Identifying urban food trees in campus green spaces

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Abstract. The environmental impact of food is one of the drivers of cities' growing interest in the developed food system in urban areas, one of which is campus green space. Green spaces (GS) on campus accompany native trees, landscaping, and water features for nurturing wildlife and people in the surrounding campus. In addition, GS can provide food sources such as fruit, alternative food, seeds, and nuts. This study aims to identify food trees in 120 hectares of the University Sumatera Utara campus area through field inventory methods. Our research showed that 49 species belong to 18 families and 1536 individuals USU campus produce beneficial food for people surrounding campus, either fruit, nuts, and alternative food. Thus, we conclude that the university’s green space can support the urban area's vision as food providers and ecological services for achieving urban sustainability. Furthermore, gathering and gleaning from green space provides opportunities for inhabitants to maintain urban resources and deeply interact with nature.

1. Introduction

The University campuses in the world today have implemented the concept of green open space to create a lot of comfort in teaching and learning activities [1]. The pattern of utilization and development of green open space on campus is now increasingly diverse. It pays attention to the academic zone and pays attention to the existence of non-academic zones that will support teaching and learning activities [2]. The university is likened to an economic engine that has a major impact on the surrounding area. As universities are areas of innovation and learning, campuses are ideal locations to test the concept of sustainable development on a small scale [3]. Thus, universities also play an important role in realizing the Sustainable Development Goals, in particular, SDG 15, which seeks to protect forests and biodiversity and their sustainable management, and SDG 4, which aims to ensure qualitative education by promoting a culture of environmental awareness in students [4].

The University of Sumatera Utara (USU) campus is one of the green spaces (GS) in the urban area of Medan. The USU campus has an area of 120 hectares consisting of academic and non-academic zones. The research conducted by [5] found 121 tree species on the USU campus and belonged to 37 families. These species have various functions: producing food [6], wood [7], medicine [8], fiber [9], energy [10], absorbing pollutants [11], aesthetics [12], and bioherbicides [13]. Related to the function of GS as a means of food security in urban areas, the presence of trees on the USU campus is also a potential source of food for this purpose. Furthermore, it is well known that urban food forestry is considered to be able to more efficiently integrate ecosystem services into a landscape of species exchange and realize urban forestry services in improving air quality, air and climate regulation, oxygen production, erosion control, and biodiversity [14]. Therefore, our research aimed to identify food
producing trees in 120 hectares of the USU campus area to support the sustainability of Urban food forestry in the small-scale area.

2. Material and methods

2.1 Research location
This research was conducted in the University of Sumatera Utara campus (3.330 N and 98.390 E), located at Padang Bulan, Medan, with an area of 120 hectares. The Padang Bulan campus is located in the city of Medan with an altitude of 2.5-37.5 m above sea level with a range of 23.2°C-33.2°C. The average air humidity in the city of Medan is between 84-85%, and the average wind speed is 0.48 m/s, and the soil type is inceptisol [15].

2.2 Data collection
The field inventory method was applied for the diversity of food-producing trees data collection. An inventory was carried out on all tree species found in the campus area of 120. Each species was observed and measured for morphological characters, diameters, and heights. Identification of tree species was carried out using a tree identification manual. Local names were used to identify the taxonomy of species. Specimens that are ambiguous and have not been appropriately identified were taken for further identification in the Botany and Taxonomy laboratory, FORDIA (Forestry Research and Innovation Agency), Ministry of Environment, and Forestry-Bogor.

3. Result and discussion

3.1 Species abundance
The integration of urban food forests into urban infrastructure can provide many benefits for urban dwellers. There is evidence that urban food forests can motivate management practices and provide opportunities for people to interact with nature and one another [16]; enabling the development of more resilient food systems and promoting social and environmental sustainability [17]; increasing social cohesion and well-being and strengthening local communities [18]; increasing biodiversity [19]; and provide economic benefits for the municipality and its citizens [20].

