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Tapanuli Orangutan Feeding (*Pongo tapanuliensis*) In Sitandiang Hamlet, Bulu Mario Village, Sipirok District, South Tapanuli

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Abstract: The tapanuli orangutan (*Pongo tapanuliensis*) is an endemic orangutan species found exclusively in the Batang Toru forest ecosystem, North Sumatra. Studying their natural diet is crucial to supporting conservation efforts for this critically endangered species. This research was conducted in Sitandiang Hamlet, Bulu Mario Village, Sipirok Sub-district, South Tapanuli Regency, with the aim of inventorying the types of food consumed by tapanuli orangutan and analyzing their feeding patterns in their natural habitat. The methods used included field surveys, interviews with local communities, and documentation. The findings revealed that tapanuli orangutan utilize a variety of plant resources, such as fruits, leaves, flowers, and tree bark. Their feeding patterns show a reliance on the availability of seasonal fruits, with an adaptation to consuming vegetative plant parts during off-fruit seasons. Local community knowledge about orangutan food sources also plays an important role in preserving their habitat. This study provides insights into ecosystem-based conservation management and emphasizes the importance of strengthening collaboration with local communities to support the sustainability of tapanuli orangutan populations in this region.

Keywords: Conflict, food, orangutan tapanuli, mitigation.

Introduction

The existence of orangutans in Tapanuli was reported in 1939 and is known as the sumatran orangutan (*Pongo abelli*). However, since 2017, the orangutan in Tapanuli, better known by the local name "Harangan Tapanuli", was declared a new species in the Batang Toru Ecosystem, Tapanuli Regency, North Sumatra, namely: as *Pongo tapanuliensis* (tapanuli orangutan). This species is different from 2 other species of orangutan, namely: P. abelli (sumatran orangutan) and P. pygmaeus (borneo orangutan). This difference is based on morphological characters (craniomandibular and dental) and DNA analysis (Nater et al. 2017).

The tapanuli orangutan population is estimated at 800 individuals (Nater et al. 2017). Kuswanda (2018) stated that the orangutan population in West Batang Toru is between 360-400 individuals, East Batang Toru is between 120-150 individuals, and South Batang Toru is 15-27 individuals. The Ministry of Environment and Forestry of the Republic of Indonesia has determined that the Tapanuli orangutan population in Batang Toru is 557-760 individuals in two metapopulations as stated in Minister of Environment and Forestry Decree No.SK.308/MENLHK/ KSDAE/KSA.2/4/2019 concerning Strategy and Plans Indonesian Orangutan Conservation Action (SRAK) 2019-2029.

The limited number of individuals and endemic distribution in the Batang Toru Ecosystem makes the tapanuli orangutan an endangered animal. Protected based on the Minister of Environment and Forestry Regulation Number P.106/MENLHK/SETJEN/KUM.1/12/2018 concerning Changes in Types of Protected Plants and Animals. According to the International Union for Conservation of Nature's

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red list (IUCN 2017), the tapanuli orangutan is included in the critically endangered category. Meanwhile, according to the Convention on International Trade in Endangered (CITES), the tapanuli orangutan (*P. tapanuliensis*) is included in Appendix I, which means that this species is prohibited from being traded (CITES 2019).

Orangutans consume fruit (frugivores) as the main source of nutrition. This animal consumes large grains so that the seeds are often not completely digested so the seeds are excreted intact. This is thought to make it easier for seeds to absorb water and germinate when located in a suitable environment, such as in nutrient-rich soil (Pasaribu & Rizki 2018). In foraging, orangutans move long distances, allowing them to spread seeds in other areas. Thus, orangutans are called keystone species and contribute to natural processes that support forest regeneration and the spread of plant species. The existence of orangutans is not only beneficial for themselves, but also supports the health and balance of the ecosystem as a whole. The health of tropical forests, which depend on this process of seed dispersal, is critical to the many species of flora and fauna that inhabit them the environment (Tarszisz et al. 2018). Therefore, orangutans are referred to as umbrella species.

Research on the tapanuli orangutan (*P. tapanuliensis*) has been carried out in various aspects, starting from the taxonomy of this species (Nater et al. 2017), the population status of the tapanuli orangutan (Prasetyo et al. 2021), identification of nest trees (Siregar & Riki 2018), tree structure and composition in the wild orangutan (*Pongo abelii*) habitat, Batang Toru Forest Area, North Sumatra (Simomangkir et al. 2009). Research by Simongmangkir et al. (2009) covers the areas of Aek Nabara, Sibulan-bulan, Sipetang, Sitandiang, Uluala, Haramonting, Lobu Sikkam, Tapian Nauli, Lobu Pining, Simardangiang, and Sitolubahal. Simongmangkir et al. (2009) stated that there are several tree species that are quite dominant in each type of Batang Toru forest as a food source for Sumatran orangutans, for example: *Madhuca* sp. and *Payena acuminata* (Sapotaceae) in lowland forests; *Castanopsis* sp. and *Lithocarpus conocarpa* (Fagaceae) in mixed forests; *Litsea firma* (Lauraceae) and *Podocarpus imbricatus* (Podocarpaceae) in upland forests; *Ganua* sp. (Sapotaceae) and *Garcinia bancana* (Clusiaceae) in mossy highland forest.

The Dolok Sibual-Buali Nature Reserve (CADS) and its surroundings are one of the last habitats of the tapanuli orangutan in the southern part of Lake Toba (Kuswanda 2007). When the initial survey was carried out in Bulu Mario Village, no tapanuli orangutans were found and there were only old nests, which were no longer used by the animals. According to Putro (2019), orangutans in the area is thought to have moved to another village because the animals were chased away by the villagers using air rifles (Hasibuan 10 August 2024, personal communication). Therefore, research on orangutan food was carried out in Sitandiang Hamlet considering that this area is a distribution area for tapanuli orangutans with a smaller population. A deep understanding of the food types of this species is very important for the conservation of the tapanuli orangutan for its survival.

Material and Method

Time and place of research

The data collection will take place over 10 effective days in the field, from August 1 to August 10, 2024. This research will be conducted in Sitandiang Hamlet, Bulu Mario Village, Sipirok District, South Tapanuli (Figure 3.1). The tools and materials used in this research include a digital camera, Stralex 8x40 binoculars with a Grossfeld 122 m/ 1000 m range, stationery, tally sheets, and clear plastic bags. The objects of this research are the tapanuli orangutan and fruit bearing tree species that serve as their food sources.

