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Revealing the biocultural importance of *Moringa oleifera* (Moringaceae) in three villages, Kediri District, Indonesia

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Abstract. *Afrianto WF, Metananda AA. 2023. Revealing the biocultural importance of* Moringa oleifera *(Moringaceae) in three villages, Kediri District, Indonesia. Biodiversitas 24: 6942-6952. Moringa oleifera* Lam. (Moringaceae) is a multi-purpose species with significant use and cultural importance. However, communities have yet to cultivate and use this plant intensively. This study aims to identify the biocultural importance of *M. oleifera* by the communities in Kediri District, East Java, Indonesia. The qualitative and quantitative ethnobotanical approach was carried out in three villages, namely Datengan, Cerme, and Ngablak Villages, Kediri District, East Java. Data were collected based on a survey of 60 informants through a semi-structured study, direct field observation, and in-depth interviews that were selected using snowball sampling. The results showed that *M. oleifera* has a score ICI of 20.19 and a UV score of 3. This plant has long been grown or grows naturally at all research locations. This plant was utilized for food, medicines, fooder feed, rituals, live fence, firewood, and most importantly, the leaves. This plant can grow in a variety of environmental circumstances and managed agroecosystem land, but it has yet to be actively grown. However, local knowledge of *M. oleifera* has declined, particularly among younger generations. The reason for this is that this plant species is less economically important than other agricultural goods. This *M. oleifera* study demonstrates the value of the cultural keystone species paradigm in landscape appraisal for conservation efforts.

Keywords: Biocultural, cultivation, *M. oliefera*, Kediri District, utilization

INTRODUCTION

Plants serve a variety of purposes, including being a vital and nutrient-rich source of food, a storehouse of medicinal compounds, an integral part of animal feed, a renewable energy source, a raw material for the production of charcoal, a medium for handicrafts, and a necessary component of construction activities (Boakye et al. 2023; Metananda et al. 2023; Muhesi et al. 2023). Various plant species have been identified and explored as potential traditional medicines for the treatment of several illnesses and for other derivative products (Arshad et al. 2023; Essandoh et al. 2023; Soussi et al. 2023). The traditional knowledge of such uses and practices has always been disseminated orally from generation to generation (Partasasmita et al. 2019). Currently, through more developed technology, plants are being investigated and studied to provide recombinant medications, genetic engineering for the food and agriculture industry, bioenergy, protein alternatives, and other secondary metabolites (Davies and Deroles 2014, Atanasov et al. 2015; Cherubin et al. 2018; Burnett and Burnett 2020).

Moringa oleifera Lam. is classified as a multipurpose plant because it can be used for food, oil, water purification, medicine, and other uses for local communities (Rockwood et al. 2013). Thus, *M. oleifera* is also known as a miracle tree (Awasthi et al. 2022). *M. oleifera* has been studied to be used for medicinal purposes in more than 300 diseases, and all the parts that have been reported can be used (Gopalakrishnan et al. 2016). *M. oleifera* has been reported as a nootropic, antidiabetic, anthelmintic, antioxidant, anti-inflammatory, diuretic, antiasthmatic, analgesic, anti-ulcer hepatoprotective, wound healing, gastroprotective, antipyretic, cardiovascular, antiepileptic, antimicrobial, anti-urolithiasis, local anesthetic, antidiarrheal properties, anti-allergic, anticancer, anti-obesity, immunomodulatory (Bhattacharya et al. 2018). Trends for *M. oleifera* as a valued plant also show continued growth in global academic research (Dou and Kister 2016; Gupta and Ahmed 2020; George et al. 2021). Furthermore, *M. oleifera* is used to enhance nutritional status and to solve malnutrition and food insecurity (Oyeyinka and Oyeyinka 2018; Bolarinwa et al. 2019).