As part of GS, the university campus can implement this concept on a small scale on food sustainability, one of which is promoting food-producing trees in the area. As part of GS in Medan city, the USU campus has regular planting for this purpose. Our study in USU Campus showed that 49 species belong to 18 families and 1536 individuals in the USU campus produce beneficial food for people surrounding campus, either fruit, nuts, and alternative food table 1. Some of the trees producing food are presented in figure 1.
### Table 1. Food producing tree in USU Campus

| No | Latin name               | Family          | Species abundance | Type of product | Native/exotic |
|----|--------------------------|-----------------|-------------------|-----------------|---------------|
| 1  | *Mangifera odorata*      | Anacardiaceae   | 2                 | fruit           | exotic        |
| 2  | *Mangifera foetida*      | Anacardiaceae   | 2                 | fruit           | exotic        |
| 3  | *Mangifera indica*       | Anacardiaceae   | 272               | fruit           | native        |
| 4  | *Anacardium occidentale* | Annonaceae      | 3                 | nut             | native        |
| 5  | *Annona muricata*        | Annonaceae      | 29                | fruit           | exotic        |
| 6  | *Annona squamosa*        | Annonaceae      | 1                 | fruit           | exotic        |
| 7  | *Annona montana*         | Annonaceae      | 2                 | fruit           | exotic        |
| 8  | *Garcinia atroviridis*   | Clusiaceae      | 14                | fruit           | native        |
| 9  | *Garcinia dulcis*        | Clusiaceae      | 1                 | fruit           | native        |
| 10 | *Garcinia mangostana*    | Clusiaceae      | 37                | fruit           | native        |
| 11 | *Diospyros discolor*     | Ebenaceae       | 4                 | fruit           | native        |
| 12 | *Muntingia calabura*     | Elaocarpaceae   | 38                | fruit           | exotic        |
| 13 | *Aleurites moluccana*    | Euphorbiaceae   | 22                | nut             | native        |
| 14 | *Antidesma bunius*       | Euphorbiaceae   | 28                | fruit           | native        |
| 15 | *Cynometra cauliflora*   | Fabaceae        | 2                 | fruit           | native        |
| 16 | *Pithecellobium dulce*   | Fabaceae        | 1                 | nut             | exotic        |
| 17 | *Theobroma cacao*        | Fabaceae        | 19                | nut             | exotic        |
| 18 | *Parkia speciosa*        | Fabaceae        | 2                 | nut             | native        |
| 19 | *Tamarindus indica*      | Fabaceae        | 305               | fruit pulp      | exotic        |
| 20 | *Gnetum gnemon*          | Gentianaceae    | 29                | bean            | native        |
| 21 | *Persea americana*       | Lauraceae       | 17                | fruit           | exotic        |
| 22 | *Durio zibethinus*       | Malvaceae       | 66                | fruit           | native        |
| 23 | *Theobroma cacao*        | Malvaceae       | 5                 | nut             | exotic        |
| 24 | *lansium domesticum*     | Meliaceae       | 13                | fruit           | native        |
| 25 | *Sondoricum koetjape*    | Meliaceae       | 9                 | fruit           | exotic        |
| 26 | *Artocarpus integer*     | Moraceae        | 2                 | fruit,nut       | native        |
| 27 | *Artocarpus heterophylla*| Moraceae        | 120               | fruit,nut       | native        |
| 28 | *Artocarpus artilis*     | Moraceae        | 31                | food alternative| exotic        |
| 29 | *Syzygium aqueum*        | Myrtaceae       | 56                | fruit           | native        |
| 30 | *Syzygium malaccensis*   | Myrtaceae       | 28                | fruit           | native        |
| 31 | *Syzygium cumini*        | Myrtaceae       | 24                | fruit           | native        |
| 32 | *Syzygium polyantum*     | Myrtaceae       | 9                 | fruit           | native        |
| 33 | *Psidium guajava*        | Myrtaceae       | 65                | fruit           | exotic        |
| 34 | *Psidium guajava Red.*   | Myrtaceae       | 1                 | fruit           | exotic        |
| 35 | *Myristica fragrans*     | Myristaceae     | 6                 | nut             | native        |
| 36 | *Averrhoa carambola*     | Phyllanthaceae  | 12                | fruit           | native        |
| 37 | *Averrhoa bilimbi*       | Phyllanthaceae  | 13                | fruit           | native        |
| 38 | *Baccaurea deflexa*      | Phyllanthaceae  | 1                 | fruit           | native        |
| 39 | *Morinda citrifolia*     | Rubiaceae       | 11                | fruit           | exotic        |
| 40 | *Flacourtia rukam*       | Salicaceae      | 6                 | fruit           | native        |
| 41 | *Dimocarpus longan*      | Sapindaceae     | 44                | fruit           | exotic        |
| 42 | *Nephelium lapaceum*     | Sapindaceae     | 126               | fruit           | native        |
| 43 | *Pometia pinnata*        | Sapindaceae     | 40                | fruit           | native        |
| 44 | *Manilkara zapotilla*    | Sapindaceae     | 7                 | fruit           | exotic        |
| 45 | *Manilkara kauki*        | Sapindaceae     | 3                 | fruit           | exotic        |
| 46 | *Chrysophyllum cainito*  | Sapotaceae      | 1                 | fruit           | exotic        |
Tamarindus indica is the most abundant species found on the USU campus, with 305 individual trees (19.85%). Tamarindus indica served a variety of functions and uses. The functions of tamarind trees cover not only small fruit of tamarind, which are tasted sourly for candy, food, and drink, but also as birds’ habitat. The high tree provides shading for cooling effects [21]. Tamarindus indica trees also provided shade in homes, public places for crops, and livestock. The tamarind trees are the big tree prospected in plant selection of urban greenery [22].