Data collection

This research employs three methods: literature review, observation, and documentation. The literature review serves as a foundation for observing the feeding habits of the Tapanuli orangutan and supports the data obtained. Observations of orangutans, as primary data, will be compared and cross-referenced with secondary data, which will reveal the diversity of food sources consumed by the tapanuli orangutan.

The observation method, which includes monitoring and sampling orangutan food sources, is conducted through field surveys and local interviews. These methods are used to collect data and samples, as well as to gather additional information from local communities regarding the types of food available and frequently consumed by the tapanuli orangutan.

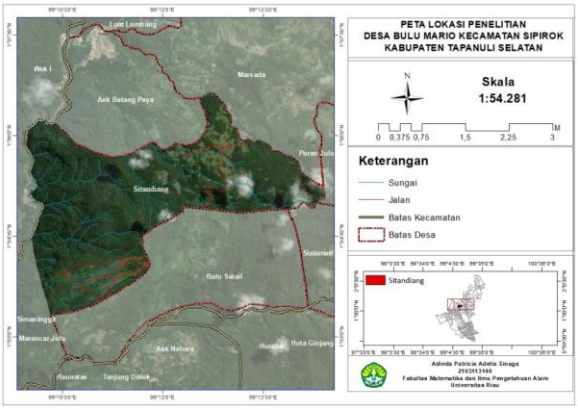

Figure 1 Map of the Tapanuli Orangutan Feeding Research Location
Source: Personal Documentation

Procedure

The data collection on the feeding habits of tapanuli orangutans in Sitandiang Hamlet, Sipirok District, South Tapanuli, was conducted by sampling each type of food and food remnants (such as fruits, seeds, leaves, or bark) that had been consumed by the orangutans. Documentation was carried out for each food type, and the photographs taken serve as a tool for identifying the food sources and as visual evidence of the collected data. Identification was assisted by a tour guide or ranger, who are local community members, to determine the local names of the food sources. Each orangutan food remnant was identified using relevant journals and theses and further confirmed by Rio Ardi, a botanist and the Restoration and Research Manager from the Sumatran Orangutan Conservation Foundation - Orangutan Information Centre.

Data analysis

The data analysis in this study will be conducted using a qualitative method to provide a comprehensive overview of the dietary diversity of Tapanuli orangutans in Sitandiang Hamlet. Data obtained from direct observations and interviews with local communities and rangers will be analyzed to identify the food sources most frequently consumed by the orangutans, including their species names and active compound content.

Morphological documentation or photographs will be visually analyzed to support the identification of food species and enhance understanding of the relationship between diet and orangutan health. Through this analysis, the study aims to draw conclusions about the importance of dietary diversity for the survival of the Tapanuli orangutan and to provide recommendations for more effective habitat conservation efforts.

Result and Discussion

Tapanuli Orangutan Feeding Habits in Sitandiang Hamlet

In Sitandiang Hamlet, Bulu Mario Village, Sipirok District, South Tapanuli, 27 plant species used as food sources for Tapanuli orangutans were identified. Of these, 23 were recognized as food species, while 4 species were only known by their local names (Table 1). The orangutan diet in Sitandiang consists mainly of leaves (77.78%), a combination of leaves and bark (3.70%), and fruits (18.52%). The findings indicate a shift in the orangutans' feeding behavior from frugivory to folivory during this period. This change is suspected to be due to the simultaneous fruiting season, which leads to a non-fruiting period, forcing the orangutans to switch and predominantly consume leaves to meet their nutritional needs.

Table 1 Tapanuli Orangutan Feeding Sources (*Pongo tapanuliensis*) in Sitandiang Hamlet, Bulu Mario Village, Sipirok District, South Tapanuli

No	Family	Latin name	Local name	Part of food
1	Anacardiaceae	*Campnosperma auriculatum*	Tumbus	Leaves
2	Anacardiaceae	*Spondias pinnata*	Dongdong	Leaves and fruit
3	Arecaceae	*Arenga pinnata*	Nira	Fruit
4	Clusiaceae	*Garcinia celebica*	Handis	Leaves

5	Euphorbiaceae	*Macaranga bancana*	Sapot	Leaves
6	Euphorbiaceae	*Omalanthus populneus*	Andulpak	Leaves
7	Fabaceae	*Parkia speciosa*	Potai	Fruit
8	Fagaceae	*Castanopsis inermis*	Hoteng Larangan	Leaves
9	Lauraceae	*Litsea cubeba* Lour.	Attarasa	Leaves
10	Lauraceae	*Phoebe* sp.	Modang Amburkom	Leaves
11	Lauraceae	*Phoebe* sp.	Modang Susun	Leaves
12	Loganiaceae	*Strychnos ligustrina*	Songgak	Leaves
13	Moraceae	*Artocarpus kemando*	Akorodan	Leaves
14	Moraceae	*Artocarpus altilis*	Hatopul	Leaves
15	Moraceae	*Artocarpus elasticus*	Torop	Leaves and fruit
16	Moraceae	*Artocarpus heterophyllus*	Nangka Hutan	Fruit
17	Moraceae	*Ficus benjamina*	Beringin	Fruit
18	Moraceae	*Ficus fitulosa*	Tappang	Leaves
19	Myrtaceae	*Eugenia* spp.	Jambu-jambu	Leavesand fruit
20	Myrtaceae	*Rhodomyrtus tomentosa*	Modang Harimoting	Leaves
21	Myrtaceae	*Syzygium polyanthum*	Ubar	Leaves and bark
22	Phyllanthaceae	*Baccaurea edulis*	Rambai Hutan	Fruit
23	Theaceae	*Adinandra dumosa*	Api-api	Leaves
24	-	-	Alihotang	Leaves
25	-	-	Ambogul	Leaves
26	-	-	Hasek	Leaves
27	-	-	Lossa	Leaves

