

Ethnobotany and conservation of Kasturi (*Mangifera casturi* Koesterm.) by Banjar Tribe in South Kalimantan, Indonesia

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Ethnobotany and conservation of *Kasturi* (*Mangifera casturi* Koesterm.) by Banjar Tribe in South Kalimantan, Indonesia

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Abstract. Gunawan, Muhamat, Maghfiroh. 2024. Ethnobotany and conservation of *Kasturi* (*Mangifera casturi* Koesterm.) by Banjar Tribe in South Kalimantan, Indonesia. *Biodiversitas* 25: 1420-1426. *Kasturi* (*Mangifera casturi* Koesterm.) is a local fruit and has become the identity flora of South Kalimantan. This study aimed to investigate the knowledge of the Banjar tribe community and formulate a conservation strategy for *Kasturi* as the identity flora of South Kalimantan. Data on ethnobotanical knowledge were collected through interview technique. There were two types of informant: Key informants and additional informants. Key informants were selected through snowball sampling technique while additional informants were selected a combination snowball sampling and purposive sampling technique. The informants in this study have different background: Sex, age, job, marital status, and educational levels. The informants were grouped based on their age: teenagers (10-18 years), adults (19-59 years), and elders (60+ years). Data were analyzed using the formula of *Kasturi* plant parts usage (F), Fidelity Level (FL). All data collected were analyzed descriptively and presented in tables or diagrams. The Banjar tribe used *M. casturi* as source of food (63%), building material (32%), and drugs (5%). The parts of the *Kasturi* plant that are widely used by the community are fruit, which is 58%, stems are 37%, and leaves are 5%. The values of F (the frequency of parts of *Kasturi* used) observed from the economic use and health aspects of *Kasturi* include: building materials, food sources, economic and medicine. The value of F for economic use are 12.78%-100% and the value F for health aspect are 5%. The result of Fidelity Level (FL) analysis proves that all age groups had 100% of FL in utilizing fruits of *Kasturi* as local food source. The FL of *Kasturi* bark used is described as follows: 51.34% among teenagers, 89.54% among adults, 87.23% among elder as building materials. The FL value of leaf described 5% among elder. Most of the Banjar tribe get *Kasturi* fruit from plants that grow wild in their yards (42%) and only 6% have planted. The research indicated that *M. casturi* had high utility value for Banjar tribe. All parts of the plant (fruits, bark, and leaves) were exploited for economic and health. Conservation of *Kasturi* can be performed by: (i) Network development and collaboration for conservation efforts, (ii) Ex-situ conservation, (iii) Intensification of socialization and publication of *Kasturi*'s uses, and (iv) Environmental education. The result of the study can be used for management conservation of *M. casturi* to ensure the availability in the future.

Keywords: Banjar, conservation, endemic, ethnobotany, *Kasturi*

INTRODUCTION

Indonesia is a tropical country characterized by a high diversity of fruit with numerous benefits. Among several regions in the country, Kalimantan, also called Borneo, has been identified as one of the 24 other hotspots of flora diversity globally (Marchese 2015). In the diverse flora Kalimantan, *Mangifera* is an important genus of *Anacardiaceae*, a plant family producing several commercial fruits globally (Fitmawati et al. 2016). *Mangifera* holds the second rank among tropical fruits renowned for their exceptional taste, color, and diversity, following bananas (Singh et al. 2016). Globally, this genus comprises around 69 species, with 30 of them being endemic to Indonesia (Anggraheni and Mulyaningsih 2021). Based on IUCN data (2022), two Borneo-endemic species, *Mangifera casturi* Kosterm. and *M. rubropetala* Kosterm., have already become extinct in their natural habitats.

Mangifera casturi, known as *Kasturi*, is a native and endemic plant from Kalimantan, particularly South Kalimantan (Kostermans and Bompard 1993). The species went extinct due to the destruction of its native habitat. The

decline of *Kasturi* mango population is attributed to the felling of various local mango fruit trees, including *Kasturi*, to be used as building materials. This significant population reduction has led to the scarcity or complete disappearance of the plants. Additionally, forest exploitation in the form of illegal logging and clearing forests for settlements and plantations (oil palm) can damage the ecosystem, including the natural habitat of mango fruit plants.

