

Feeding behavior and food palatability of Sunda slow loris (*Nycticebus coucang*) at the Primates Research Center, IPB University

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Abstract. Sunda slow loris (*Nycticebus coucang*) is a primate native to Indonesia, West Malaysia, southern Thailand, and Singapore. This omnivore species feeds mainly on tree gum, fruits, and insects. Sunda slow loris in ex-situ conservation facilities might not have a similar diet to that of the natural habitat. Here, we studied the feeding behavior and food palatability of Sunda slow loris at the Primate Research Center, IPB University (PRC-IPB). We selected three males and three females of Sunda slow lorises. Over 30 days, we conducted behavioral observations during two time periods: 06:00-12:00 pm and 01.00-06.00 am, using the focal animal sampling method. The first meal was weighed before being delivered to the lorises to monitor Sunda's slow lorises' food palatability. Then, after twelve hours, the remaining meal was weighed. Sunda slow loris behavior data was analyzed using one-way ANOVA to differentiate gender. A descriptive analysis of the palatability data was also conducted. Our findings revealed that the feeding behavior percentage (7.34%) of Sunda slow lorises was lower than resting behavior (16.1%) and locomotion behavior (73.8%). Males exhibited a significantly higher percentage of ingestive behavior (19.74%), drinking behavior (33.33%), and defecation behavior (18.52%) than females. The Sunda slow loris feed at PRC-IPB consisted of banana fruit, papaya fruit, boiled chicken eggs, and crickets (as an additional diet). In particular, the banana fruit demonstrated the highest palatability among the foods.

1 Introduction

Indonesia is a country rich in flora and fauna diversity. Geographically, Indonesia is flanked by two continents, the Asian and Australian continents, and two oceans, the Indian Ocean and the Pacific Ocean, which makes Indonesia rich in biodiversity [1]. As

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many as 12% of the world's animals come from Indonesia. Indonesia has approximately 40 primate species, or 25% of 200 species worldwide. As many as 24 species of Indonesian primates are endemic. Almost all of them are endangered or extinct [2]. The Sunda slow loris is one of the endemic and endangered Indonesian primates (*Nycticebus coucang*).

Sunda slow lorises are found in Sumatra. Generally, Sunda slow lorises can be found in areas with an altitude of 1,300 meters above sea level that inhabit primary, secondary, or community forests. However, uncontrolled hunting and illegal trade have caused a declining population, which resulted in this species being included in the endangered animal category (EN) [3]. As the illicit trade in Sunda slow lorises increases, the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) has categorized the Sunda slow lorises into Appendix I, meaning that international trade is prohibited. In addition, Sunda slow loris is included in the protected animals by the Indonesian government, based on the Regulation of the Minister of Environment and Forestry Number P106/MENLHK/SETJEN/KUM.1/12/2018 concerning Protected Plants and Animal Species. Nevertheless, Sunda's slow lorises illegal trade continues.

Ex-situ conservation with a captive breeding system needs to be carried out to maintain the Sunda slow loris population. One of the ex-situ conservation facilities is the Primates Research Center (PRC), IPB University. The Indonesian Minister of Agriculture recognized the captive breeding facilities at PRC-IPB in 2004. Understanding the feeding behavior can be the first step towards successfully increasing the Sunda slow loris population through a captive breeding system. Sunda slow lorises are included in omnivorous primates. Gums, fruits, seeds, leaves, insects, bird eggs, lizards, and small animals are the main foods they consume [4]. Ex situ conservation feed availability and daily behavior patterns will differ significantly from their natural habitat [5]. Therefore, this study aims to observe the feeding behavior and feed palatability of Sunda slow loris at the PRC-IPB.

2 Materials and methods

2.1 Times and locations

Data collection occurred at the Conservation Laboratory of the PRC-IPB, located at Lodaya Street II No. 5, Bogor. Preparation and data collection spanned roughly four months, with a two-week habituation period from late January to February 2024 to acclimate to the animals observed. Data was collected over 30 days from mid-February to mid-March 2024. Data analysis was conducted at the Biology Laboratory, Faculty of Mathematics and Natural Sciences, Sebelas Maret University (UNS).