Figure 2 Sample of tapanuli orangutan food leaves in Sitandiang Hamlet, Bulu Village Mario, Sipirok District, South Tapanuli (A) Torop (*Artocarpus elasticus*), (B) Hatopul (*Artocarpus altilis*), (C) Attarasa (*Litsea cubeba* Lour.), (D) Tumbus (*Campnosperma auriculatum*), (E) Api-api (*Adinandra dumosa*), (F) Andulpak (*Omalanthus populneus*), (G) Dongdong (*Spondias pinnata*), (H) Tappang (*Ficus fitulosa*), (I) Sapot (*Macaranga bancana*), (J) Modang Harimoting (*Rhodomyrtus tomentosa*), (K) Lossa, (L) Akorodan (*Artocarpus kemando*), (M) Ubar (*Syzygium polyanthum*), (N) Alihotang, (O) Songgak (*Strychnos ligustrina*), (P) Jambu-jambu *Eugenia* spp.), (Q) Ambogul, (R) Hasek, (S) Modang Amburkom (*Phoebe* sp.), (T) Hoteng Larangan (*Castanopsis inermis*), (U) Handis (*Garcinia celebica*), (V) Modang Susun (*Phoebe* sp.). Source: Personal Documentation

The tapanuli orangutan's food species consist of several families including Anacardiaceae, Arecaceae, Clusiaceae, Euphorbiaceae, Fabaceae, Fagaceae, Lauraceae, Loganiaceae, Moraceae, Myrtaceae, Phyllanthaceae and Theaceae with the Moraceae family being the family most commonly found in terms of the number of species and individual species found in Sitandiang Hamlet. Each food species has certain parts that are consumed by orangutans, such as *Campnosperma auriculatum*, *Rhodomyrtus tomentosa*, *Ficus fitulosa*, and several other species that only consume the leaves because they do not produce fruit. The food species *Arenga pinnata*, *Baccaurea edulis*, *Ficus benjamina* only consume the fruit, while some food species such as *Eugenia* spp. and *Spondias pinnata* consume the leaves and fruit by orangutans.

Based on the results obtained, tapanuli orangutans, particularly in Sitandiang Hamlet, consume a variety of food species, mainly leaves, especially during the non-fruiting

season. This occurs because orangutans are opportunistic feeders and omnivores, meaning they can eat whatever is available to them (Haddad et al., 2017). Orangutans are known to prefer leaves from trees that produce sap, as these types of leaves often contain beneficial nutrients such as proteins and minerals. Their preference for certain types of leaves or sap is also influenced by the orangutans' species and the local environmental conditions. For example, in degraded habitats or agroforestry areas, orangutans show more diverse eating habits, including consuming unconventional food sources (Laing et al., 2012).

The fruit consumed by tapanuli orangutans in Sitandiang Hamlet includes dongdong fruit, sugar palm fruit, petai, jackfruit, banyan fruit, guava, and torop fruit. Bitter fruits such as petai and dongdong are also consumed by orangutans, and it is known that these fruits are rich in essential nutrients such as proteins, fats, and fibers that are necessary for their growth and health (Schaik, 2003). The diversity in their diet also allows orangutans to take advantage of foods with stronger or unusual tastes. Some food samples were found on the ground with signs of tearing on the fruit stems and bite marks on the fruits (Figure 3).

Figure 3. Fruit Feed of Tapanuli Orangutans in Sitandiang Hamlet
Source : Personal Documentation

Active Compounds in Tapanuli Orangutan Food Sources

Orangutans require various active compounds to support their health and growth, including primary metabolites that are crucial for development and growth, such as carbohydrates, proteins, and fats, as well as secondary metabolites like flavonoids and tannins, which serve as antioxidants and anti-inflammatory agents. Carbohydrates and proteins are derived from various fruit and leaf species consumed in their natural habitat, while fats are also essential for energy (Russon, 2017). Some of the food species identified in Sitandiang Hamlet were analyzed for their active compound content to support conservation and maintenance efforts for this species.

By understanding the nutritional composition and secondary metabolites in their natural diet, we can design more effective rehabilitation and preservation programs, ensuring that Tapanuli orangutans in Sitandiang Hamlet receive the proper nutrients for their health and well-being. This information also aids in protecting the habitat of Tapanuli orangutans by identifying key food plant species critical for their survival. Additionally, a deeper understanding of the dietary needs of tapanuli orangutans in Sitandiang Hamlet can inspire more strategic conservation actions, such as replanting endangered food species and promoting sustainable ecosystem management. The active compound content of the tapanuli orangutan's food sources is presented in **Table 2**.

The content of carbohydrates, proteins, and fats as primary metabolites in the diet is crucial for orangutans to support their development, health, and survival. Carbohydrates provide the main energy source needed for daily activities and metabolism. Proteins play a role in growth, tissue repair, and the production of enzymes and hormones essential for bodily functions. Fats, although required in smaller amounts, offer a more concentrated energy source and assist in the absorption of fat-soluble vitamins (Dapkus et al., 2017).

Flavonoids, tannins, and saponins are secondary metabolites with various important functions for health, both in humans and animals, including orangutans. Flavonoids are known as antioxidant compounds that protect cells from damage caused by free radicals, and they also have anti-inflammatory and antimicrobial properties that help combat infections (Nabavi, 2015). Tannins, on the other hand, have the ability to bind to proteins and other compounds, which can help prevent poisoning and improve digestive health (Hasan, 2018). Saponins also serve as antimicrobial agents and have the potential to boost the immune system (Bhat & Poojary, 2017). Therefore, the presence of these three compounds in their natural diet is vital for

maintaining orangutans' health and well-being, supporting optimal body functions, and helping protect against various diseases.

