BIOMA
p-ISSN: 0126-3552
e-ISSN: 2580-9032

DOI:10.21009/Bioma20(1).5 Research article

The natural food composition of long-tailed macaque *(Macaca fascicularis* Raffles, 1821*)* inhabiting the Muara Angke Wildlife Reserve in North Jakarta

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ABSTRAK

*Monyet ekor panjang (*Macaca fascicularis*) merupakan salah satu spesies satwa liar yang menghuni Suaka Margasatwa Muara Angke (SMMA), cagar lahan basah yang sebagian besar ditumbuhi hutan rawa bakau. Karena tingginya perjumpaan* M. fascicularis *dengan manusia dan insiden makanan yang diberikan manusia, penting untuk memahami komposisi makanan alami* M. fascicularis*. Metode yang digunakan adalah kuantitatif dengan teknik pengumpulan data menggunakan teknik scan sampling dengan interval 5 menit. Sumber makanan alami untuk* M. fascicularis *di SMMA disediakan oleh 17 jenis tumbuhan. Sumber makanan alami utama yang menyediakan baik daun dan buah adalah* Ficus benjamina *(54,62%) dan* Sonneratia caseolaris *(28,9%). Bagian tumbuhan yang paling umum dimakan oleh* M. fascicularis *adalah daun (61%) dan buah (21%), mirip dengan monyet daun (langur). Namun, ada kemungkinan besar bahwa nutrisi yang dibutuhkan untuk melengkapi konsumsi daun yang tinggi pada monyet SMMA disediakan oleh makanan yang diberikan manusia secara non-alami.*

Kata kunci: aktivitas makan; komposisi pakan;* Macaca fascicularis*; pakan alami

ABSTRACT

*Long-tailed macaque (*Macaca fascicularis*) is one species of wild animals inhabits Muara Angke Wildlife Reserve (SMMA), a wetland reserve predominantly grown by mangrove swamp forest. As there is high encounter of* M. fascicularis *with human and high incident of human-given food, it is important to understand the composition of natural food of* M. fascicularis*. The method used was quantitative with data collection techniques using scan sampling technique with 5-minute intervals. Natural food source for* M. fascicularis *in SMMA is provided by 17 species of plants. The main natural food sources providing both leaves and fruits are* Ficus benjamina *(54.62%) and* Sonneratia caseolaris *(28.9%). The most common plant parts eaten by* M. fascicularis *are leaves (61%) and fruit (21%), resembles to those of leaf monkeys (langurs). However, is a high possibility that nutrient needed to supplement high leaf consumption in SMMA monkeys is provided by non-natural human-given food.*

Keywords: eating activity; food composition;* Macaca fascicularis*; natural food

INTRODUCTION

The long-tailed macaque (*Macaca fascicularis*) is a species that plays a pivotal role in the regeneration and sustainability of tropical forests. One of the significant contributions of *M. fascicularis* is on seed dispersal, role of which facilitates the reproduction of new plants and rejuvenates the ecosystem (Atmanto, 2014). The seed dispersal role of primates is associated with their daily activities, especially feeding. During foraging, *M. fascicularis* consumes various types of food within its range, and within its daily activities, which generally are categorized into four main activities; moving, resting, feeding, and socializing (Rizaldy *et al*., 2016).

M. fascicularis, is an omnivorous primate that feeds on a wide variety of food items such as fruits, leaves, meat, insects, and even human-related food sources (Oriza *et al*., 2019). The species exhibits a diverse diet and has been reported to utilize various plant species as a food source, as documented in the research by Kamilah *et al.* (2013), which highlights the characteristic of food source exploitation by *M. fascicularis* in its natural habitat.

In Greater Jakarta, as a megapolitan city, natural population of *M. fascicularis* can still be found, for example in the mangrove forest area in Muara Angke Wildlife Reserve (SMMA). The habitat of SMMA, even it is surrounded by human settlements and industries, serves as a vital life support system for plants and animals, especially for the *M. fascicularis* population. Djuwantoko *et al*. (2008) stated that the behavior of *M. fascicularis* is not likely to interfere with human activity if they live in their natural habitat and are not near human settlements. However, with the increase in human population around the SMMA area and its location on the side of the main road close to residential areas, the interaction between the community and *M. fascicularis* has become more frequent. This has led to the development of a new habit among the *M. fascicularis* of waiting and receiving food from the local community in the edge area of the SMMA. According to research conducted by Safitri (2017), surrounding residents give food to *M. fascicularis* every day because they think there is no food within the area.

