaque type de nourriture était offert

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séparément dans une auge à 10 h chaque jour. Le surplus a été prélevé et mesuré après 24 heures. La position de l'auge a été changée chaque jour. L'eau était fournie à volonté dans un bac à eau. La différence entre le poids offert et le poids restant a été considérée comme un apport. La préférence alimentaire a été déterminée à partir du coefficient de préférence (COP), et une valeur unitaire a été considérée comme préférée. Par ordre décroissant de préférence, les aliments préférés qui avaient un COP ≥ 1 étaient *Musa sapientum*, *Zeamays* et *Solanummelongena*. Le singe mona et d'autres espèces sympatriques gardées en captivité pourraient recevoir ces aliments en plus d'autres aliments qui pourraient répondre à leurs besoins nutritionnels. Les dosages nutritionnels de ces aliments pourraient fournir des indices sur leur préférence aux autres.

Mots clés : Coefficient de préférence, préférence alimentaire, singe singe, primate non humain.

Introduction

Primates in the wild forage on and consume from a variety of foods that meet their nutritional needs. Their choice depends on availability and inherent qualities of the food items. Many factors contribute to what the animal consumes; these are the food and animal factors. An animal would choose what it prefers or what is available. What food an animal consumes when there is no variation in the availability of such food is the measure or index of its preference of that food in its diet (Ganas *et al.*, 2008). The brown howler monkeys (*Alouatta guariba clamitans*) for instance showed variation in food choices based on local and seasonal differences in availability of the food resources (Chaves and Bicca-Marques, 2016). Food preference differs from food choice because although food choice investigates how the attributes of each food species (their differing availabilities and nutrient compositions) may influence the decision of what an animal consumes, preference controls for differences in availability and then calculates which species would be chosen over another (Ganas *et al.*, 2008). Information on which nutrient and foods are preferred by an animal show which food species may influence feeding competition, habitat utilization, and which food species and habitats should be considered in management and conservation efforts

(Ganas *et al.*, 2008). Food preference studies gives insight into the nutritional requirements of an animal, which is vital to survival, fitness, and perpetuity through reproduction (Lambert, 2007). Determining nutrient requirements by analyses of food choice and/or selectivity may not give a true representation of an animal's needs. This is because during periods of low food availability, animals may eat poor quality but available foods to subsist on (Ganas *et al.*, 2008). Food preference and choice seem to mean the same thing. An animal's choice may mean its preference. An animal may choose a particular food based on what is available in the environment. However, the part of the food it would consume is that portion that would provide the nutrients needed. Food preference calculation helps in determining nutritional requirements, while that for food choice determines factors that influence the consumption of particular foods in a variable environment (Ganas *et al.*, 2008). The food choices of primates have been attributed to one of two principal factors: the nutritional and/or toxic content of the plant part, or its relative availability in space or time. Body size has been suggested to also influence primate food choice (Milton, 2006). Foods contain different levels of nutrients. Thus, many primates must choose from more than one dietary category each day to get the balance

of essential nutrients and the energy they require (Lambert, 2007). In livestock production, the preference and acceptability of a feed has been used as a measure of voluntary feed intake which is a fast way of determining feed quality (Kalio *et al.*, 2012; Sandoval-Castro *et al.*, 2005). Feed preference studies have been conducted for such livestock animals as goats, sheep, rabbits either to test alternative source of feed or browse plants that can easily be used as cheap sources of protein supplements during dry seasons when forages are scarce and of low quality (Bamikole *et al.*, 2004; Osuga *et al.*, 2008; Abu and Turner, 2016; Kalio and Owthorji, 2018; Ziblim *et al.*, 2019; Belachew *et al.*, 2020). In the wild or captivity, non-human primates make food choices. This could be based on the food factors or animals' age, digestive organs or physiological state, and physiological state (pregnant or lactating). It could be due to the availability of the foods (Ganas *et al.*, 2008). Ruby (2017) described the food preference of captive Garnett's greater bush-baby (*Otelemur garnettii*) as consisting of insects and fruits which was alluded as being similar to their wild counterparts. This study aims to provide in empirical values, what foods mona monkeys in captivity prefer when presented with various options. The objective was to determine what provisioned foods mona monkeys in captivity would prefer. The results could be useful to zoos where this or sympatric species are kept.