Table 2. Active Compounds in Tapanuli Orangutan Food Sources in Sitandiang Hamlet, Bulu Mario Village, Sipirok District, South Tapanuli

No	Famili	Nama Latin	Nama Daerah	Bagian	Zat Aktif
1	Anacardiaceae	*Campnosperma auriculatum*	Tumbus	Leaves	Carbohydrates: approximately 35-50%, protein: 10-15%, fat: 2-4%, flavonoids, tannins, and alkaloids. (Sumardi *et al*. 2018)
2	Anacardiaceae	*Spondias pinnata*	Dongdong	Leaves and fruit	Carbohydrates: 25-40%, protein: 8-12%, fat: 2-5%, flavonoids, tannins, and organic acids. (Anwar *et al*. 2021)
3	Arecaceae	*Arenga pinnata*	Nira	Fruit	Carbohydrates: 30-45%, protein: 8-12%, fat: 1-3%, flavonoids, tannins, and saponins (Sari *et al*. 2020)
4	Clusiaceae	*Garcinia celebica*	Handis	Leaves	Carbohydrates: 30-50%, protein: 5-10%, fat: 1-3%, flavonoids, tannins, and organic acids (Simanjuntak *et al*. 2020)
5	Euphorbiaceae	*Macaranga bancana*	Sapot	Leaves	Carbohydrates: 30-50%, protein: 8-12%, fat: 1-3%, flavonoids, tannins, and saponins (Hartono *et al*. 2021)
6	Euphorbiaceae	*Omalanthus populneus*	Andulpak	Leaves	Carbohydrates: 35-50%, protein: 10-20%, fat: 2-5%, and contents of flavonoids, tannins, and saponins (Sudarsono *et al*. 2020)
7	Fabaceae	*Parkia speciosa*	Potai	Fruit	Carbohydrates: around 30-40%, protein: around 10-15%, fat: around 1-3%, flavonoids, tannins, and saponins. (Rahman *et al*. 2021)
8	Fagaceae	*Castanopsis inermis*	Hoteng Larangan	Leaves	Carbohydrates: 30-50%, protein: 8-12%, fat: 1-3%, flavonoids, tannins, and saponins. (Rahman *et al*, 2021)
9	Lauraceae	*Litsea cubeba Lour*	Attarasa	Leaves	Carbohydrates: 40-50%, protein: 10-15%, fat: 2-7%, flavonoids, tannins, and essential oils. (Ismail *et al*. 2019)
10	Lauraceae	*Phoebe* sp.	Modang Amburkom	Leaves	Carbohydrates: 30-50%, protein: 5-10%, fat: 1-3%, flavonoids, tannins, and essential oils. (Kurniawan *et al* 2020)
11	Lauraceae	*Phoebe* sp.	Modang Susun	Leaves	Carbohydrates: 30-50%, protein: 5-10%, fat: 1-3%, flavonoids, tannins, and essential oils. (Kurniawan *et al* 2020)
12	Loganiaceae	*Strychnos ligustrina*	Songgak	Leaves	Carbohydrates: 30-45%, protein: 8-12%, fat: 1-3%, alkaloids, flavonoids, and tannins (Harahap *et al*. 2017)
13	Moraceae	*Artocarpus*	Akorodan	Leaves	Carbohydrates: 40-50%, protein:

		kemando			10-20%, fat: 2-5%, flavonoids: 3.5%, and tannins: 4.2% (Prasetyo *et al*. 2019)
14	Moraceae	*Artocarpus altilis*	Hatopul	Leaves	Carbohydrates: 40-50%, protein: 10-20%, fat: 2-5%, flavonoids: 3.5%, and tannins: 4.2%. (Prasetyo *et al*. 2019)
15	Moraceae	*Artocarpus elasticus*	Torop	Leaves and fruit	Carbohydrates: 40-50%, protein: 10-20%, fat: 2-5%, flavonoids: 3.5%, and tannins: 4.2%. (Prasetyo *et al*. 2019)
16	Moraceae	*Artocarpus heterophyllus*	Nangka Hutan	Fruit	Carbohydrates: 30-40%, protein: 2-3%, fat: 1-2%, flavonoids: 10-15 mg/g in leaves (Adnyani *et al* 2017)
17	Moraceae	*Ficus benjamina*	Beringin	Fruit	Carbohydrates: 30-50%, protein: 5-10%, fat: 1-3%, flavonoids, tannins, and phenolic acids. (Purnamasari *et al*. 2021)
18	Moraceae	*Ficus fitulosa*	Tappang	Leaves	Carbohydrates: 25-40%, protein: 8-15%, fat: 1-3%, flavonoids, tannins, and saponins (Prabowo *et al.* 2020)
19	Myrtaceae	*Eugenia* spp.	Jambu-jambu	Leaves and fruit	Carbohydrates: 30-50%, protein: 7-12%, fat: 1-4%, flavonoids, tannins, and phenolic acids. (Widyastti *et al*. 2021)
20	Myrtaceae	*Rhodomyrtus tomentosa*	Modang Harimoting	Leaves	Carbohydrates: 30-45%, protein: around 5-10%, fat: 1-3%, flavonoids, tannins, and phenolic acids. (Noor *et al*. 2019)
21	Myrtaceae	*Syzygium polyanthum*	Ubar	Leaves and bark	Carbohydrates: 30-50%, protein: 8-15%, fat: 1-3%, flavonoids, tannins, and essential oils (Hidayat *et al*. 2021)
22	Phyllanthaceae	*Baccaurea edulis*	Rambai Hutan	Fruit	Water: 90%, carbohydrates: 3.7%, protein: 0.2%, fat: 0.2%, and contains phenolic compounds, flavonoids, and tannins (Gunawan *et al* 2016)
23	Theaceae	*Adinandra dumosa*	Api-api	Leaves	Carbohydrates: 30-45%, protein: 8-15%, fat: 1-3%, flavonoids, tannins, and saponins. (Sari *et al*. 2020)
24	-	-	Alihotang	Leaves	-
25	-	-	Ambogul	Leaves	-
26	-	-	Hasek	Leaves	-
27	-	-	Lossa	Leaves	-

In addition to flavonoids, tannins, and saponins, orangutans also require several other bioactive compounds to support their health. Omega-3 and omega-6 fatty acids, for example, are important for heart health and brain function, as well as having anti-inflammatory effects. Vitamins and minerals such as vitamin C, vitamin E, calcium, and iron are also essential for supporting the immune system, bone formation, and oxygen transport in the blood. Fiber is another important component

that supports digestive health and prevents gastrointestinal issues (Marsh & Smith, 2020).

The bark of the ubar tree (*Syzygium polyanthum*) is known to have benefits as both food and traditional medicine for orangutans. According to interviews with local communities, tapanuli orangutans are often seen consuming ubar bark (Hasibuan, personal communication). In the wild, orangutans utilize a variety of plants, including ubar, for food and medicinal purposes. Ubar is rich in bioactive compounds that can provide health benefits to orangutans, such as anti-inflammatory, antimicrobial, and antioxidant properties. Like many other tropical forest plants, this plant may help orangutans combat infections or digestive disturbances, as well as boost their immune system. Additionally, the use of medicinal plants is part of the adaptive behavior of orangutans in selecting food based on the diversity of natural resources available in their surroundings.

