Faloak (*Sterculia quadrifida* R.Br.) bark harvesting for curing hepatitis in Kupang City: Herbal medicine in the urban environment

S Siswadi1,3, G S Saragih1,3, H Rianawati3, A Umroni3, E Pujiono3, R Setyowati3, V F I D B Wuli Turu3 and F Banani3

1Banjarbaru Environment and Forestry Research and Development Institute, Jl. A. Yani KM.28.7, Banjarbaru 70721, Indonesia
2Center of Research and Development for Quality and Environmental Laboratory, Gd. 210, Puspiptek, 15315, Indonesia
3Kupang Environment and Forestry Research and Development Institute, Jl. Alfons Nisnoni No.7, Kupang 85519, Indonesia

Email: zieslitbanglhk@gmail.com

Abstract. Trees in an urban environment play an important role. Studies have shown that the presence of trees can improve human physical and mental health. People in Kupang, Nusa Tenggara Timur Province, Indonesia, harvest *Sterculia quadrifida* R.Br. (faloak) bark for medicinal decoction for hepatitis and energy booster. Hepatitis cases in Kupang City continue to increase, from 40 cases in 2016 to 147 cases in 2017 and 220 cases in 2018. This study aimed to assess *S. quadrifida* bark harvesting intensity and its utilization in Kupang City. This study was conducted in five sub-districts in Kupang, namely Alak, Kelapa Lima, Kota Raja, Maulafa, and Oebobo. In each district, 20 faloak trees were selected to be observed. Parameters observed included: diameter, height, trees that were recently debarked and have recovered bark, distance from the road, and the presence of seedlings around the tree. The data were tabulated and analyzed descriptively. There were 98 trees observed because, in Kota Raja, only 18 faloak trees were found. The recently debarked trees in Kota Raja, Alak, and Maulafa were 54.12%, 49%, and 41.05%, respectively. Meanwhile, trees with recovered bark were found mainly in Kelapa Lima (50%), Oebobo (38.95%), and Kota Raja (31%). Most debarked faloak trees were those closest to roads and settlements with a diameter ranging from 10.38 to 89.17 cm. The distance from the road to the trees was 1-203 m. A large number of debarked faloak trees indicates a high demand for faloak bark.

1. Introduction
Kupang City consists of 6 sub-districts and 51 villages with a total population of 423,800 people in 2018. Based on its population, Kupang City is a "medium" city and categorized as one of the most developing areas in Nusa Tenggara Timur (NTT) Province [1]. However, as a developing area, several problems are faced. One of which is that health care is unaffordable for some people. People's income estimated by the minimum wage of Kupang City, which is around 1.85 million rupiahs [2], is sufficient for basic needs but cannot cover the health cost.
One of the most common diseases in Kupang is hepatitis. Hepatitis cases in Kupang City have increased from 2016 to 2018 [3-5]. Hepatitis treatment costs are expensive. For example, the expenses to buy hepatitis B drugs range from 10 to 100 million rupiah, depending on the brand of the drug (e.g., Telbivudine, Adefovir, Pegylated interferon and the duration of therapy ranging from 4 to 6 months [6]. Hepatitis vaccine is included in the basic immunizations for newborns provided free by the government. However, adults can also get Hepatitis A and B vaccines at the cost of 350 – 675 thousand rupiah. On the other hand, the hepatitis C vaccine has not yet been available, while the treatment can cost up to 2.5 million rupiah/week [7].

For generations, people in Kupang City have been using faloak bark (*Sterculia quadrifida* R.Br.) to treat hepatitis. Faloak is scientifically proven to contain anti-hepatitis active compounds [8-9]. In addition, the faloak bark contains phenolic compounds, alkaloids, terpenoids, flavonoids [10], antioxidants [11], anti-cancer [12], and immunomodulators [13-14]. Faloak bark also contains Hexadecanoic acid, which lowers cholesterol in the blood [15].