The study focuses on investigating the potential dependence of *M. fascicularis* on humans due to their frequent interaction. The presence of non-natural food is an interaction between humans and *M. fascicularis*. According to research by Safitri (2017), the percentage of the non-natural *M. fascicularis* food category in SMMA is 41%. To mitigate this issue, the research aims to find out the percentage and identify natural food composition of *M. fascicularis* in SMMA, with a particular emphasis on plants and other organisms. The findings of this investigation could contribute to a better understanding of the ecological dynamics of the area and help implement measures for the sustainable coexistence of humans and *M. fascicularis.*

MATERIALS AND METHODS

This study was conducted in Muara Angke Wildlife Reserve (SMMA), located in North Jakarta, Indonesia. Data collection was carried out over five repetitions from February to March 2023. According to the phenology data collected at SMMA in 2020, the composition of total mangrove litter at SMMA is as follows: leaves (47%), reproductive organs (37%), and twigs

(16%). It was observed that mangrove litter production is higher during the rainy season (September-February) compared to the dry season during March-August yearly (YKAN & BKSDA, 2020). The study employed quantitative methods, utilizing scan sampling techniques as described by Zairina *et al*. (2015). Data was collected at 07.00-17.00 WIB, with a recording interval of 5 minutes. Primates typically initiate their daily activities upon waking and conclude their activities by moving to their sleeping tree, as noted by Sontono et al. (2016). This method enables the observation and documentation of animal behaviours and interactions over specific time intervals, in this case 5 minutes.

The data collected pertained to the natural food sources and plant parts consumed by *M. fascicularis*. Observations were made along transect paths that were adapted to the research location and are illustrated in **Figure 1**.

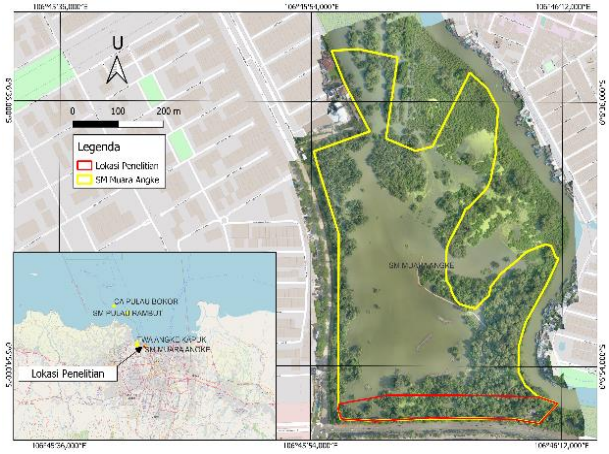

FIGURE 1. Map of the research site (Source: Polhut, Kementerian Lingkungan Hidup dan Kehutanan)

The field observation used stationery, tally sheets, binoculars, watches, and digital cameras. The study aims to observe the *M. fascicularis* and record their frequency of eating behavior during five-minute intervals (Martin & Bateson, 2007). Additionally, the types of food-getting activities carried out over a certain period will be continuously observed and recorded using instantaneous sampling methodology (Wahyuni *et al*., 2015). The observed and recorded variables include the type of natural food, such as the type of plant, part of the plant, and the frequency of food sources eaten.

RESULTS AND DISCUSSION

Based on the observations of the plant consumption patterns exhibited by the *M. fascicularis* primate species at the SMMA within one month of observation, a total of 17 distinct plant species were identified. These 17 species exhibited varying levels of distribution across the different stages of plant growth, with 6 species occurring at the tree level, 2 species at the pole level, 3 species at the sapling level, and 6 species at the seedling level. Furthermore, the identified plant species belong to 14 families (**Table 1**).