Methodology

The study was conducted in the Service Area; University of Lagos where a monkey shed with two sections was used. The foods used for the study were selected from those previously observed to be consumed by wild populations of mona monkeys in University of Lagos, caged mona monkeys and baboons in the University of Lagos

Zoological, and mona monkeys in Okomu National Park (Edo State).

Determination of plant foods preferred by mona monkeys

Food preference of captive mona monkeys was determined by the cafeteria technique described by Babayemi (2007). Four adults mona monkeys (2 males and 2 females) purchased from Iddo market, Lagos were housed together in a cage that had two compartments. The animals were fed with the food samples for three days after which weighted amounts of the foods were offered for three days. A total of 13 food items (Table 1) consumed by mona monkeys were assessed in the preference studies. Eight of these were from the food types monkeys in the University of Lagos forests consumed (Olaleru and Egonmwan, 2012). Three were the foods offered to caged baboons and monkeys in the Zoological Garden, University of Lagos, while two were part of the diets of mona monkeys in a lowland rainforest of Okomu National Park (Olaleru, 2016). The foods were offered in batches. Four batches were used to determine the foods the monkeys consumed most, and the fifth batch was used for re-acceptability to determine the most preferred foods. Each food was weighed and offered separately in food troughs. The test food types were offered at 10:00 hrs each day and the left over were withdrawn and measured 24 hours after. The difference between what was offered previously and what remained was regarded as intake. A batch of food was offered for six days. Three days were used for acclimatization period, while food intake was monitored for the remaining three consecutive days. On each day, the positions of the food troughs were changed in order to check the monkeys from associating one type of food to a particular position. Water was provided *ad libitum* in a water trough. Food preference by mona monkeys was determined from the coefficient of

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preference (COP) value. The value was calculated from the ratio between the intakes for each food divided by the average intake of the foods.

COP for each food was determined using the equation:

$$\text{COP(A)} = \frac{\text{Intake of food A}}{\text{Mean of the food intakes}} \quad (\text{Bamikole et al., 2004}).$$

A food is preferred when the COP is greater than or equal unity (Karbo et al., 1993;

Bamikole et al., 2004; Babayemi, 2007). Re-acceptability study was carried out for three days with foods that had COP values above one. This was to determine the most preferred food(s). Apart from *T. catappa* and *A. altilis* that were sourced from the trees in the University of Lagos, all the other items were procured from the market.

Data analysis

Data was analysed for average consumption of each food and were presented using Tables.

Table 1: Types and sources of foods used for the cafeteria feeding studies

S/NO.	Scientific Name of Plant	Family	Common Name
1	² <i>Arachis hypogaea</i> L.	Fabaceae	Ground nut
2	³ <i>Dacrodies edulis</i> H.J. Lam	Burseraceae	Local pear
3	^{1,2,3} <i>Carica papaya</i> L.	Caricaceae	Paw paw
4	^{1,2,3} <i>Mangifera indica</i> L.	Anacardiaceae	Mango
5	^{1,2,3} <i>Musa sapientum</i> L.	Musaceae	Banana
6	^{1,3} <i>Ananas comosus</i> L.	Bromeliaceae	Pineapple
7	² <i>Ipomoea batatas</i> (L.) Lam.	Convolvulaceae	Sweet potato
8	^{1,2} <i>Zea mays</i> (fresh) L.	Poaceae	Corn/maize
9	¹ <i>Terminalia catappa</i> L.	Combretaceae	Almond
10	² <i>Solanum melongena</i> L.	Solanaceae	Garden eggs
11	³ <i>Irvingia gabonensis</i> Baill.	Irvingiaceae	Bush mango
12	¹ <i>Artocarpus altilis</i> (Parkinson) Fosberg	Moraceae	Bread fruit
13	¹ Bread	Bread	Bread