The utilization of medicinal plants in urban areas can be found in several locations. One of them is the Malay community in Jambi City, which utilizes 28 types of plants found in the urban forest of Bagan Pete, Jambi City [16]. In addition to having a function as an absorber of air pollution particles and creating a microclimate, some trees in urban areas also have potential as medicinal plants. For example, a previous study revealed that 9 out of 119 species of shade trees in Jakarta are Indonesian native plants and have the potential as antimalarial, antioxidant, antimicrobial, anti-inflammatory, anti-venom, odorant, antitumor, and anti-cancer [17].

The use of faloak as a medicinal plant is usually carried out by bark harvesting so that most faloak trees in Kupang City have been debarked. To avoid over-exploitation and ensure sustainable use of faloak, knowledge and assessment on the potential of faloak, bark harvesting techniques, and how the community utilizes the bark are needed. Therefore, this study aimed to assess *S. quadrifida* bark harvesting intensity and the utilization of the bark by the community in Kupang City.

2. Method

2.1. Study area

This research was conducted in Kupang City, Nusa Tenggara Timur province, located between 10° 36' 14" - 10° 39' 58" South Latitude and 123° 32' 23" - 123° 37' 01" East Longitude with an area of 180,127 km². Administratively, Kupang City consists of six sub-districts (figure 1). The elevation ranged from 0-50 m asl (in the northern area) to 100-350 m (in the southern area) with an average slope of 15%. The climate of Kupang City is tropical with two major seasons, the dry season and the rainy season, in which the period of the dry season (7-8 months) is longer than the rainy season (4-5 months). Based on the Population Census in 2020, population numbers in Kupang City are 442,758 people, dominated by productive age population (70%) [18].

2.2. Preliminary survey

To assess faloak bark harvesting, a preliminary survey was carried out to determine the location of the faloak trees and identify groups related to faloak utilization (faloak user, herbalist, faloak seller, and faloak suppliers). Based on the initial survey, 5 out of 6 sub-districts in Kupang city, namely Alak, Kelapa Lima, Kota Raja, Maulafa, and Oebobo sub-districts, were selected as study locations (figure 1). Meanwhile, the Kota Lama sub-district was not chosen because it is a trading and tourism area, so no faloak trees were found. Faloak trees grow naturally, and some trees are dispersed randomly, and some grow in a cluster.
2.3. Observation of faloak bark harvesting

During the faloak seeds collection in 2012 and 2014, the distribution of faloak trees in Kupang City was obtained. Based on the distribution information and to ensure that the selected samples are evenly distributed in each sub-district, 20 trees were purposively selected. The selected sample trees are generally in the yard, roadside, and garden. There are no specific criteria for the size of the diameter and height of the tree.

A tally sheet was used to collect data on the location of the coordinates and altitude, distance from the road, height, diameter, percentage of old debarking marks, recent debarking marks, and bark that was never debarked, flowering and fruiting stage, presence of seedlings, presence of pest attack on the bark. At the same time, the coordinates and altitude of the faloak tree were determined using GPS. The distance from the road was measured using a measuring tape for distances less than 10 meters and GPS for distances of more than 10 meters. Tree height and tree diameter were measured using a haga meter and diameter tape, respectively [19].

Bark harvesting dimensions were measured by a ruler and classified into old debarking marks, recent debarking marks, and the original bark. The old bark harvesting mark is the recovered bark with dark color. The recent debarking mark is indicated by visible or exposed inner bark (estimated to be one day to two months counted from the bark stripping time). The harvested bark dimension measurement starts from the ground level to the top that is still reachable. The measurement was carried out by estimating the size with millimeter block paper to compare the harvested surface area (figure 1).

However, a faloak tree was also debarked from the ground to the top of the tree. The number of flowering and or fruiting trees was recorded using binocular. Regarding faloak seedlings observation, data collection was carried out by direct observation for the presence or absence of faloak seedlings.
within a radius of 5 meters from the outer part of the canopy. The debarking marks were also observed for the presence of pests and fungi.