2.2 Materials

The research objects were six individual Sunda slow lorises, consisting of three females and three males. Two individuals were in a cage measuring 2 m x 2 m (Table 1). The Sunda slow loris' daily feed consisted of four ripe bananas, one piece of ripe papaya, a

quarter of a boiled chicken egg, and drinking water. Live crickets were provided once every two weeks as additional feed.

Table 1. Sunda slow loris is an individual at Primates Research Center (PRC), IPB University.

No	Individual	Sexes	Cages
1	C1	Female	Cage 1
2	C2	Female	Cage 3
3	C3	Female	Cage 5
4	C4	Male	Cage 3
5	C5	Male	Cage 4
6	C6	Male	Cage 6

2.3 Feed palatability of Sunda slow loris.

Feed weighing was done daily at 05:00 pm to obtain the initial feed weight. The weighed feed was placed into each Sunda slow loris cage at 06:00 pm. The remaining feed was weighed twelve hours after initial weighing. Feed palatability was calculated using the reference formula [6]:

$$\text{Feed palatability} = \frac{\text{Weight of initial feed (gr)} - \text{Weight of remaining feed (gr)}}{\text{Total weight of initial feed (gr)}} \times 100\%$$

2.4 Daily and feeding behavior

The feeding behavior of Sunda slow lorises was observed using the focal animal sampling method. The focal animal sampling method is sampling animal behaviors with all events or behaviors of specific individuals or groups of individuals recorded during each period in a predetermined time interval [7]. Observations were carried out for six days a week, Monday to Saturday. Each behavior was observed and simultaneously adjusted to the distance/condition of the cage between individuals. The time interval observation was 5 minutes. The feeding behavior of Sunda slow loris consisted of ingesting behavior, drinking behavior, and defecation behavior. Its daily behavior consisted of moving, resting, and probing behavior, which was also recorded. The percentage of feeding behavior and daily behavior was calculated using the formula [8] as follows:

Percentage of feeding behavior or daily behavior of Sunda slow lorises:

$$P = \frac{X}{Y} \times 100\%$$

Description:

P = percentage of an observed behavior

X = frequency of an observed behavior

Y = total frequency of all observed behaviors

2.5 Data analysis

Data on daily behavior and feeding behavior were presented in diagram charts and analyzed statistically using One-Way ANOVA to compare between sexes. Feed palatability data was analyzed descriptively. Data analysis was performed using Rstudio software version 2024.04.1-748.

3 Results and discussion

3.1 Feed palatability of Sunda slow loris at PRC-IPB.

Sunda slow loris at PRC-IPB receives two types of food: main feed and additional feed (enrichment). The main feed includes four kepok bananas, one piece of papaya, and a quarter of a boiled chicken egg. Additionally, they are given 15 live crickets. The diet at PRC-IPB is predominantly fruit, which is high in sugar, indicating that Sunda slow lorises consumes energy-rich foods. At San Diego Zoo, Sunda slow lorises are fed fruits, vegetables, and insects [9]. Sunda slow lorises eat fruits, small vertebrates, sap, insects, small reptiles, and birds in nature. Therefore, the diet at PRC-IPB aligns with their natural diet. They are fed daily at 6:00 pm, matching their nocturnal activity [10,11].

Table 2. Feed palatability of Sunda slow loris at Primates Research Center (PRC), IPB University.