It is a species of plant from the family Moringaceae and the genus *Moringa.* The distribution of *M. oleifera* is in numerous countries of the tropics and subtropics. (Leone et al. 2015). *M. oleifera* has several common names, i.e., moringa, horseradish tree, drumstick tree, and ben oil or benzolive tree (CABI 2017). This plant is categorized as fast-growing, drought tolerant, and grows in wide rainfall and soil conditions. It can grow with maximum temperature ranging from 38°C to 48°C and at least -1 to 3°C (Devkota and Bhusal 2020). The height of *M. oleifera* can reach a maximum height of 12 m, with a trunk medium size (30 cm in diameter) (Roloff et al. 2009). The character of the stem is woody, sturdy, thin skin, and the surface is rough straight up, but sometimes some grow sideways. The morphological characteristics of leaves are green and have glabrous surfaces (Zhigila et al. 2015).

However, despite the myriad of worthwhile uses associated with *M. oleifera*, communities still need to embrace or considerably cultivate this versatile plant thoroughly (Wati et al. 2022). Low dissemination of information also results in loss of access to resources (Salvi and Katewa 2016; Hussain et al. 2020). The management of plant cultivation is influenced by cultural attributes (Tebkew et al. 2014). Changes in trends and patterns of people's consumption continue to change over time, so several species of plants are once popular but are no longer in demand. Some factors influencing the desire for it are ethnicity, knowledge about biology, and the main socio-economy activities (Gandji et al. 2018). Exploration and study of the ethnobotany of *M. oleifera* in Kediri are essential for several reasons. First, a complete understanding of local agroecological conditions and particularities can unclose the maximum prospect of *M. oleifera* adaptability and resilience, providing optimal cultivation practices adapted to the area. Second, with their unique socio-economic and environmental dynamics, these study sites offer the opportunity to explore the miscellaneous uses of *M. oleifera* for community welfare. This has fulfilled healthy necessities, promoted sustainable agriculture, and contributed to economic development by growing and utilizing this versatile crop. This study will provide valuable insights beyond common knowledge, encouraging practical applications and societal benefits. The study aims to identify the biocultural importance of *M. oleifera* by the communities in Kediri District, East Java, Indonesia. Ethnobotanical exploration can be a first step and an effort to optimize bioprospection, eventually becoming a strategic step for conservation actions (Afrianto et al. 2020; Afrianto et al. 2022; Afrianto et al. 2023).

MATERIALS AND METHODS

Study area

This research was conducted in Datengan Village, Ngablak Village, Cerme Village, Kediri District, East Java Province, Indonesia (Figure 1) in March 2023. Ngablak is a village in the Banyakan Sub-district, while Datengan and Cerme Village are in the Grogol Sub-district. These villages are located in lowland topography. The majority ethnic of the three communities was East Java ethnic. The primary source of livelihood was agriculture, and some of the commodities cultivated included rice (primary), corn, tobacco, chili water melon, and rock melon.