2.4. Interview with groups related to faloak bark utilization
Interviews were conducted with faloak users, herbalists, and faloak suppliers to obtain additional information regarding the social aspects of faloak utilization. Respondents were selected using the snowball sampling technique. The recommended number of respondents for the snowball sampling technique of medium population size is 2-20 people [20]. This study began with the number of faloak trees being debarked, either on the roadside or around the yards. Then interviews were conducted with several residents whose trees were debarked, and then they directed the interviewer to the herbalists. Another tree owner also showed some of his neighbors who have debarked faloak trees for hepatitis treatment. The garden owner also informed his family members who harvested faloak bark to sell to traditional markets in Kupang. In Pasar Kasih, Kupang City, information on herbal gatherers was obtained from faloak bark sellers.

In total, 20 respondents consist of ten faloak users, four herbalists, four traders of faloak bark, and two suppliers of faloak [21]. In interviews with faloak bark users and herbalists, the information asked were:

- How long does it take for a person to recover after consuming faloak?
- Where do they get the traditional knowledge?
- What mixture is used in their treatment?
- The origin of the faloak bark used?

Meanwhile, in interviews with faloak bark sellers and suppliers, the questions were: (a) how much faloak bark is taken from each tree and the origin of the faloak tree? (b) where do they sell faloak bark? (c) how many days/months do they harvest faloak? (d) how many are sold per year/week? and (e) the origin of the faloak buyer?

2.5. Analysis
A quantitative descriptive approach was used to analyzed data on faloak bark harvesting and social aspect of faloak utilization. The results of data analysis were then linked to the sustainable use of faloak.

3. Results and discussion

3.1. Faloak bark harvesting
There were 98 faloak trees measured in five sub-districts in Kupang City: 93 trees were debarked, and only five trees were never debarked. In Kelapa Lima and Maulafa, 100% of the faloak trees were harvested. Faloak trees in all sub-districts have a relatively large average diameter (> 30 cm) and a height of more than 5 meters. Based on interviews conducted with people who have faloak trees near their homes or yards.

A total of 93 (93.89%) of the 98 faloak trees in five sub-districts of Kupang City were harvested (table 1), and 51 trees (51.56%) had new debarked marks, and old debarked marks were found on 83 trees (84.89%). The results of this inventory indicate that the faloak tree is harvested repeatedly. It can be seen that all faloak trees have recent debarked marks as well as old debarked marks. In the Maulafa sub-district, there are more recently debarked trees than trees with old debarked marks. It shows that the faloak tree is an important tree for people in Kupang City. In the city park, green open spaces, and green lanes of Kupang City, faloak trees are naturally growing. However, faloak trees in these public spaces usually have debarked marks because people are free to harvest them.
The results of primary metabolites are distributed to nectar as food pollinators. Primary pollinators that have been found in faloak flowers are *Heterotrigona* sp bees and *Apis mellifera*. In addition, other factors that affect the flowering process of plants are primary metabolites. Primary metabolites play a role in forming flowering, and secondary metabolites support the flowering stage. The results of primary metabolites are distributed to nectar as food pollinators/pollinators. Primary metabolic tissue is susceptible to environmental disturbances such as heat and drought, inhibiting plant reproduction by disrupting the entire flower metabolism [23]. If plants lack water during flowering to bear fruit, fruit production will be disrupted [24].

Seedlings were found only around 15 faloak trees (15.30%). This low number of seedlings is probably related to Kupang's climatic conditions, such as rainfall, humidity, and air temperature. In 2017 and 2018, the average rainfall for the city of Kupang was 1,202 mm/year, with an average temperature of 27.48 and average humidity of 76.63% [2,25]. Besides that, another reason is the characteristic of

### Table 1. Inventory of debarked faloak trees in Kupang.

| Sub District | Total | Average Altitude (m asl) | Number of debarked trees | Trees with old recovery | Trees with new recovery |
|--------------|-------|--------------------------|--------------------------|------------------------|------------------------|
|              |       |                          |                          | N                      |                      |
|              |       |                          |                          | Average of recovery area (%) |                      |
|              |       |                          |                          | N                      |                      |
|              |       |                          |                          | Average of recovery area (%) |                      |
| Alak         | 20    | 149                      | 17                       | 15                     | 22                    |
| Kelapa Lima  | 20    | 49                       | 20                       | 20                     | 50                    |
| Kota Raja    | 18    | 151                      | 17                       | 17                     | 31                    |
| Mastafa      | 20    | 223                      | 20                       | 12                     | 21.67                 |
| Oebobo       | 20    | 66                       | 19                       | 19                     | 38.95                 |
|              | 98    | 128                      | 93                       | 83                     | 32.72                 |