Continued population decline and loss of *Kasturi*'s natural habitat could lead to the species' extinction. One of the efforts for conservation is through revealing the benefits of the species through ethnobotanical studies. Ethnobotany is a study that reveals the relationship between humans and plants and the use of plants by certain ethnicities. The results of ethnobotanical research can be used as basic data for conservation efforts and sustainable utilization of biological resources. Yusro et al. (2014) stated that local knowledge of the community needs to be maintained because it is very valuable for preserving biodiversity in Kalimantan forests. In this context, several biodiversity conservation strategies have been developed, such as the inventory of plant use, cultivation and conservation

through ethnobotany (Supiandi et al. 2019). Hence, the ethnobotanical study is anticipated to play a role in bolstering cultural sustainability in plant utilization. The knowledge within local communities also enhances advancements in science and technology, offering scientific methodologies that can be expanded upon for future sustainable applications (Cao et al. 2020).

Kasturi as endangered Kalimantan endemic has fragrant fruit and a sweet taste characterized by small-sized fruit with colors ranging from yellow-orange to purple-black (Figure 1). The Decree of the Minister of Indonesia No. 48 issued in 1989 designated *Kasturi* as the flora identity of South Kalimantan Province (Darmawan 2015). This is due to the popularity of the fruit, leading to rapid market sales during the fruiting season. Kalimantan Island is divided into five provinces, including South Kalimantan Province which majorly consists of the majority of the Banjar tribe. The Meratus Mountains area in South Kalimantan is home to an indigenous group called the Meratus Mountains Dayak or Bukit Dayak tribe. In recent years, ethnobotanical research has significantly increased in the field of pharmaceuticals and conservation programs globally, influencing biodiversity conservation (Pieroni et al. 2014), and the discovery of new food sources, health, and culture (Tamalene et al. 2016). Traditionally, relationship between *Kasturi* and local community has been established as a consumed fruit. Thus, ethnobotany of the *Kasturi* can be explored in the form the relationship between humans and plants to provide insights about the traditional local knowledge of the community regarding plants use to become valid information.

The decline of *Kasturi* population, which leads to extinction, may result in the loss of the benefits of *Kasturi*. Therefore, this study aims to reveal the utilization of *Kasturi* by the Banjar tribe and provide recommendations for *Kasturi* conservation strategies as a typical flora of South Kalimantan.

MATERIALS AND METHODS

Study area

The research was conducted in December 2022-July 2023 in South Kalimantan, Indonesia. Surveys were conducted in areas that were selected based on having the Banjar tribe, including district Banjar (BN), Tapin (TP), Hulu Sungai Selatan (HS), Hulu Sungai Tengah (HT), Balangan (BL), and Tabalong (Figure 2). The geographic scope of this study includes the area of approximately 1°21'49" S-1°10'14" S and 114°19'33"E-116°33'28"E.

Data collection and analysis

This study was carried out using a qualitative method with an ethnobotanical approach. Qualitative data were collected through open-ended, semi-structured, and structured interviews conducted at the homes of key and additional informants. Key informants were selected through snowball sampling based on information from the village head. Additional informants were selected using a combination of snowball and purposive sampling with the following

criteria: (i) informants who have used *Kasturi* plants; (ii) informants who know about the use of *Kasturi* plants (Al Yamini et al. 2023). Firstly, additional informants were obtained based on the recommendations of previous key informants, and secondly, the informants were screened to ensure that they met the predetermined criteria. The data collection process begins with the identification of key informants and ordinary informants who have knowledge about *Kasturi*.

The analysis included 212 informants, with 35 individuals from each district, representing diverse backgrounds in terms of sex, age, job, marital status, and educational levels (Susiarti et al. 2020). The participants were classified into different age groups, namely teenagers (10-18 years), adults (19-59 years), and the elderly (60+ years), as indicated in Table 1 (Ministry of Health of the Republic of Indonesia 2024). Ethnobotanical information encompassed the identification, habitat characteristics, techniques for obtaining *Kasturi*, cultivation methods, and its various uses (Desti et al. 2019). *Kasturi* specimens were collected in the field. Voucher specimens are kept at the Biosystematics Laboratory of Lambung Mangkurat University. The identification process uses the Mango Book (Kostermans and Bompard 1993) by matching the morphological characteristics of the specimen with the morphological characteristics in the book. The gathered data underwent descriptive analysis and was presented through tables or diagrams (Tallei et al. 2019). Descriptive statistical analysis was also used to describe/analyze parts of the *Kasturi* plant, which were often used for economic, and medical.