Figure 4. Ubar bark (*Syzygium polyanthum*)
Source: Personal Documentation

Understanding the bioactive compounds in the food sources of tapanuli orangutans in Sitandiang Hamlet is crucial for conservation efforts, particularly given their endangered status. By understanding the nutritional composition of the various plants consumed by the orangutans, we can identify food sources rich in bioactive compounds, such as flavonoids, tannins, and essential fatty acids, that are necessary for the orangutans' health. This information can be used to design better habitat management strategies, ensuring that orangutans have access to nutritious food that supports their health and reproduction. Moreover, sustainable natural resource management can help maintain healthy ecosystems and support the long-term survival of orangutans.

Knowledge of bioactive content also contributes to local community education about the importance of biodiversity and the need for orangutan food conservation. The people of Sitandiang Hamlet can be involved in habitat protection and restoration efforts by understanding the value of the food sources around them. By raising awareness about the important role of local flora in supporting orangutan health, communities can be motivated to engage in environmentally friendly farming practices and habitat preservation, thereby creating synergy between wildlife conservation and local community well-being. This will have a positive impact not only on orangutans but also on the ecosystem as a whole.

The sufficiency of bioactive compounds in orangutan food is essential to support their health and well-being. However, the percentage of bioactive compounds found in natural food sources, such as flavonoids, tannins, and protein, must meet specific nutritional requirements. For example, the protein requirement for adult orangutans ranges between 10-15% of their total daily food intake, while carbohydrates should supply around 50-60% of the total required calories. Fat, although needed in smaller amounts, should make up about 5-10% of the total intake (Marsh & Smith 2020). Research by Aveling et al. (2020) in the *Journal of Animal Ecology* suggests that food that does not meet these standards can lead to health problems, including decreased immunity and growth disorders. Therefore, it is essential to ensure that the food available in the orangutan habitat in Hamlet Sitandiang has sufficient content to meet their nutritional needs.

Conflict between Tapanuli Orangutans and Local Communities

Observations over the past 10 years have shown an increasing number of conflicts between humans and Tapanuli orangutans. Development around the orangutan habitat, especially infrastructure projects such as the Batang Toru hydroelectric power plant, has escalated conflicts with local communities. These projects not only destroy forests but also reduce the natural resources that orangutans depend on. Land clearing leads to habitat

fragmentation and reduces the orangutans' roaming area, resulting in more frequent interactions between humans and orangutans. Additionally, development activities pave the way for poaching and illegal logging, which further worsen the threats to the survival of Tapanuli orangutans.

Figure 5. Deforestation and fragmentation in Sitandiang Hamlet
Source : Personal Documentation

On the other hand, food conflicts between orangutans and local communities are also a significant issue. Farmers, who largely depend on agricultural yields, often suffer losses when their fruits are eaten by orangutans. Crops like durian, petai, jengkol, and aren (sugar palm) are frequently targeted as primary food sources for tapanuli orangutans, especially in Hamlet Sitandiang. The availability of natural food sources for orangutans has become increasingly limited due to land conversion, forcing orangutans to forage in farmers' fields. A key biophysical factor that heavily influences these conflicts is the proximity of farmers' fields to the forest boundary, which is typically around 20 meters (Putro et al., 2019).

Orangutans consume entire fruits from a single tree, and once the fruits are depleted, they move on to other nearby trees. Additionally, the sap of the aren tree, collected in bamboo tubes or lodong placed by farmers, is often damaged by orangutans trying to access the sap inside. Bamboo lodong are frequently found fallen from aren trees as a result of orangutans, causing significant losses for sugar palm farmers in Sitandiang Hamlet (Figure 6).

Figure 6. The Tapanuli orangutan damaged the bamboo tube (lodong) in Sitandiang Hamlet.
Source : Personal Documentation

From this conflict, it is known that the crop loss experienced by farmers, especially in Hamlet Sitandiang, can reach IDR 70,000,000.00 within a one-year period (Hasibuan, August 10, 2024, personal communication). This also occurs in several other villages such as Bulu Mario, Aek Nabara, and Batu Satail, with varying degrees of loss.

On the other hand, the Tapanuli orangutans do not only consume fruits from agricultural lands, but also feed on a variety of other foods such as leaves, shoots, flowers, epiphytes, lianas, wood starch, and tree bark. This behavior causes losses for farmers because the shoots of the aren fruit (*Arenga pinnata*) are potential sources of kolang-kaling (aren fruit) or palm sugar, which can be harvested about three months after the appearance of the "aren eye." Orangutans are particularly fond of aren shoots because, in addition to their sweet taste, aren trees are widely planted by the community and are often very close to other food plants for the orangutans (Siregar et al. 2015).

Other fruit shoots consumed by orangutans also reduce harvests for the local community. To mitigate these losses, the local community resorts to forcefully driving the orangutans away using air rifles, making fires under trees, or hitting the tree trunks while shouting to disturb the orangutans and drive them away from their fields. This harassment forces orangutans to move from one village to another, potentially causing psychological stress, which may make them more aggressive. The increasing intensity of the conflict with the community presents the risk of violent encounters and even killings due to these hostile methods (Putra et al. 2019).

Mitigation of Tapanuli Orangutan Protection and Management

The diminishing food sources, shrinking habitat, and the increasing human-orangutan conflicts pose major threats to the survival and well-being of the Tapanuli orangutan population. Therefore, conservation efforts have emerged, including education, policies, funding, collaboration, and partnerships with various conservation organizations to protect the Tapanuli orangutan population. One of the main priorities is ensuring the sustainability and increase in food sources necessary for the survival of the orangutans.

Planting tree species that are used as food or nesting sites for the Tapanuli orangutans is an important aspect of this conservation work. The conservation of the tapanuli orangutan (*Pongo tapanuliensis*) in terms of food source replenishment is a critical step in maintaining their population in their natural habitat. Given that this species is highly dependent on the diversity of fruit-bearing trees for their nutritional needs, replenishing food sources can be achieved by replanting native plants that serve as their primary food, such as forest durian, figs (*Ficus* spp.), and other local fruit trees.