Kelapa Lima sub-district and Alak sub-district are coastal areas. The distribution of *S. quadrifida* trees in these two sub-districts from the road is further than the other three sub-districts (85 and 64m). Oebobo and Kota Raja sub-districts are areas in the middle of the city with a flatter topography than Alak and Kelapa Lima. Faloak in these two sub-districts was generally found in yards or gardens around settlements. Maulafa sub-district is the furthest sub-district from the coast, with a hilly topography that is not too steep. Faloak in the sub-district of Maulafa grows mainly in the area for other uses area and on the roadside. Of these five locations, faloak in Maulafa and Alak sub-districts are more vulnerable to extinction due to the conversion of faloak habitat into settlements in these two areas.

### Table 2. Characteristics of faloak trees in Kupang.

| Sub-district | Total number of trees | Average diameter (cm) | Average height (m) | The average distance from the street (m) | Number of trees with seedling | Number of trees with pest attack | Number of Flowering trees | Number of Flowering and Fruiting trees |
|--------------|-----------------------|-----------------------|--------------------|------------------------------------------|-------------------------------|-------------------------------|-------------------------------|--------------------------------------|
| Alak         | 20                    | 31.39                 | 7.28               | 64.38                                    | 1                             | 2                             | 10                            | 9                                    |
| Kelapa Lima  | 20                    | 39.22                 | 5.76               | 85                                       | 4                             | 3                             | 13                            | 13                                   |
| Kota Raja    | 18                    | 40.99                 | 7.78               | 19.2                                     | 0                             | 2                             | 11                            | 5                                    |
| Maulafa      | 20                    | 41.05                 | 7.15               | 39.57                                    | 4                             | 3                             | 11                            | 10                                   |
| Oebobo       | 20                    | 32.33                 | 6.35               | 23.5                                     | 6                             | 4                             | 14                            | 9                                    |

The faloak trees in Kelapa Lima and Alak were located the furthest from the road (85 and 64.38m) compared to the average distance of faloak trees growing in Maulafa (39.57 m), Oebobo (23.5), and Kota Raja (19.2 m) (table 2). As many as 59 (60%) trees out of 98 faloak trees in Kupang city flower, only 46 (46.56%) produce fruit. It means that 22.03% of the flowering faloak trees do not pollinate, and the process of fruit formation is good. Internal and external factors influence the formation of flowers and ovules. These external factors include pollinators, water availability, and temperature [22]. Some pollinators that have been found in faloak flowers are *Heterotrigona sp* bees and *Apis mellifera*. In addition, other factors that affect the flowering process of plants are primary metabolites. Primary metabolites play a role in forming flowering, and secondary metabolites support the flowering stage. The results of primary metabolites are distributed to nectar as food pollinators/pollinators. Primary metabolic tissue is susceptible to environmental disturbances such as heat and drought, inhibiting plant reproduction by disrupting the entire flower metabolism [23]. If plants lack water during flowering to bear fruit, fruit production will be disrupted [24].
faloak trees in Kupang city growing on coral soil which causes the seeds to die before their dormancy period ends. Furthermore, harvesting the bark of faloak trees can trigger pest and disease attacks on tree trunks. Pests attacked a total of 14 trees (14.22%). Strips that have not been fully recovered cause pests such as termites, beetles, ants, and various other insects to take advantage of this condition to make holes in tree trunks for nesting. Apart from the faloak trees observed in this study, many faloak trees have died due to excessive harvesting and pest attack.

Figure 2. (a) debarked faloak tree on the roadside; (b) debarked faloak tree; (c) faloak tree which has never been debarked.

Figure 2 shows a blooming faloak tree. The flowering and fruiting phases of faloak trees generally occur not simultaneously, where the flowering stage usually starts in April. The fruit will completely run out after October [26]. Trees recorded as flowering were the remains of flowers that have not become fruit. Therefore, not all faloak trees are found to flower and not all flowering faloak trees fruit. So that only 48 trees (48.91%) of faloak trees were found that produce flowers.