Figure 1. Tree and fruit of *Mangifera casturi*. Bar = 2 cm

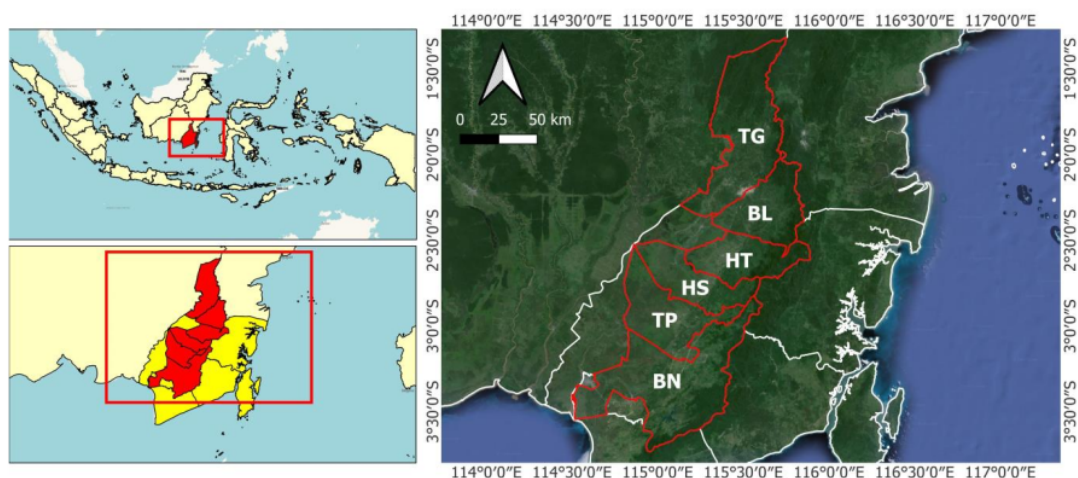


Figure 2. Location of study in South Kalimantan: BN: Banjar, TP: Tapin, HS: Hulu Sungai Selatan, HT: Hulu Sungai Tengah, BL: Balangan, TG: Tabalong

The frequency of *Kasturi* plant parts usage was assessed by gauging informant responses using the following formula:

$$F = \frac{S}{N} \times 100;$$

Where :

S : Number of informants with positive responses regarding plant parts used

N : Total number of informants

The formula elucidated by Monteiro et al. (2006) was employed to assess the level of consensus among the informants regarding the plant parts utilized.

The Fidelity Level (FL), employed to understand the specific purposes of using particular plant parts, was computed using the formula recommended by Friedman et al. (1986):

$$FL (\%) = \frac{n}{N} \times 100$$

Where :

n : Number of informants for a specific use

N : Total number of informants

RESULTS AND DISCUSSION

Socio-demographic characteristics

A total of 210 informants participated in this study, comprising 135 males and 77 females. The educational background of informants ranged from elementary school to college education, but most informants graduate from high schools. The age range of the informants was 10-60+ years old, with the majority being 19-59 years old and married (Table 1).

Morphology

The bark of *Kasturi*, has a grayish-white to light brown color, occasionally consisting of small cracks or gaps of ± 1 cm in the form of dead bark, which is similar to *Mangifera indica*. These plants can reach a height of 25-50 m or even more, with a stem diameter of ± 40 -115 cm, without buttress roots. When injured, the bark emits sap which is initially clear, reddish, and black within a few hours. The sap contains turpentine and has a strong odor, capable of injuring the skin or causing irritation, particularly for sensitivity. The leaves are singular, glabrous, arranged in a spiral or tight spiral, long-stemmed, elongated lanceolate with a pointed tip. Both sides of the central leaves vein are characterized by 12-25 sides, without support, while the young leaves hang limp, and are dark purple.