This effort includes not only restoring damaged forests but also planting trees in surrounding buffer zones to expand food availability and reduce conflicts with humans. Additionally, introducing year-round fruit-bearing plants into orangutan habitats could help address seasonal food shortages. This program should be supported by the involvement of local communities, both through training in environmentally friendly agroforestry techniques and through conservation-based economic empowerment, ensuring benefits for both orangutans and surrounding communities. Sustainable food source replenishment can improve the survival of the Tapanuli orangutans while preserving the tropical forest ecosystem in the area.

Environmental impact assessments regarding road construction and infrastructure development should also be a primary focus of mitigation efforts, especially to support the habitat and natural ecosystem of the endemic species in Batang Toru. The development should be further evaluated in terms of its causes and potential solutions to arising problems. This can also be addressed by creating boundaries between development areas and natural ecosystems or forests for wildlife habitats in Batang Toru. These boundaries could also act as a solution to the issue of local farming being frequently encroached upon by Tapanuli orangutans, thus minimizing crop losses for the local farmers. While infrastructure development is important for regional advancement, the areas chosen for development should be carefully considered, as development in areas that divide the Batang Toru region and create edge effects would further exacerbate conflicts between endemic wildlife and humans.

Other forms of mitigation to reduce conflicts between the Tapanuli orangutans and local communities, especially regarding crop damage, include involving various parties responsible for wildlife conservation and protection, such as YOSL-OIC (Sumatran Orangutan Conservation Foundation - Orangutan Information Centre) and BBKSDA (Sumatran Natural Resources Conservation Agency).

These organizations can play a key role in safely and controlledly removing orangutans from farmers' fields. This eviction program aims to minimize losses for farmers caused by crop damage without endangering the lives of orangutans. The approach involves using non-harmful deterrents, such as sound or natural barriers, while ensuring that the orangutans return to their natural habitats without entering more dangerous or isolated areas. Collaboration among these involved parties is also essential to provide education to the local community about how to coexist with orangutans, thereby reducing potential conflicts in the future.

Conclusion

In Sitandiang Hamlet, the tapanuli orangutan’s food sources consist of 27 species, with 23 species identified and 4 others known only by their local names. These food sources include fruits, leaves, and tree bark, which are scattered across the area. Each available food source contains different active compounds that fulfill the nutritional needs of the tapanuli orangutans.

Infrastructure development such as hydroelectric power plants (PLTA), plantations, road construction, and illegal logging poses significant problems for the Tapanuli orangutans, as these activities threaten their habitat and food trees, which are essential for their survival. The harvests of local farmers, such as fruits, often become the primary food source for the orangutans. Farmers, feeling disadvantaged by this, sometimes resort to unfriendly methods of driving the orangutans away, endangering their safety.

The conflict between humans and orangutans can be addressed through several measures, including the reorganization of the Batang Toru Ecosystem by establishing a dedicated conservation area with sufficient habitat and food sources, protected from any activities that could threaten the Tapanuli orangutans or other wildlife. Additionally, creating boundaries between development areas and natural forests or the endemic ecosystems of Batang Toru is crucial. Educating and raising awareness among the local community about the importance of preserving the Batang Toru ecosystem, as well as fostering cooperation between the community, conservation organizations, and the government for the management and conservation of tapanuli orangutans, are also key steps to mitigating this conflict.

References

Adnyani MRD, Parwata MOA, Negara MS. 2017. Potensi Ekstrak Daun Nangka (*Artocarpus heterophyllus* Lam.) sebagai Antioksidan Alami. *Jurnal Harian Regional* 1 (1): 10-15.

Aisyah Y, Setiawan B, Damayanti E. 2018. Phytochemical and Antioxidant Activity of Shorea Resin from Borneo Island. *Natural Product Research 32*(2): 155-162.

Ancrenaz M, Whittaker RA, Marshall AJ, Melnick DJ. 2004. Orangutans and Their Habitats. *The Ecological Society of America* 15(5): 123-145.

Anwar MA, Harahap AA, Zainuddin A. 2021. Phytochemical Properties and Biological Activities of Spondias pinnata. *Journal of Medicinal Plants Research* 15(3): 56-63.

Arumugam P, Manjula P. 2019. Phytochemical Analysis and Bioactivities of *Parkia speciosa* (Petai) Pods. *Journal of Pharmacognosy and Phytochemistry* 8(4): 2047-2052.

Aveling CP dan Cuthill IC. 2020. Nutritional Ecology of Orangutans: Implications for Conservation. *Journal of Animal Ecology* 89(6): 1543-1554.

Azhari A, Muthmainnah S. 2021. The Potential of Kuweni (*Schleichera oleosa*) as a Natural Source of Antioxidants and Antimicrobial Agents. *Asian Journal of Pharmaceutical and Clinical Research* 14(3): 1-6.

Aziz A, Ahmad RJ. 2024. Bioprospeksi Keruing Gunung (*Dipterocarpusretusus* Bl) Sebagai Antibakteri Dan konservasinya Di Taman Nasional Gunungrinjani. *Jurnal Tambora* 8(1): 1-10.

Bhadani A, Kumar S. 2016. Phytochemical Analysis and Antimicrobial Activity of *Symplocos celastrifolia*. *Asian Pacific Journal of Tropical Disease* 6(1): 24-29.

Bhat R dan Poojary B. 2017. Saponins: Properties, Applications and Health Benefits. *Journal of Nutrition & Food Sciences* 7(5): 1-6.

Christine EMH, Ahmad S, Dian R. 2021. Aktivitas Harian Orangutan Kalimantan (*Pongo pygmaeus*) Pasca Pelepasliaran di Hutan Lindung Gunung Tarak, Kalimantan Barat. *Jurnal Zoo IndonesiaI*, 27(2): 91-98.

CITES. 2019. Convention on International Trade in Endangered Species of Wild Fauna and Flora. http://www.cites.org. diakses pada 8 Februari 2024.

Dapkus B, Houghton RA, Laffan S. 2017. Nutritional Ecology of Orangutans: Dietary Composition and Feeding Behavior. *American Journal of Primatology* 79(4): 67-78.

Davis MJ, Whelan P. 2017. Potential Applications of Insect Protein in Food Production: The Case of *Lymantria dispar*. *Food Research International* 99(1): 876-885.

Dewi C, Rohula U, Nur HR. 2012. Aktivitas Antioksidan dan Antimikroba Ekstrak

Melinjo (*Gnetum gnemon* L.). *Jurnal Teknologi Hasil Pertanian* 5(2): 74-81.