Morphologically, the faloak trees in the five sub-districts of Kupang City do not have a distinct difference. However, the studies of genetic research of faloak trees from four sub-districts, namely Alak, Kelapa Lima, Maulafa, and Oebobo, resulted in two clusters, namely (1) Maulafa, Alak, and Kelapa Lima and (2) Oebobo and Kelapa Lima [27].

3.2. Faloak bark utilization
The reasons for the community to harvest the bark of the faloak tree can be classified into several groups: 1) For personal needs. Usually, they will harvest the faloak tree closest to the road, in public facilities, and the tree nearest to the house; 2) For sale. They harvest by selecting trees that have never been harvested. The recovery process of the bark of the faloak tree is complete (generally located far from settlements or roads) to obtain large amounts of smooth bark; 3) For ill family members that do not live in Kupang. Usually, they will harvest bark from a location with many faloak trees to get a lot of faloak bark. This second and third harvesting behavior is usually not only the part that is easily peeled but carried out more than 40% of the tree's bark so that it does not need to return to the exact location to harvest the bark of the faloak, and 4) to treat patients. This treatment practice is carried out by herbalists and only harvest trees that are around their homes. Usually, they also have a permanent tree that they will visit whenever there is a request for faloak bark from a patient. They take the bark as needed.
Recent debarking marks were found mainly in Maulafa and Oebobo, namely 18 and 13 trees (table 1). In these two sub-districts, many falaoak trees that were inventoried were found not too far from the road. In this condition, people from various sub-districts can come to peel the trees in Oebobo and Maulafa sub-districts. Hepatitis cases in Kupang City increased yearly, but in the Oebobo sub-district in 2017 and 2018, 48 people with hepatitis (table 3). Thus, there may be a relationship between the hepatitis case and the number of harvested falaoak trees in this area. According to consumers of falaoak bark decoction, they can recover from hepatitis by consuming falaoak decoction for two weeks to three months. However, on average, the benefit of drinking falaoak bark decoction takes effect from the second day after drinking it regularly, two to three times a day. Utilization of falaoak bark by boiling falaoak bark until it boils and the water is red. Most of these gatherers boil falaoak bark without mixing it with other ingredients, but some mix it with other ingredients such as ginger, turmeric, kencur, shallots, and garlic. It can be seen from the new debarked marks with hepatitis treatment practices carried out by the community. The use of falaoak is not only for hepatitis but also for several functions such as restoring stamina, back pain, blood purification after childbirth, stomach ulcers, and malaria [28-29].

Table 3. Hepatitis case in 5 subdistricts in Kupang.

| Sub-district | Year (Hepatitis case) | 2016 | 2017 | 2018 |
|--------------|-----------------------|------|------|------|
| Alak         |                       | 14   | 26   | 58   |
| Kelapa Lima  |                       | 0    | 24   | 45   |
| Kota Raja    |                       | 6    | 1    | 17   |
| Maulafa      |                       | 11   | 22   | 36   |
| Oebobo       |                       | 7    | 48   | 48   |

Source: [3-5]

Local market suppliers usually take one to two sacks (± 25 kg) of wet bark from forests, yards, and gardens and dry them in the sun for three days before they are sold to traders in the market. For shipping outside the area, it is usually not only done by suppliers. Still, it is usually done by people who are asked for help by their families who are sick with liver dysfunction taking one cardboard (8-10 kg of dry skin). The bark of the falaoak that is harvested by the community is not only intended for their families in the city of Kupang, but they send it outside the islands such as Flores, Java, Sumatra, and Kalimantan, and some even say that they have sent it to Malaysia and Australia.

People usually try to find the recovered bark from the falaoak tree, and if they don't find it, they will look for other falaoak trees nearby. There are also harvesting bark on the branches and roots, but there are not many of them. Some people choose to optimize harvesting the existing trees rather than looking for other trees that have never been debarked. As a result, many falaoak trees have been harvested even though the bark has not been fully recovered. However, the utilization of the recovered bark is appropriate because the antioxidant compounds in the recovered bark are higher than the bark that has never been debarked [11]. Intensive debarking caused the tree to be unable to recover and can become a nest for pests. Cambium removing when debarked can cause the death of the tree (figure 3).
Figure 3. (a) faloak tree attacked by pests and diseases, and (b) faloak tree die due to intensive debarking.