Based on the results of vegetation analysis conducted by Mujadid *et al*. (2020), the tree level in SMMA is dominated by three species: *Ficus benjamina*, *Sonneratia caseolaris*, and *Nypha fruticans*. Plant diversity in SMMA is divided into true mangroves and associated mangroves. SMMA has 9 species of true mangroves; *Acanthus ilicifolius*, *Nypa fruticans*,

Avicennia marina, *Excoecaria agallocha*, *Acrostichum aureum*, *Bruguiera gymnorhiza*, *Rhizophora apiculate*, *Rhizophora mucronata*, and *Sonneratia caseolaris* (Rahayu *et al*., 2018; YKAN & BKSDA Jakarta, 2020). However, our results (**Table 1**) showed that *M. fascicularis* predominantly consumes the leaves of *Ficus benjamina* and *Sonneratia caseolaris*, both of which are abundantly found in the SMMA and constitute the primary sources of natural food for the species. Specifically, the study records 81 times of *M. fascicularis* consuming leaves from *F. benjamina* trees and 50 times consuming leaves from *S. caseolaris* trees. The species exhibits a preference for tall trees with horizontal branches and wide crowns that provide suitable resting and sheltering opportunities. *F. benjamina* and *S. caseolaris* meet this criterion, as established by Nasution and Rukayah (2020). According to Djuwantoko's (2000), fig tree as *F. benjamina* is predominantly used by *M. fascicularis* as a source of food, play area, and protection. Fig trees are an essential food source for primates, as they are rich in nutrients such as cellulose and high-fat content, especially in the leaf shoots (Ritonga *et al*., 2022). During the observation, it was observed that many young *M. fascicularis* preferred leaves as their food, as they were able to digest the fibre in the leaves better than adult individuals. According to Farida *et al*. (2010), adult individuals require a relatively longer mealtime or duration to eat leaves or prefer fruit compared to juveniles.

TABLE 1. The species and percentages of food plants that are consumed by *Macaca fascicularis* at SMMA; Lf (leaf), Fr (fruit), Br (branch), Hr (hanging roots), Gs (grass seed), Sl (stalk), Ba (Bark), dan Fl (flower)

NO	FAMILY	SCIENTIFIC NAME	ORGAN CONSUMED									(%)
			Lf	Fr	Br	Hr	Gs	Sl	Ba	Fl	Total	
1	Acanthaceae	*Acanthus ilicifolius* L.	1	0	0	0	0	0	0	0	1	0.42
2	Arecaceae	*Nypa fruticans* Wurmb	1	2	0	0	0	0	0	0	3	1.26
3	Asteraceae	*Tridax procumbens* L.	0	0	0	0	0	0	0	1	1	0.42
4	Combretaceae	*Terminalia catappa* L.	3	2	0	0	0	0	0	0	5	2.1
5	Cyperaceae	*Cyperus rotundus* L.	0	0	0	0	1	0	0	0	1	0.42
6	Euphorbiaceae	*Ricinus communis* L.	1	0	0	0	0	0	0	0	1	0.42
7	Fabaceae	*Leucaena leucocephala* (Lam.) de Wit	1	1	0	0	0	0	0	0	2	0.84
8	Fabaceae	*Adenanthera pavonina* L.	1	0	0	0	0	0	0	0	1	0.42
9	Lythraceae	*Sonneratia caseolaris* (L.) Engl.	50	7	8	0	0	3	0	1	69	28.99
10	Lythraceae	*Lagerstroemia speciosa* (L.) Pers.	2	0	0	0	0	0	0	0	2	0.84
11	Moraceae	*Ficus benjamina* L.	81	36	7	6	0	0	0	0	130	54.62
12	Poaceae	*Cynodon dactylon* (L.) Pers.	0	0	0	0	6	0	0	0	6	2.52
13	Poaceae	*Sporobolus indicus* (L.) R.Br.	0	0	0	0	1	0	0	0	1	0.42
14	Rhizophoraceae	*Rhizophora mucronata* Poir.	8	0	0	0	0	1	1	0	10	4.2
15	Rubiaceae	*Ixora coccinea* L.	0	0	0	0	0	0	0	1	1	0.42
16	Solanaceae	*Solanum torvum* Sw.	1	0	0	0	0	0	0	0	1	0.42
17	Vitaceae	*Causonis trifolia* (L.) Mabb. & J.Wen	2	1	0	0	0	0	0	0	3	1.26
	TOTAL		152	49	15	6	8	4	1	3	238	100

There is peculiarity when the numbers in **Table 1** and **Figure 1** are analyzed. That is due to the similarity of the diet of *M. fascicularis* studied to leaf monkeys. According to Suarez (2013), the percentage of food in leaf monkeys (langurs) is dominated by leaves as much as 46.2%, with young leaves consumed more (31.3%) than old leaves (12.4%), fruit as much as