Kasturi flowers are bisexual compounds, forming coralline flowers in panicles with numerous, actinomorphic, and often covered in dense hairs. The length of the flower stalk is ± 28 cm with a very short stalk of 2-4 mm, sitting on panicle branches, while the leaves are elongated ovate and 2-3 mm long. The crown leaves are elongated and the flowers smell sweet. The stamens are the same length as the corolla, and the staminodia are very short, resembling stamens stuck to the base of the flower (Rashedy et al. 2014). *Kasturi* mango fruit is round to elliptical, weighing 60-84 g, 4.5-5.5 cm long, and 3.5-3.9 cm wide. Furthermore, the flesh is yellow or orange, stringy, and the texture is slightly rough, the fruit tastes sweet, slightly sour, and has a distinctive aroma. The skin of the fruit when it is young is green, and turns blackish brown at an older age, with a smooth surface. The fruit is oval with a length/width ratio of 1.25-1.53. The thickness of the fruit skin is around 0.24 mm and the seeds are classified as stone seeds with thick walls. A single seed, occasionally with multiple embryos, is enveloped in a hardened, skin-like endocarp shell. At the beginning of the rainy season or around January, this mango bears fruit.

Habitat

Based on observations at the location, *Kasturi* grows in the yards and fields of the Banjar tribe. Besides that, it is also found growing in secondary forests and on the banks of rivers. From the results of a survey conducted on several owners of *Kasturi*, it is known that the majority of these fruit plants were left over from the owners' parents, many of which grow wild (without cultivation technology), are up to 50 years old, and there has been no effort from the owners to carry out rejuvenation or seeding. Profile habitat of *Kasturi* is at an altitude (35-109 masl), air temperature (27.9-33.1°C), humidity (64.3-86.9%), light intensity (19.442-96.938 lux), soil temperature (27.1-32.8°C), soil moisture (40.6-77.2 %), and soil pH (5.4-6.8) (Gunawan et al. 2022).

Local knowledge of *Mangifera casturi*

Mangoes have become an integral part of Indonesian life, offering economic, health, and cultural benefits. The Javanese people have also been acquainted with mangoes for more than 10 centuries, as written in the Old Javanese Ramayana (Mulyanto et al. 2023). Similarly, the Banjar tribe in South Kalimantan has been using plants, including mangoes, during the time of their ancestors.

In this study, the values of F observed from the economic use and health aspects of *Kasturi* included: (i) building materials, (ii) food source, (iii) economic, and (iv) medicine. Knowledge values of *Kasturi* as construction materials were found in 12.78% of teenagers, 85.12% of adults, as well as 100% of elderly, with all groups using plants as food sources (100%). Furthermore, knowledge of the economic values of *Kasturi* as fruit that sells in the market was found in 89.19% of teenagers, 100% of adults, and elders. As medicine in Banjarnese ethnic group, a proportion of 5% was observed in the elders age, indicating significant health benefits, particularly as high uric acid.

Resulting Fidelity Level (FL) analysis showed that all age groups had 100% FL in using fruits of *Kasturi* as a local food source. The FL of *Kasturi* bark used was described as follows, 51.34%, 89.54%, and 87.23% among teenager, adult, and elderly respectively. Furthermore, the FL value of leaves had a proportion of 5% among elderly (Table 2).

Based on the results, the parts of the *Kasturi* plant that are widely used by the community include 58% fruits, 37% stems, and 5% leaves (Figure 3). The morphology characteristics show that the fruit flesh is dark orange, has a sweet and delicious taste. Moreover, the exceptional properties of the plant are evident in the fragrant fruit aroma, leading to the high preference by the majority population in South Kalimantan. Local people consume *Kasturi* fruit fresh and as a complement to fruit iced drinks. During the fruit season (November-January), the plant bears abundant fruit, with bunch prices ranging from IDR 20,000 to 25,000. Although the fruit flesh has a high water content (87.2%), acid levels (4.7%), and carbohydrates (12%) several other chemical components are low, such as protein (0.3%), fat (0.04%), starch (1.4%), total sugar (2%), and calories (9.6 cal/100g). The *Kasturi* fruit is a source of medicine due to its useful phytochemicals, including saponins, phenolics, tannins, triterpenoids, flavonoids, polyphenols (Darmawan 2015).

Harvesting *Kasturi* fruit when ripe is crucial for maintaining aroma and color quality. When harvested prematurely, the thick and hard skin of the fruit cannot be stored for more than six days, experiencing weight loss from 5 to 17%. Furthermore, a decrease in texture is observed during storage, leading to a wrinkled appearance (Antarlina 2009). Another part used by the community is the stem (wood), serving as building material and containers. According to the informants, the wood quality is not excellent for building materials due to its softness, leading to rapid decay. Additionally, only 5% of informants identified the Banjar tribe's use of the leaves as medicine for treating gout.