Considering the enormous benefits of faloak and massive environmental pressures for residential development, this plant is vulnerable to extinction. The public must be socialized on the importance of this plant to reduce pressure on faloak trees from land conversion. Faloak can be propagated generatively [30-31] and vegetatively [32].

4. Conclusion

More than 94.89% of the trees in Kupang city were debarked. The community used faloak bark to treat hepatitis. Faloak bark is an affordable alternative to cure hepatitis. The natural regeneration rate of faloak is low. Therefore, faloak propagation is needed to ensure their survival. Excessive harvesting can cause tree death.

5. References

[1] Sagajoka E and Banda F L 2020 Analysis of the characteristics and development disparities among districts/cities in east Nusa Tenggara province J. Ekon. Pembang. 17 186-197
[2] Statistics of Kupang Municipality 2019 Kupang Municipality in Figure 2019 Report Kupang
[3] Dinas Kesehatan Kota Kupang 2016 Profil Kesehatan Kota Kupang Kupang [in Indonesia]
[4] Dinas Kesehatan Kota Kupang 2017 Profil Kesehatan Kota Kupang Kupang [in Indonesia]
[5] Dinas Kesehatan Kota Kupang 2018 Profil Kesehatan Kota Kupang Kupang [in Indonesia]
[6] Andriani T 2018 Analisis efektivitas biaya (Cost Effectiveness Analysis) pengobatan hepatitis B kronik menggunakan interferon dan antiviral di RSUP H. Adam Malik [skripsi] Medan: Universitas Sumatera Utara [in Indonesia]
[7] https://Health.Detik.com. 2013 Mahalnya biaya pengobatan hepatitis bikin kantong kempis. Retrieved June 5, 2021, from https://health.detik.com/berita-detikhealth/d-2279570/mahalnya-biaya-pengobatan-hepatitis-bikin-kantong-kempis [in Indonesia]
[8] Sola M A W M 2019 Identifikasi bahan aktif kulit batang faloak (Sterculia quadrifida R. Br) sebagai antivirus hepatitis C. [thesis] Surabaya : Universitas Airlangga [in Indonesia]
[9] Dean M, Handajani R and Khotib J 2019 Faloak (Sterculia quadrifida R. Br) stem bark extract
The 2nd ISATrop2021
IOP Conf. Series: Earth and Environmental Science 918 (2021) 012014 doi:10.1088/1755-1315/918/1/012014

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inhibits hepatitis C virus JFH1 Orient. J. Chem. 35 430-435

[10] Siswadi S, Rianawati H, Saragih G S Sulistyjo D H 2014 The potency of falooak’s (Sterculia quadrifida, R.Br.) active compunds as natural remedy Forests and Medicinal Plants for Better Human Welfare 73-79

[11] Saragih G S and Siswadi S 2019 Antioxidant activity of plant parts extracts from Sterculia quadrifida R. Br Asian J. Pharm. Clin. Res. 12 143-148

[12] Rollando R and Prilianti K R 2017 Fraksi etil asetat kulit batang falooak (Sterculia quadrifida R. Br) menginduksi apoptosis dan siklus sel pada sel kanker payudara T47D J. Pharm. Sci. Community 14 1-14 [in Indonesia]

[13] Hertiani T, Purwantiningsih, Winanta A, Sasikirana W, Munawaroh R, Setyowati E P, Murwanti R and Siswadi 2019 In vitro immunomodulatory and cytotoxic potentials of falooak (Sterculia quadrifida R.Br.) bark Online J. Biol. Sci. 19 222-231

[14] Winanta A, Hertiani T, Purwantiningsih and Siswadi 2019 In vivo immunomodulatory activity of falooak bark extract (Sterculia quadrifida r.br) Pakistan J. Biol. Sci. 22 590-596