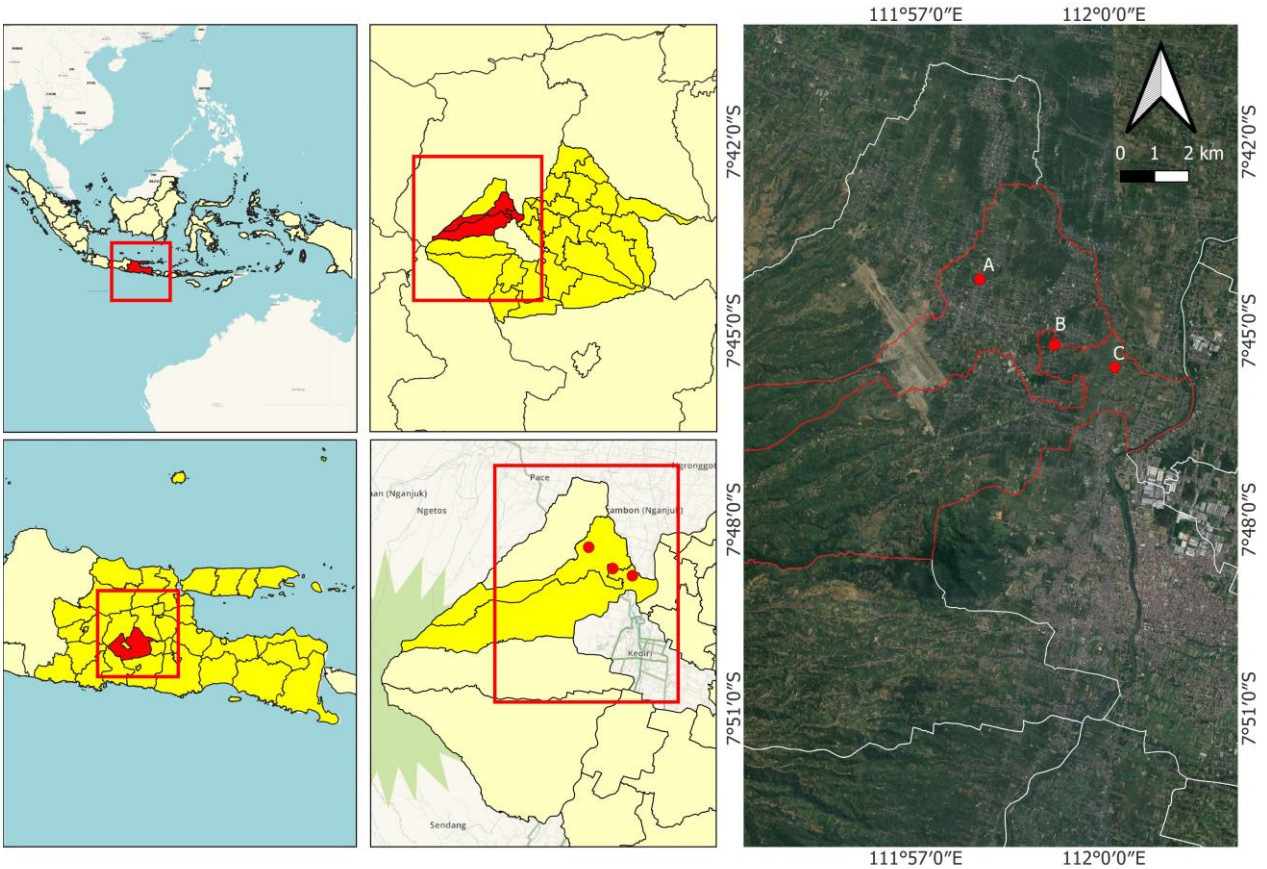

Figure 1. Map of the study sites for biocultural importance identification of *Moringa oleifera* in Kediri District, East Java Province, Indonesia. A. Cerme Village, B. Datemgan Village, C. Ngablak Village

Data collection

This research used qualitative research through the ethnobotany approach (Iskandar 2018). Primary data was collected by direct field observation, in-depth interviews, and semi-structured interviews. Direct field observations were done to observe the existence of *M. oleifera* in agroecosystems in home gardens. The semi-structured interview was conducted to identify communities' knowledge about *M. oleifera* the cultural keystone species, use, habitat, and cultivation. The snowball sampling technique was used to select informants who were considered competent (Albuquerque et al. 2014). The key informants of this research (the first interviewed) were communities' leaders. The key or earlier informants nominated other informants who were thought to know about *M. oleifera* from various backgrounds. The status of the informants in this study were the village staff, hamlet heads, older people, empowering family welfare administrators, and homemakers. Sixty individuals were interviewed about their knowledge of plants.

This study used the cultural keystone species (CKS) concept to examine a species' cultural salience (Coe and Gaoue 2020). This idea has arisen over the last two decades. This concept can be approached through qualitative and quantitative methods. A cultural keystone species is defined as a species with high cultural value within the communities regarding cultural identity based on its role as a medicine, ingredient, food, and spiritual practice (Cristancho and Vining 2004). Cultural keystones are essential to maintaining cultural or environmental sustainability (Garibaldi and Turner 2004).