Gunawan, Tatik C, Sobir, Sulistijorini. 2016. Fitokimia Genus *Baccaurea* spp.. *Bioeksperimen* 2(2): 96-110.

Haddad A, Hari P, Muhammad SA. 2017. Perilaku Makan dan Jenis Pakan Orangutan (*Pongo Pygmaeus*) di Yayasan International Animal Rescue Indonesia (YIARI) Kabupaten Ketapang, Kalimantan Barat. *Jurnal Hutan Lestari* 5(2): 300-306.

Hanum F, Nugrahani EH, Susanti S. 2015. Pemanfaatan Sumber Daya Alam Terbarukan dalam Modal Sewa Ekonomi. *Jurnal Manajemen dan Agribisnis* 14(2): 57-70.

Hartono S, Wibowo A, Hidayati SN. 2020. Phytochemical Analysis and Biological Activities of Macaranga bancana. *Journal of Medicinal Plants Research* 14(8): 148-155.

Hasan N. 2018. Tannins: A Review on Their Chemical Properties and Biological Activities. *International Journal of Food Properties* 21(1): 2070-2086.

Hidayat T, Taufiq M, Abdurrahman A. 2021. Phytochemical Analysis and Biological Activities of Syzygium Polyanthum Leaves. *Journal of Medicinal Plants Research* 15(6): 97-104.

Ismail MR, Saari N, Ahmad FB. 2019. Chemical Composition and Biological Activities of *Litsea cubeba* (*Lour*.). *Journal of Essential Oil Research* 31(3): 263-270.

IUCN. 2017. IUCN Red List of Threatened Species. Diakses dari www.iucnredlist.org pada 8 Februari 2024.

Kumar P, Kumar S, Kumar A. 2020. Phytochemical Analysis and Biological Activities of *Osbornia octodanta*. *Journal of Medicinal Plants Research* 14(2): 16-23.

Kurniawan A, Widiastuti T, Rachmawati H. 2020. Phytochemical Screening and Biological Activities of *Phoebe* sp. *Journal of Medicinal Plants Research* 14(7): 145-152.

Kuswanda W. 2018. Update Sebaran Habitat dan Populasi Orangutan tapanuli (*Pongo tapanuliensis*). *Laporan Sintesa Penelitian*. Medan: Balai Litbang LH dan Kehutanan Aek Nauli.

Laing A, Kenneth P, Jahan S, Katie W. 2012. Ape Eviction? These Orangutans are Losing More Than Their Homes. Diakses dari http://adapt136.ucsc.edu pada 29 November 2024.

Marsh LK.dan Smith TE. 2020. Nutritional Ecology and Health of Orangutans: Implications for Conservation. *American Journal of Primatology* 82(6): 70-80.

Matsuura K, Nishida T. 2015. Chemical Composition and Antimicrobial Activity of Termite Secretions. *PLOS ONE* 10(5): 1-15.

Moustafa AM, Ezzat, SM, El SAM, Labib RM. 2014. Phytochemical and Biological Studies of *Ficus benjamina* Leaves. *Journal of Pharmaceutical and Biomedical Analysis* 89(1): 125-131.

Nabavi SF. 2015. Flavonoids and Their Effects on Human Health. *Current Medicinal Chemistry* 22(18): 2182-2194.

Nasution DPS, Abdul L, Mawardi, Ekariana SP. 2023. Keanekaragaman Vegetasi Tumbuhan Pakan Orangutan Sumatera (Pongo abelii). *Jurnal Pendidikan Sains dan Teknologi* 11(1): 119-128.

Nater A, Mattle GMP, Nurcahyo A, Nowak MG, Manuel M, Desai T, Krutzen M. 2017. Morphometric, Behavioral, and Genomic Evidence for a New Orangutan Species. *Current Biology* 27(22): 3487-3498.

Noor NM, Abdullah R, Ismail N. 2019. Phytochemical Analysis and Biological Activities of *Rhodomyrtus tomentosa*. *Journal of Medicinal Plants Research* 13(2): 22-30.

Ola MS, Ayo JO, Durodola OA. 2019. Nutritional Value and Health Benefits of Banana (*Musa acuminata*) : A Review. *Food Science & Nutrition* 7(9): 3144-3153.

Pasaribu SE, Rizki EH. 2018. Partisipasi Kelompok Pecinta Alam Forester Tapanuli Bagian Selatan Dalam Pelestarian Orangutan sumatera (*Pongo Abelii*) Di Cagar Alam Dolok Sibual-Buali Kabupaten Tapanuli Selatan. Jurnal Ilmu Pengetahuan Sosial 4(1): 17-23.

Prabowo HE, Widiastuti T, Nuryanto A. 2020. Phytochemical Screening and Biological Activities of *Ficus fitulosa*. *Journal of Medicinal Plants Research* 14(9): 111-118.

Prasain, JK, Stefanowicz, P. 2019. Chemical Constituents of Rinorea Species and Their Potential Biological Activities. *Journal of Natural Products* 82(7): 1985-1992.

Prasetyo D, Yokyok H, Wanda K, Jito S. 2021. Population Status of Tapanuli Orangutan (*Pongo tapanuliensis*) within the Renewable Energy Development and its Management Implications. *Forest and Society* 5(2): 478-493.

Prasetyo YT, Widiastuti T, Nugroho AS. 2019. Phytochemical analysis of Artocarpus species and their medicinal potential. *Journal of Medicinal Plants Research*, 13(5): 102-108.

Pratiwi D, Widyastuti T, Nugroho A. 2021. Phytochemical Analysis and Biological Activities of *Syzygium polyanthum*. *Journal of Medicinal Plants Research* 15(1): 34-41.

Purnamasari R, Nugroho A, Widiastuti T. 2021. Phytochemical Analysis and Biological Activities of *Ficus benjamina*. *Journal of Medicinal Plants Research* 15(5): 90-97.

Putro HR, Dones R, Harnios A, Rinekso S, Wanda K, Fitri N, Dede AR, Nandi K, Joko M, Yun Y, Fahmi H, Fadillah RNP, Yuri DS. 2019. *Ekologi Orangutan (Pongo tapanuliensis)*. Bogor: Pokja Batang Toru.