No	Feed Item	Average Initial Weight of Feed (gr)	Average Remaining Weight of Feed (gr)	Total Initial Weight of Feed (gr)	Feed Palatability (%)
1	Kepok banana fruit	213.26	133.37	8846.3	0.90
2	Papaya fruit	63.87	29.93		0.38
3	Boiled egg chicken	14.78	0.29		0.16
4	Live crickets	3.00	0.00		0.03

Feed palatability was determined by the weight of feed consumed over 30 days. The results showed that Sunda slow lorises at PRC-IPB prefer bananas, followed by papaya, boiled chicken egg, and live crickets. The palatability of bananas was 0.90%, attributed to their significant proportion in the diet and their sweet, soft taste, preferred by the Sunda slow lorises. Evolutionarily, primates, including Sunda slow lorises, seek ripe, sweet fruits [12]. Sunda slow lorises have a sluggish metabolism, characterized by wide intestines and functional caeca, aiding in the digestion and fermentation of feeds containing sugar and other complex compounds [11].

The sweet taste of bananas comes from their natural sugar content, which increases with ripeness. Bananas have a high carbohydrate content (27%), with other components including 70% water, 0.5% fiber, 1.2% protein, and 0.31% fat [13, 14].

Papaya fruit provides good nutrients for Sunda slow lorises, with 100 grams containing 86.6 grams of water, 0.5 grams of protein, 0.3 grams of fat, 12.1 grams of carbohydrates, 0.7 grams of fiber, 0.5 grams of ash, and 74 mg of vitamin C [15]. Chicken eggs are also nutritious, containing 73.70% water, 0.90% carbohydrates, 12.90% protein, and 11.20% fat, aiding tissue growth and maintenance.

Crickets, fed as supplementary feed every two weeks, have the lowest palatability (0.03%). Insects provide protein and fat for Sunda slow lorises [9]. Feeding live insects ensures balanced energy intake and expenditure [16]. Sunda slow lorises at PRC-IPB have removed canine teeth, requiring soft-textured feed for good nutrition. The canines help them bite and chew tree exudates, so removal affects this ability. Consequently, they have adapted by eating softer feed and chewing more slowly [17].

3.2 Daily behavior and feeding behavior of Sunda slow lorises at PRC-IPB

The daily behavior of Sunda slow lorises at PRC-IPB was observed for 360 hours six days a week (Monday to Saturday) using the focal animal sampling method. Observations were divided into 6:00-12:00 pm and 00.00-06.00 am, with 12 hours per day and a time interval of every 5 minutes. Overall, the highest frequency of daily behavior performed by Sunda slow lorises at PRC-IPB, respectively, are moving behavior (73.8%), resting behavior (16.1%), and ingestive behavior (7.34%).

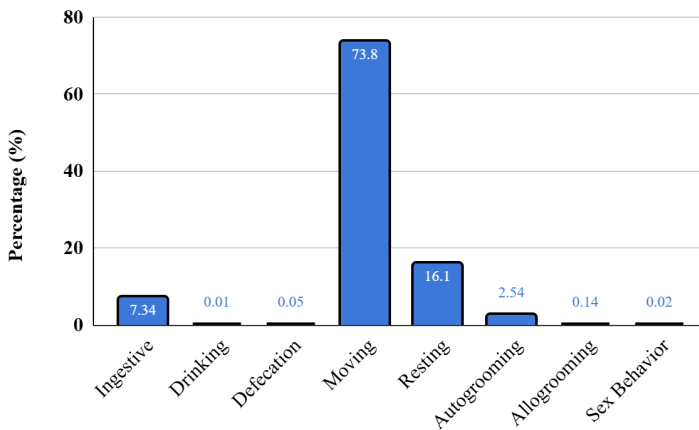


Fig. 1. Daily behavior of Sunda slow loris at PRC-IPB.

3.3 The daily behavior of Sunda slow lorises in PRC-IPB

Movement behaviors include walking, moving from one place to another, climbing, and hanging. Sunda's slow lorises use all four legs to move and climb. Statistical analysis shows that gender significantly affects (p -value < 0.05) the movement behavior of PRC-IPB Sunda slow lorises. Males move more frequently than females due to territorial marking and foraging behaviors [18,19].