Every component of the *Mangifera* tree, including flowers, leaves, bark, fruit, peel, pulp, and seeds, possesses vital nutrients that can be utilized. Moreover, *Mangifera* peel comprises minerals, fiber, and antioxidants (such as phenolic compounds like mangiferin, kaempferol, quercetin, and anthocyanins), while the mango seed kernel contains starch, fiber, lipids, sterols (like campesterol, stigmasterol, and β -sitosterol), and tocopherols (Jahurul et al. 2015). *Mangifera* has been used extensively in traditional medicine for the treatment of conditions such as, diabetes, diarrhea, dysentery, rheumatism, high blood pressure, and various skin diseases (Parves 2016). Table 2 demonstrates that *Kasturi* is not only a source of food and materials, but its parts also have medicinal potential. Several previous studies have publicized the potential of *Kasturi* derived from several parts of the *Kasturi* as antioxidant, anticancer, antifungal, and anti-inflammatory properties (Table 3).

Table 1. Characteristic of informants

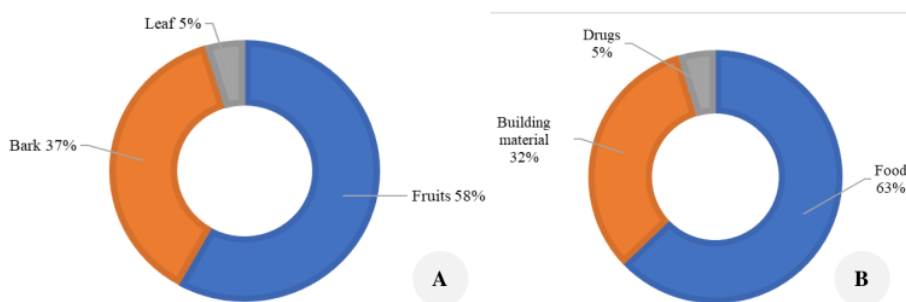
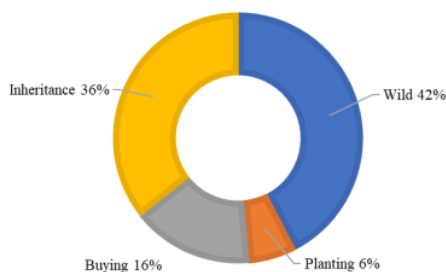
Characteristics	Data	Total	Percentage (%)
Sex	Male	77	36.7
	Female	133	63.3
Age	10-18	35	16.7
	19-59	110	52.4
	60+	65	30.9
Formal education	No educations	20	9.5
	Elementary school	48	22.8
	Secondary school	60	28.6
	High school	76	36.1
	University	6	3
Marital status	Single	27	12.9
	Married	167	79.5
	Widower	16	7.6
Occupation	Farmer	75	35.7
	Trader	25	11.9
	Laborer	46	21.9
	Employee	15	7.2
	Housewife	29	13.8
	Unemployed	20	9.5

Table 2. Part use and fidelity level of *Mangifera casturi*

Part use	Used	Fidelity Level (FL) %		
		Teenagers	Adults	Elderly
Fruits	Food	100	100	100
Leaves	Medicine	-	-	5
Bark	Constructions	51.34	89.54	87.23

Table 3. *Mangifera casturi* content and potential part

Part	Content	Potency
Skin	Saponins, flavonoids, tannins, and steroids (Zulfina et al.2021), distearil phosphite, Trans-13-octadecenoic acid, Heptadecane (Zulfina et al. 2021)	Anti-infectives, such as antiseptics, antibiotics, chemotherapy, contraception, antiasthmatic, bronchodilator, and medicine for bladder system illness (Zulfina et al. 2021)
Fruit	Methyl gallate (Sutomo et al. 2017), alpha hydroxy acid (Zulfina et al. 2021)	Antioxidants, Speed up the exfoliation of dead skin cells to promote soft and blemish-free skin
Leaf	Terpenoid and polifenol (Darmawan 2015); alkaloid, terpenoid, flavonoid, saponin (Rahim et al. 2017)	Antioxidants and tannins exhibit antibacterial, antiviral, and antitumor activities, antioxidants (Sutomo et al. 2017)
Bark	Terpenoid, steroid, and saponin (Rahim et al. 2017)	Antioxidants (Ramadhan et al. 2021),
Root	Saponin and tannin (Darmawan 2015)	Hypercholesterolemia, antioxidants, hyperglycemia, anticancer, antifungal, and anti-inflammatory properties