[15] Siswadi S and Saragih G S 2021 Phytochemical analysis of bioactive compounds in ethanolic extract of Sterculia quadrifida R. Br AIP Conference Proceedings vol. 2353 30098

[16] Albayudi A and Saleh Z 2020 potensi tumbuhan obat yang digunakan masyarakat melayu kota Jambi di hutan kota Bagan pete kota Jambi Bio-Lectura 7 1-9 [in Indonesia]

[17] Kemal R A, Yulita A, Nufadianti G, Rosadi I and Muthmainah S I 2015 Tumbuhan di kota urban Indonesia: Nilai bioteknologis dan proyeksi keragaman pada 2050 Pros. Seminar Nasional Masyarakat Biodiversitas Indonesia 21 Maret 2015 Yogyakarta [in Indonesia]

[18] Statistics of Kupang Municipality 2019 Kupang Municipality in Figure 2019 Report Kupang

[19] Delvaux C, Sinsin B and Damme P V Impact of season, stem diameter and intensity of debarking on survival and bark re-growth pattern of medicinal tree species, Benin, West Africa 2010 Biol. Conser. 143 2664-2671

[20] Nurdiani N 2014 Teknik sampling snowball dalam penelitian lapangan ComTech 5 1110-1118 [in Indonesia]

[21] Aragón C F Escudero A and Valladares F 2008 Stress-induced dynamic adjustments of reproduction differentially affect fitness components of a semi-arid plant. J. of Ecol. 96 222-229

[22] Gomez-Beloz A 2002 Plant use knowledge of the Winikina Warao: the case for questionnaires in ethnotobany Economic Botany 56(3) 231-241

[23] Borghi M and Fernie A R 2021 From flowers to seeds: how the metabolism of flowers frames plant reproduction Biochem. (Lond) 1-5

[24] Jaimez R E, Vielma O, Rada F and García-Núñez C 2000 Effects of water deficit on the dynamics of flowering and fruit production in Capsicum chinense Jacq in a tropical semiarid region of Venezuela J. Agron. Crop Sci. 185 113-119

[25] Statistics of Kupang Municipality 2018 Kupang Municipality in Figure 2018 Report Kupang

[26] Siswadi H R, Dani S H and Grace S 2011 Teknik konservasi dan domestikasi falooak (Sterculia quadrifida) sebagai tumbuhan obat potensial di NTT Report. Hasil Penelitian (Unpublished), Kupang [in Indonesia]

[27] Uslan U and Pharmawati M 2020 Genetic diversity of Sterculia quadrifida in Kupang, Indonesia based on RAPD (Random Amplified Polymorphic DNA) markers Biodiversitas J. Biol. Divers. 21

[28] Siswadi S, Raharjo A S, Pujiono E and Rianawati H 2016 Utilization of Falooak Bark (Sterculia quadrifida R. Br.) As Herbal Medicinal Raw Material on Timor Island. Savana biod. of Nusa Tenggara

[29] Siswadi S, Pujiono E, Rianawati H and Saragih G S 2016 Nilai Ekonomi Kulit Batang Pohon Falooak (Sterculia quadrifida R.Br.). Proc. of Mulawarman Pharm. Con. (Manado, 5-6 July 2013) 3 379-388 [in Indonesia]

[30] Siswadi S, Rianawati H, Umroni A, Hidayatullah M and Saragih G S 2020 Karakteristik
pertumbuhan faloak (*Sterculia quadrifida* R. Br.) asal populasi Pulau Rote J. Penelit. Kehutan. *FALOAK* 4 81-94 [in Indonesia]

[31] Siswadi S, Saragih G S, Setyowati R and Puspiyatun R Y 2019 Constraints in stem cuttings propagation of faloak (*Sterculia quadrifida* R.Br.) in high temperature region Proc. Promotin Sustainable Resources from Plantations for Economic Growth and Community Benefit Yogyakarta pp 27

[32] Rianawati H and Siswadi S 2020 Effect of donor plants and rooting medium on the stem cutting propagation of faloak (*Sterculia quadrifida*) *Trop. Drylands* 4

**Acknowledgment**
The authors wish to thank Environment and Forestry Research and Development Kupang Institute, Indonesia for funding this study.