Sunda's slow loris movement at PRC-IPB includes various activities such as hanging, using all four legs, walking on the cage floor, and climbing. Resting is the second most common daily behavior, accounting for 16.1%, and is not significantly affected by gender (p -value > 0.05). Resting behaviors include staying on tree branches, sitting on the floor, and sleeping in a ball shape. The high percentage of resting behavior is influenced by seasonal climate variations, temperature, and moonlight observed during the dry-rainy season [20]. Observations of Sunda slow lorises at PRC-IPB were carried out during the dry-rainy season, allowing sleeping or resting behavior

to increase during active time. Sunda's slow lorises returned to sleep in the nest between 5:00 and 6:00 am.

Grooming behavior includes auto grooming and allogrooming. Females more frequently engage in auto grooming, while gender does not significantly affect this behavior (p -value > 0.05). Allogrooming, performed only in the shared cage (Cage 3), is more frequent among males (0.1%) than females (p -value < 0.05). This behavior involves licking or biting body parts, especially after waking up, resting, or eating [21]. Mating behavior is observed only in pairs within Cage 3.

3.4 Feeding behavior of SundasSlow loris at PRC-IPB

3.4.1 Ingestive behavior Sunda slow loris in PRC-IPB

The frequency of ingestion behavior of Sunda slow lorises at PRC-IPB was significantly different based on gender (p -value < 0.05). In this study, male Sunda slow lorises tended to engage in more ingestion behavior than female Sunda slow lorises. Moving activities affect the eating behavior of male Sunda slow lorises. Male Sunda slow lorises tend to expend more energy to move, requiring more energy intake [15]. Females' Sunda slow lorises maximize energy more than males. In this study, the movement behavior percentage of male Sunda slow lorises was greater (27.26%) than that of females (25.87%).

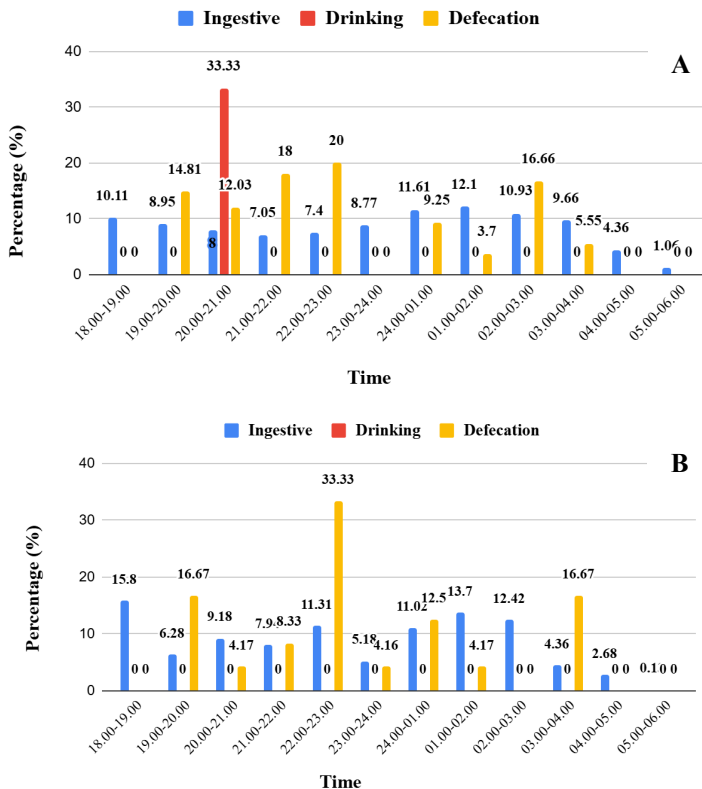


Fig. 2. The feeding behavior pattern of Sunda slow loris is at PRC-IPB. (A. Male and B. Female).