Rahman MM, Hossain MM, Begum F. 2021. Phytochemical Properties and Biological Activities of *Castanopsis inermis*. *Journal of Medicinal Plants Research* 15(1): 45-52.

Rahmasiahi, Shabran H, Tika Y. 2023. Skrining Fitokimia Ekstrak Metanol Daun Pandan Wangi (*Pandanus amarillyfolius Roxb*). *Journal of Pharmaceutical Science and HerbalTechnology* 1(1): 33-39.

Rizal A, Setyowati EM, Catur R. 2019. Phytochemical Content and Toxicity of Jengkol (*Archidendron pauciflorum*). *Journal of Applied Pharmaceutical Science* 9(5): 108-113.

Russon AE. 2017. Dietary Habits of Orangutans and Their Impact on Health. *Primates* 58(1): 1-11.

Sari AR, Sulistyowati L. 2020. Phytochemical Analysis and Antioxidant Activity of *Tetramerista glabra*. *Indonesian Journal of Pharmaceutical Sciences* 5(1): 10-17.

Sari DR, Setiawan H, Suhendi A. 2020. Phytochemical Analysis and Biological Activities of *Adinandra dumosa*. *Journal of Medicinal Plants Research* 14(11): 160-167.

Sari DR, Widiastuti T, Anwar M. 2020. Phytochemical Analysis and Biological Activities of *Arenga pinnata*. *Journal of Medicinal Plants Research* 14(6): 111-118.

Schaik CP. 2003. *Why are orangutans so frugivorous?*. Inggris: Cambridge University Press.

Schaik CP, Marc A, Gwendolyn B, Birute G, Cheryl DK, Ian S, Akira S, Sri SU, Michelle M. *2003. Orangutan Cultures and the Evolution of Material Culture. Science* 299(5603): 102-105.

Sharma A, Sharma P, Thakur A. 2020. Phytochemical Composition and Biological Activities of *Pimenta officinalis*. *Journal of Medicinal Plants Research* 14(4): 48-55.

Simanjuntak P, Nursyamsi D, Wibowo A. 2020. Phytochemical Analysis and Biological Activities of *Garcinia celebica*. *Journal of Medicinal Plants Research* 14(10): 128-135.

Siregar DI, Anita Z, Pindi P. 2015. Pemetaan Daerah Rawan Konflik Orangutan Sumatera (Pongo Abelii) dengan Manusia di Desa Sekitar Cagar Alam Dolok Sibual-Buali. *Peronema Forestry Science Journal*

Siregar RAD, Riki R. 2018. Identifikasi Sarang Orangutan tapanuli (*Pongo tapanuliensis*) di Kawasan Cagar Alam Dolok Sibual-buali. *Journal Education and Development* 6(2): 31-36.

Sudarsono S, Hidayati SN, Nasution SN. 2020. Phytochemical screening and biological activity of Omalanthus populneus. *Journal of Medicinal Plants Research* 14(2): 34-40.

Sudhakar C, Singh R. 2021. Nutraceutical Importance of Natural Products for Health. *Journal of Ethnopharmacology* 275(1): 1-12.

Sumardi S, Yuliana ND, Haryanto M. 2018. Phytochemical Screening and Biological Activities of *Campnosperma auriculatum*. *Journal of Medicinal Plants Research* 12(4): 66-72.

Supriatna, Jatna, Edy HW. 2000. *Panduan Lapangan Primata Indonesia.* Jakarta : Yayasan Obor Indonesia.

Syafriana V, Rachmatiah T, Utama NW. 2020. Aktivitas Antibakteri Ekstrak Metanol Kulit Batang Meranti Sarang Punai (*Shorea parvifolia* Dyer) Terhadap *Staphylococcus aureus* dan *Propionibacterium acne*. *Jurnal Farmasi Udayana* 2(1): 160-170.

Tarszisz E, Sean T, Mark EH, Helen CM , Adam JM. 2018. Gardeners of the Forest: Effects of Seed Handling and Ingestion by Orangutans on Germination Success of Peat Forest Plants. *Biological Journal of the Linnean* Society 123(1): 125-134.

Van SCP, Knott CD, Melnick DJ. 2009. *Orangutans: Geographic Variation in Behavior, Ecology, and Conservation*. New York: Springer.

Wich SA, David G, Nicola A, Marc A, Alessandro B, Stephen B, Lisa C, Roberto AD, Andi E, Gabriella MF, Benoit G, Simon JH, Isabelle L, Andrew JM, Anita N, Elis M, Nardiyono, Anton N, Kisar O, Adventus P, Purnomo, Andjar R, Dessy R, Adi HS, Imam S, Carel PS, Jamartin S, Stephanie S, Eddy S, Amat S, Albertus T, Graham U, Sri SUA, Erik PW, Erik M. 2012. Understanding The Impacts Of Land-Use Policies On A Threatened Species: Is There A Future For The Bornean Orangutan?. *PLOS ONE* 7(11): 1-10.

Widyastuti T, Anwar M, Nugroho A. 2021. Phytochemical Analysis and Biological Activities of *Eugenia* spp. *Journal of Medicinal Plants Research* 15(2): 123-130.

Yadav A, Choudhary D, Kumar A. 2015. Phytochemical Analysis and Antioxidant Activity of Shorea robusta. *International Journal of Pharmacognosy and Phytochemical Research* 7(4): 797-802.

Yantoko MY, Siti S, Yohanes EG. 2022. Aktivitas Makan Orangutan Kalimantan (*Pongo Pygmaeus Wurmbii*) di Taman Nasional Tanjung Puting Wilayah Camp Leakey Kab. Kotawaringin Barat Sebagai Penunjang Materi Konservasi. *Jurnal Ilmu Pertanian* 16(2): 115-125.

Yuniar SD, Susilowati H. 2021. Phytochemical Screening and Antioxidant Activity of Ethanol Extract of Rengas Leaves (*Gluta renghas*). *Journal of Pharmaceutical Research International* 33(1): 19-26.

Zukhri S, Rahmi N. 2019. Uji Efektivitas Antibakteri Ekstrak Etanol Daun Karet Kerbau (*Ficus Elastica* Roxb. Ex Hornem.) Terhadap Bakteri *Staphylococcus aureus*. *Jurnal Ilmu Kesehatan* 14(1): 58-70.