39.5%, with seeds and pulp consumed from immature fruit (23.9%) more than ripe fruit (12.6%). Flowers are 8.9%, while insects and others are less than 5%. Our result showed 61% of *M. fascicularis* diet in SMMA are leaves, followed by fruit as much as 21% (**Figure 2**), which is similar to leaf monkey. However, Suarez (2013) also stated that the exact percentage of leaves in their diet can vary depending on the species, season, and the availability of other food sources such as fruit or flowers. In general leaves can make up about 50% to 90% of their total food intake, according to food availability. Besides *F. benjamina* and *S. caseolaris* leaves, *M. fascicularis* also consumed several other leaves, notably *Rhizophora mucronata, Terminalia catappa* and *Causonis trifolia*. This is not new to science, as *R. mucronata* has been recorded by dos Santos (2019), *T. catappa* observed by Kassim et al (2019) and *C. trifolia* observed by Rukmi et al (2018).

Following leaves, plant organ sought after by the *M. fascicularis* are fruits. The fruit of the *F. benjamina* tree is a favorite of *M. fascicularis* (**Table 1**). The fruit of *F. benjamina* is small, abundant, and easy to find throughout the branches of the tree, making the fruit the main natural food source of *M. fascicularis*. According to Reinegger *et al*. (2023) *M. fascicularis* is known to favor juicy, sour, and sweet fruit and is known to choose bright yellow, orange, and sometimes red colors due to their trichromatic vision of the fruit they find. In SMMA these criteria meet exactly to *F. benjamina.*

Besides consuming the fruit of the *F. benjamina, M. fascicularis* also feeds on the fruit of the *S. caseolaris*, although this behavior is not commonly observed. Anggraeni *et al*. (2013) suggest this could be since the existing *S. caseolaris* trees have not yet entered their fruiting season or because the fruit is still too young to be eaten. *S. caseolaris* trees have two fruiting seasons a year, spanning from April to July and from October to January (Hastuti *et al*., 2013). Nevertheless, during the study, *M. fascicularis* was seen eating unripe *S. caseolaris* fruit. Previous research has indicated that monkeys consume unripe fruit to obtain tannins and phenols, which can aid in digestion (Kool, 1993). Apart from its nutritional content, fruits containing sap such as *F. benjamina* and *S. caseolaris* are also known to be consumed by *M. fascicularis* because contain many benefits for their health, as anti-inflammatory, anti-diabetic and anti-allergic potential which could be the reason why animals such as *M. fascicularis* choose to consume it (Dev *et al*., 2021).

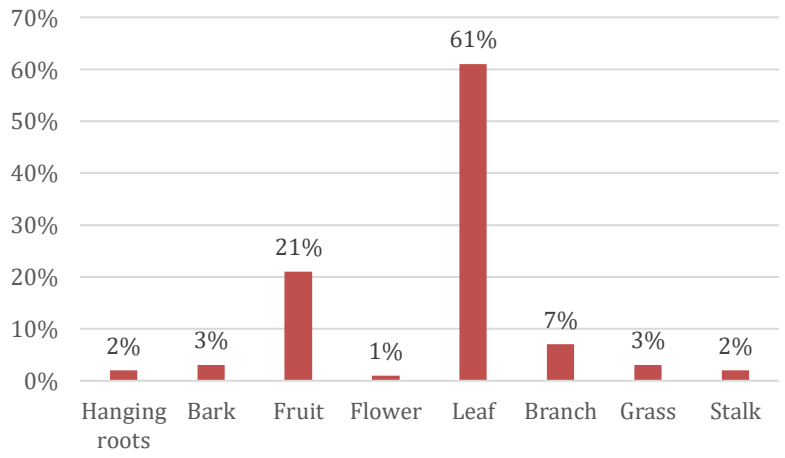

FIGURE 2. Percentage of plant organs consumed by *M. fascicularis* at SMMA

It is interesting that based on **Table 1**, *M. fascicularis* put both *F. benjamina* and *S. caseolaris* as most important plant species, because they consumed both leaves and fruits at the highest compared to other species. This means that *F. benjamina* and *S. caseolaris* are the two most important trees, providing *M. fascicularis* food sources both in the form of fruits and leaves.