The second abundant species is Mangifera indica, with the individual number 272 trees (17.70%). Mango (Mangifera indica L.) is a member of the Anacardiaceae family and is known as the most popular, edible tropical fruit due to its unique taste, attractive color and taste, and high nutritional quality [23]. Mangoes are rich in vitamins, organic acids, carbohydrates, amino acids, phenolic acids (e.g., gallic acid, caffeic acid, and tannic acid), and certain volatile compounds. Pharmacological studies found the phenolic acid content in mangoes, considered a strong antioxidant, anti-diabetic, anti-inflammatory, antilytic, and anti-carcinogenic [24].

Based on families, Myrtaceae and Fabaceae are the most common families found on the USU campus. The Syzygium genus is quite dominant for fruit-producing trees from the Myrtaceae family. All Syzygium species are shown rich medicinal applications, and some studies have shown that this genus possesses useful therapeutic agents such as anti-diabetic, anti-cancer, antioxidant, and antimicrobial properties [25]. Besides the fruit and medicinal properties, Syzygium plays an important role in the forest ecosystem to maintain the balance of the components inside. This could mean the relationship is complementary and mutually beneficial among components in the ecosystem. Chrome (1985) stated that one form of this relationship is the system of pollination and fertilization of Syzygium cormiflorum with bats, birds, and insects as pollinator agents [26]. Fabaceae is known as a cosmopolitan family. Fabaceae has the advantage of nitrogen fixation for protein synthesis. This advantage causes the protein concentration in leaves and seeds to vary between 20% and 40% dry weight, depending on the species [27]. Local people also recognize Fabaceae as a source of amino acids and food beverages in the seeds and fruits they contain. In addition, Fabaceae are also a major provider of non-animal protein, along with carbohydrates provided by cereals [28].

![Figure 1](image_url)

**Figure 1.** Trees producing food in USU campus: (a) Tamarindus indica, (b) Flacourtia rukam, (c) Mangifera indica, (d) Anacardium occidentale
Based on their origin, food-producing trees on the USU Campus are divided into exotic species and native species. Among the 48 species found, 26 are native species, while 22 are exotic species from other tropical regions. Another study conducted by [29] found 34 edible fruit trees comprised of native and exotic in planted along the road of Yogyakarta with the dominant species T. indica (tamarind tree), A. heterophyllus, M. calabura, T. trifolla, and M. indica. Fruit trees are preferred as greenery plants that have more prospects for benefiting the city and society. These trees are categorized as productive trees, providing food and having other productive functions such as climate improvement, pollution control, and biodiversity.

Apart from being a means of food security, the planting of food-producing tree species must also pay attention to certain aspects of the risks posed. Furthermore, [30] recommends a study of the toxicological profile of the soil before planting food-producing trees to avoid the health risks posed by the uptake of pollutants such as heavy metals by plants. Species selection and culture techniques can also help prevent the accumulation of contaminants in the edible parts of the plant: translocation pollutants absorbed by roots to the edible parts, as well as the amount of air pollutants penetrating the fruit epicarp, proved to be very different for each species [31]. Technically, harvestable fruit is harmless and unsightly when it falls from the tree and can also attract pests and pests. Therefore, programs for maintaining and managing fruit trees are essential in developing a productive urban landscape. The limited use of space in the city is also the only reason for developing food security in urban areas; however, technical matters and important matters concerning population security and consumption safety also need to be considered.

4. Conclusion
Our research showed that 49 species belong to 18 families and 1536 individuals in the USU campus produce beneficial food for people surrounding campus, either fruit, nuts, and alternative food. Thus, we conclude that the university green space can support the urban area’s vision as food providers and ecological services for achieving urban sustainability. Furthermore, gathering and gleaning from green space provides the opportunities to increase people-nature experiences that help conserve urban resources.

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Acknowledgement
This research was supported by the Indonesian Ministry of Research, Technology/ BRIN through scheme Penelitian Dasar Unggulan Perguruan Tinggi (PDUPT) grant number 161/UN5.2.3.2/PPM/KP-DRPM/2021.