¹ Foods consumed by wild populations of mona monkeys in University of Lagos

² Foods fed to monkeys in University of Lagos Zoological Garden

³ Foods consumed by monkeys in Okomu National Park

Results

Coefficient of preference of batch one foods

The mona monkeys' Coefficient of preference for foods offered in Batch One is shown on Table 2. All the foods apart from *Arachis hypogaea* (ground nut) had COP values that were above unity for all the days. However, *Carica papaya* was less than unity on day 1. *Musa sapientum* had the highest COP value of 1.66.

Coefficient of preference of batch two foods

The mona monkeys' Coefficient of preference for foods offered in Batch Two is shown on Table 2. On Day One, only *Carica papaya* and *Musa sapientum* had

COP above 1. For the three days, *Ananas comosus* and *Ipomea batatas* had COP that were below 1, while *Musa sapientum* had COP above 1. On the average, *Musa sapientum* had the highest COP value of 1.70.

Coefficient of preference of batch three foods

The mona monkeys' Coefficient of preference values for foods offered in Batch Three is shown on Table 4. Bread had the least COP value for all the days. This was followed by *Terminalia catappa*. *Mangifera indica* and *Solanum melongena* had COP values that were above unity for the three days, while the latter had the highest COP value of 1.78.

Table 2: Coefficient of preference of foods offered in Batch One to mona monkeys

	Days	Day 2	Day 3	Ave. COP
Food Sample	1	2	3	
<i>Arachis hypogaeae</i>	0.62	0.21	0.00	0.28
<i>Carica papaya</i>	0.85	1.22	2.05	1.37
<i>Mangifera indica</i>	1.61	1.40	1.14	1.38
<i>Musa sapientum</i>	1.55	1.96	1.48	1.66

COP= Coefficient of Preference

Table 3: Coefficient of preference of foods offered in Batch Two to mona monkeys

	Day 1	Day 2	Day 3	Ave. COP
Food Sample				
<i>Carica papaya</i>	1.79	0.91	1.49	1.40
<i>Musa sapientum</i>	1.34	1.67	2.08	1.70
<i>Ananas comosus</i>	0.67	0.91	0.30	0.63
<i>Ipomea batatas</i>	0.30	0.30	0.12	0.24
<i>Zea mays</i> (fresh)	0.9	1.21	1.01	1.04

COP= Coefficient of Preference

Table 4: Coefficient of preference of foods offered in Batch Three to mona monkeys

	Day 1	Day 2	Day 3	Ave. COP
Food Sample				
Bread	0.44	0.69	0.89	0.67
<i>Terminalia catappa</i>	0.87	1.19	0.89	0.98
<i>Mangifera indica</i>	1.88	1.13	1.44	1.48
<i>Solanum melongena</i>	1.81	1.98	1.56	1.78

COP= Coefficient of Preference

Coefficient of preference of batch four foods

The mona monkeys' Coefficient of preference for foods offered in Batch Four is shown on Table 5. *Irvingia gabonensis* had the highest average COP value of 1.8. This was followed by *Terminalia catappa* with a COP value of 1.11. *Zea mays* (fresh) and *Artocarpus altilis* had the least COP values of 0.81 and 0.28 respectively.

Reacceptability coefficient of preference

The mona monkeys' re-acceptability Coefficient of preference is on Table 6. Only *Carica papaya* had COP value that was below unity. *Musa sapientum*, fresh *Zea mays*, and *Solanum melongena* had COP values that were on the average above unity, but in a declining order. The preference was in the order of *Musa sapientum* > *Zea mays* > *Solanum melongena*.