In this study, the results differ from the research of Sari *et al*. (2024), where *M. fascicularis* in Tambora National Park consumes fruit (91%), flowers (8%), and leaves (1%) with 9 types of plant food. The findings of the feeding activity observations conducted on *M. fascicularis* with 17 different types of plants have revealed that the consumption of leaves (61%) and fruits (21%) was observed more frequently. The remaining plant parts, including twigs, hanging roots, grass, stalks, stems, and flowers, were observed to be consumed by *M. fascicularis* in less than 7% of cases (refer to **Figure 2**). Rizaldy *et al*. (2016) stated that during certain seasons, the availability of fruit as a food source in *M. fascicularis's* habitat is limited, and thus, *M. fascicularis* must rely on other plant parts. However, as per Misbah's (2010) findings, *M. fascicularis* possesses exceptional habituation abilities and can utilize and consume other food sources only in small quantities as an alternative. These observations are consistent with Nugroho and Sugiyarto's (2015) research, which asserts that the percentage of plant parts other than leaves and fruits, including flowers and others, is less than 6%.

Several studies have been conducted on the dietary preferences of *M. fascicularis*, an omnivorous primate that feeds on a variety of food items including fruits, leaves, flowers, tubers, mushrooms, insects, snails, young grass, and even crabs. Natural food sources in the form of insects were not observed during the study period. However, Yamin *et al.* (2021) have reported that *M. fascicularis* may consume insects during periods of drought or low food availability. It is worth noting that the present study was conducted in the rainy season, and therefore, no data is available on the primate's insectivorous tendencies.

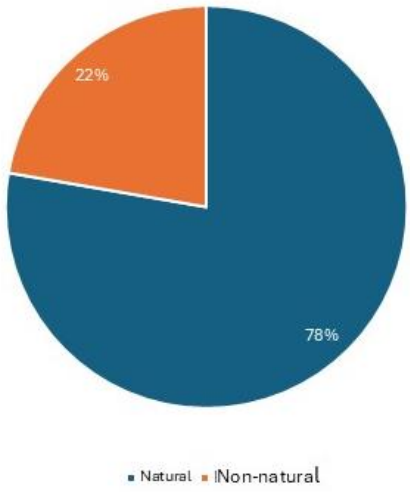

FIGURE 3. Percentage of natural and non-natural food

During afternoon and evening observations, *M. fascicularis* has been observed to frequently venture out of the SMMA forest area towards the adjacent highway in search of food from visitors who disregard the prohibition on feeding in the area (**Figure 3**). **Figure 3** showed that 22% of the time use in feeding is on non-natural food, i.e. human given food. This

may also be the explanation on why *M. fascicularis* diet in SMMA similar more to leaf monkey diet (**Figure 1**). It is possible that the food given by human including processed non-natural food items, such as satay, dumplings, and bread (Desy & Atmaja, 2018) may supplement the nutrient obtained from largely leaves (61%). Further research is needed to analyse the composition of non-natural food. Natural food has a crucial role, a key element in the ecosystem that supports the monkey's survival, both in terms of nutrition, behaviour, and health (Chapman *et al*., 2012). Therefore, the role of natural food will be disrupted if there is additional food in the form of non-natural food given by humans.

CONCLUSIONS

Natural food source for *M. fascicularis* in SMMA is provided by 17 species of plants. The main natural food sources providing both leaves and fruits are *Ficus benjamina* (54.62%) and *Sonneratia caseolaris* (28.9%). The most common plant parts eaten by *M. fascicularis* are leaves (61%) and fruit (21%), resembles to those of leaf monkey; however, there is a high possibility that nutrient needed to supplement high leaf consumption in SMMA monkeys is provided by non-natural human given food.

AUTHOR CONTRIBUTIONS

ADL, AB: project conception; ADL, FA, SAF, NAF, NNI: administration and supervising; ADL, NAF, NNI, DK, SAF, FA, DDP, FNH, AB: fieldwork; ADL, NAF, NNI, DDP, FA: data analyses; ADL, NAF, NNI, AB: manuscript revision; NAF: editing; YM: supervising and making area maps.

ACKNOWLEDGEMENTS

We thank BKSDA Jakarta for their administrative and logistic assistance. We thank Ade Suryanda of UNJ and Ardian Khairiah of UIN Syarif Hidayatullah Jakarta, for their supervision, assistance and discussion throughout the research. We thank all the field staffs of Muara Angke Wildlife Reserve, Amin Indra Wahyuni, Rizka Malintan, volunteers and alumni of KPP & KSP who assisted the fieldworks.

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