Sunda's slow lorises exhibit feeding behaviors such as selecting, smelling, taking, biting, swallowing, and discarding food. They choose accessible food like bananas on tree branches, papayas hanging from cage wires, live crickets, and boiled chicken eggs in containers. Sunda slow lorises often smell their food before using their front legs to bring it closer. They feed on the cage floor or tree branches, discarding scraps like banana skins. Sunda slow lorises may eat bananas directly from tree trunks or papayas with their heads up or down, depending on their grip on the cage wires. They use their front legs (anterior extremities) to hold food while their back legs (posterior extremities) hold the wire tightly.

Both male and female Sunda slow lorises started eating at 6:00-7:00 pm. The frequency of ingestion in male Sunda slow lorises increased at 1:00-2:00 am by 12.10% and decreased from 2:00-3:00 am to 10.93% until dawn to 1.06%. Meanwhile, the frequency of ingestion behavior in female Sunda slow lorises tended to be inconsistent. The ingestion behavior of female Sunda slow lorises tended to be higher at 6:00-7:00 pm or after they woke up from sleep. However, there was an increase in ingestion behavior at 1:00-2:00 am and decreased at 2:00-3:00 am until sunrise at 5:00-6:00 am.

In nature, Sunda's slow loris' feeding times range from 6:00 to 7:00 pm [21]. The high frequency of feeding behavior was because it was a wake-up time for Sunda's slow loris. When they wake up, Sunda slow lorises feed more to increase their energy [23]. Another study in captivity showed that the frequency of Sunda slow loris' feeding behavior increased at 00:00-02:00 am [24]. As a nocturnal animal, Sunda slow loris increases activity in the middle of the night. In addition, lower temperatures and higher humidity during the night until early morning encourage Sunda slow lorises to meet their energy needs to keep their body temperature warm. The frequency of Sunda slow loris ingestion behavior at PRC-IPB tends to decrease at 5:00-6:00 am when they start to sleep (inactive) as the sun rises [25].

3.4.2 Drinking behavior Sunda slow lorises in PRC-IPB

The frequency of Sunda slow loris drinking behavior at PRC-IPB did not differ significantly based on gender (p -value > 0.05). Drinking behavior was only found in male C6 individuals. Drinking water is provided in a coconut shell container that is hung near the nest. When drinking, he holds the water container using both front legs and then uses his mouth to drink. Sunda slow lorises infrequently drink because their water need has been fulfilled from the feed [26]. Bananas, papaya, and boiled egg chicken have a water content of 70% [14], 87.67% [27], and 73.7% [28]. In addition, slow movement can also be a factor that causes Sunda slow lorises to drink rarely [26].

3.4.3 Defecation behavior Sunda slow lorises in PRC-IPB

Defecation behavior is excreting solid waste or feces from the food digestion process. Defecation behavior is more frequent in male Sunda slow lorises (18.52%) than in female Sunda slow lorises (14.81%). This difference is significant (p -value < 0.05). Sunda's slow lorises defecation behavior was performed by staying on a tree branch in a

squatting position. Since Sunda slow lorises at PRC-IPB choose to consume more bananas than other feed items, the feces tend to have a solid texture and are not too soft. It differs from the captive's Sunda slow lorises' feces, which feed more papaya; they tend to have a slightly smoother texture [24].

4 Conclusions

The feeding behavior percentage of Sunda slow lorises (*Nycticebus coucang*) at PRC-IPB was lower (7.34%) than other daily behaviors. Males exhibited a significantly higher rate of ingestive behavior (19.74%), drinking behavior (33.33%), and defecation behavior (18.52%) than females. The initial active feeding time was 6:00-7:00 pm and increased during 00:00-02:00 am. The Sunda slow loris feed at PRC-IPB consisted of banana fruit, papaya fruit, boiled chicken eggs, and crickets (as an additional diet). In particular, the banana fruit demonstrated the highest palatability (0.90%) among the foods.

Acknowledgment

The author would like to thank the supervisor who has provided support in terms of both funds and contributions in completing this research.

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