Table 5: Coefficient of preference of foods offered in Batch Four to mona monkeys

	Day 1	Day 2	Day 3	Ave. COP
Food Sample				
<i>Irvingia gabonensis</i>	1.62	2.06	1.71	1.80
<i>Terminalia catappa</i>	0.34	1.09	1.91	1.11
<i>Zea mays</i> (fresh)	1.7	0.54	0.19	0.81
<i>Artocarpus altilis</i>	0.34	0.31	0.19	0.28

COP= Coefficient of Preference

Table 6: Coefficient of preference of foods offered to mona monkeys for the re-acceptability trial

	Day 1	Day 2	Day 3	Ave. COP
Food Sample				
<i>Musa sapientum</i>	1.38	1.02	1.5	1.30
<i>Zea mays</i> (fresh)	1.06	1.29	0.96	1.10
<i>Solanum melongena</i>	1.35	0.88	1.03	1.09
<i>Carica papaya</i>	0.65	0.81	0.51	0.66

COP= Coefficient of Preference

Discussion

The most preferred food was *Musa sapientum*, followed by fresh *Zea mays* and then *Solanum melongena*. Each had coefficient of preference (COP) value that was above one. These food items met the condition reported by Karbo *et al.* (1993); Bamikole *et al.* (2004) and Babayemi (2007), that a food is preferred when the COP is greater than unity. As omnivores, NHPs are regarded as generalists with flexible feeding habits. They show some preferences for either fruits (frugivores), leaves (folivores), seeds (gramnivores), exudates (gumnivores) or even animals (faunivores) (Lambert, 2007). As a frugivorous omnivore, *M. sapientum* was the most preferred food of the mona monkey. The seeds of fresh *Z. mays* could be succulent enough for the monkeys, while the seeds of *Solanum melongena* could be a good source of protein and other micro nutrients. Bonobos (*Pan paniscus*) also showed preference for fruits over vegetables (Verspeek *et al.*, 2020). *Carica papaya* that showed high preference initially was least preferred when compared with other preferred foods. *Ipomea batatas* offered to captive nonhuman primates in the University's Zoological Garden had very low preference. It is likely the animals consume it because they do not have alternatives. Bread was consumed by mona monkeys in the University of Lagos either as scavenged in rubbish bins or provisioned by people. It was not part of the food of monkeys in Okomu National Park. This could be a form of dietary adaptation to urbanization. On the field, *Terminalia catappa* was observed to be frequently eaten as a wild food. In the captivity feeding trial, this fruit was not preferred. This could be due to the fact that the animal ate it fresh from the tree top, as compared to the ones offered, which were picked from the ground. Field observation showed that the mona monkey does not come down to

pick its food droppings. The foods they picked from the ground were those offered by people or those sourced at dumpsites, a feeding strategy peculiar to the urban habitat. Food preference could be difficult to measure in the wild because of the variation in the availability of food items and the compounding effects of secondary compounds (Ganas *et al.*, 2008, Verspeek *et al.*, 2020). In the present study, mona monkeys held in captivity were used for ease of food preference measure which allowed for controls. The disadvantage of controlled studies is that only few food options per experiment could be offered which does not represent what wild animals experience (Laska, *et al.*, 2000; Remis, 2002). This was also observed for callitrichids (marmosets and tamarins) where foods in the diets of captive individuals were limited in types and varieties when compared to options in the wild. When offered a limited variety of succulent foods, callitrichids may select those that are high in sugar, high in fat, or simply novel. Thus, it is important to offer foods that complement each other nutritionally (Crissey *et al.*, 2003). The critical determinants of dietary choice in animals may be internal (body size, basal metabolic rate, digestive adaptations, nutritional and energy needs), and to some extent external, in terms of social rank, and feeding competition (Lambert, 2007; Chapman *et al.*, 2012). This suggests that food choice may be a digestive strategy in which animals maximize the nutrients they obtain to meet their needs by consuming not just the available foods, but that which they can efficiently digest. As a monogastric, this might explain the mona monkeys' choice of *M. sapientum*.

Conclusion

The captive mona monkeys showed preference for *Musa sapientum*, fresh *Zea mays* and *Solanum melongena*. Nutritional

analyses of these foods could provide clues for their preference. Captive non-human primates could be provided with these foods in addition to other foods that could meet their nutritional needs.

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