**Figure 3.** A. Percentage part used of *Kasturi*, B. Percentage useful of *Kasturi* by Banjar tribe, South Kalimantan, Indonesia**Figure 4.** Way to get *Mangifera casturi* by Banjar tribe

The Banjar tribe has not extensively cultivated *Kasturi*, with only a small population planting the seeds in gardens. *Mangifera casturi* ('Kasturi'), *M. caesia* ('Binjai'), *M. foetida* ('Hambawang'), and *M. odorata* ('Kueni') have been cultivated by local farmers. In contrast, others are wild in the forest to obtain the stems and fruit (Ariffin et al. 2015). According to the survey, the Banjar tribe obtained *Kasturi* fruit through planting, inheritance, and purchasing at traditional markets, as well as from wild plants, as shown in Figure 4. The majority of informants reported obtaining the fruit from wild plants in their gardens, while trees were typically passed down from parents to children. The fruit-bearing capacity was cited as the reason for the *Kasturi*'s existence, with many informants selling the fruit to collectors. Specifically, buyers would climb the trees, and harvest the fruits, which are transported to the local market.

Conservation strategies of *Kasturi*

Kasturi is a fruit plant endemic to South Kalimantan, that faces the threat of extinction due to the absence of local cultivation efforts and loss of *Kasturi*'s natural habitat due to land conversion to plantations and residential areas. Based on the survey conducted on several owners of *Kasturi* trees, it was discovered that most of these fruits were left over from their parents and have been growing wild without cultivation technology for approximately 50 years. However, there has been no effort from the owners to conduct rejuvenation or seeding. The cultivation is only carried out by plant collectors, causing a decline in the *Kasturi* and affecting both individual counts and genetic diversity. According to informants, the lack of cultivating *Kasturi* is attributed to the long fruiting period and thin flesh.

Kasturi has been assigned a classification in the IUCN Red List categories. The World Conservation Monitoring Center assessment team decided that *Kasturi* should be listed in the category extinct in situ of extinct in the wild (EW) category. Endemic fruit plants that are wild or have not been cultivated are often threatened by various human activities, such as the expansion of agricultural land, fires, conversion to plantations, and selective harvesting (Suwardi et al. 2020). In the case of Indonesia, mainly in the Kalimantan area, the depletion of forests can be attributed to the conversion of land for agricultural purposes (Busch and Ferretti-Gallon 2017), such as oil palm plantations, and mining. Restoration should be performed for the recuperation of forest ecosystems (Sofiah et al. 2018). According to Yang et al. (2013) habitat degradation, fragmentation, over-

exploitation, and a growing human population, are critical factors responsible for species loss worldwide.

Conservation strategies are essential to protect species from extinction. Based on research results, several efforts that can be made to protect the *Kasturi* from extinction include:

Network development and collaboration

These conservation efforts require collaboration from various parties, including academics, government companies, private companies, related agencies, and local governments. The success of conservation really depends on the role of each of these parties. Through collaboration, land conversion can be reduced

Ex-situ conservation

The development of regional botanical gardens will greatly assist conservation efforts. botanical gardens are not subject to land conversion, they can protect endemic species that are already highly endangered or extinct in their natural habitat.

Socialization and publication the benefit of *Kasturi*

Socializing the benefits of *Kasturi* as a food source, building material, and medicine to the local community will increase the local community's knowledge and information about *Kasturi*. Increased knowledge and information about *Kasturi* is expected to encourage local communities to plant *Kasturi*. Socialization can be conducted by the local government or related agencies.

Environmental education

Environmental education can be carried out starting from elementary school, junior high school and senior high school levels. This will increase knowledge and the importance of biological resources for human interests, as well as the importance of conservation efforts towards biological resources, including *Kasturi*.

This study presents insights into the ethnobotanical knowledge of the Banjar tribe regarding the utilization of *Kasturi*. The findings contribute to advancements in science and technology, shedding light on the potential of tropical plants in Borneo, Indonesia. Furthermore, these results serve as a foundation for sustainable conservation efforts, aiming to empower the local community. Traditional knowledge can be used as a means for in-situ conservation. Some sites that are identified as having *Kasturi* can be protected from logging and prioritized for conserving *Kasturi* in its native habitats.

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