Data analysis

Data analysis was approached using a descriptive analysis cross-checking, summarizing, and synthesizing (Iskandar et al. 2018). Cross-checking was the first to validate the data collected from informants and the field observation results. Summarizing was taken to screen data. Lastly, synthesizing was to conclude the information obtained. The informants were questioned for scoring 1-5 per measure utilized to assess the cultural keystone species status (1: yes, although low or irregular; 2: yes, low; 3: yes, intermediate; 4: yes, high; and 5: yes, significantly high) (Uprety and Asselin 2023). The totality of the responses approximates the Identified Cultural Influence (ICI) index. The use value (UV) was also figured based on use information acquired from the key informants and was utilized to evaluate the UV as follows (Navia et al. 2021):

$$UV = \frac{\Sigma Ui}{n}$$

Where:

Ui : the number of benefits cited per informer for a shared species

n : the entire number of informers.

The data collected were analyzed using the Kruskal-Wallis as a non-parametric examination for validation of significant differences between background education, locations, ages and all ICI ratings, and the Mann-Whitney U test as a non-parametric test for characterization of differences between the genders and all ICI ratings, the level of significance of 5%. Analysis Spearman was used to determine which factors correlate with all ICI ratings. A Multiple Correspondence Analysis (MCA) was used as a cluster of observations depicted by non-linear nominal variables. Statistical analyses were performed using R 4.1.2 (R Core Team 2021) and JAMOVI Version 2.3 (The Jamovi Project 2023).

RESULTS AND DISCUSSION

Biocultural importance of *M. oleifera*

Table 1 shows the informants' knowledge and understanding of the six criteria for assessing CKS status. The score ICI of *M. oleifera* in study sites was 20.19 (Figure 2). Besides, the UV score was 3 based on 180 reports by 60 informants. These results indicate that the CKS status of *M. oleifera* plants in the study sites is low. In comparison, research shows Churi plants in Central Nepal have a CKS of 34 and UV 5.72, that is almost perfect (Uprety and Asselin 2023). Based on the Kruskal-Walli's analysis, it was found that ICI Q3 was significantly different from location (χ^2 = 14.471; df = 2; p = < .001), education (χ^2 = 16.259; df = 4; p = 0.003), and also age (χ^2 = 7.7; df = 2; p = 0.021). Apart from that, ICI Q4 is also significantly different from education (χ^2=10.595; df= 4; p = 0.032). Meanwhile, in the Mann-Whitney test, gender was significantly different from ICI Q1a (p = 0.01), Q1b (p = 0.002), Q4 (p = 0.002), Q5 (p = < .001), and Q6 (p = 0.031).

Table 1. Participants' ratings of *M. oleifera* to examine cultural keystone species status

Category	Criteria assessment
Q1	Intensity, variety, and assortment of usage a. Is the species utilized intensively (routinely and/or in extensive portions)? b. Does the species have numerous usages?
Q2	Naming and vocabulary in the language, including usage as seasonal or phenological indicators, terms of months or seasons, location names Does the vocabulary include terms and specialized terminology associated with the species?
Q3	Function in descriptions, rituals, or symbolism Is it prominently featured in descriptions and (or) rituals, dances, songs, or as a significant totem, crest, or symbol?
Q4	Perseverance and remembrance of usage in association with cultural transformation Is the species general in the communal cultural consciousness and continually concerned?
Q5	Level of a distinctive function in culture Would it be tough to substitute this species with another functional native species?
Q6	The scope to which it supplies opportunities for resource purchase from exceeding the region. Is this species utilized as a commerce commodity for different parties?

There are several reasons why communities do not utilize *M. oleifera*, even though this plant has many health and nutritional benefits. Some of the reasons are that people need to learn about or become acquainted with nutritional benefits. A lack of education and information about this plant can lead to a lack of interest in using it. Communities have distinct dietary tastes and may be unfamiliar with preparing or ingesting *M. oleifera*. *M. oleifera* supply is a problem in some areas, especially if the plant is not available in local markets. Lack of accessibility can make it difficult for communities to use. Eating habits and food preferences can be influenced by cultural beliefs or societal customs. If *M. oleifera* is regarded as a recognized or traditional food, it may aid in societal acceptance. Furthermore, other, more common or well-known plants may compete for public attention with *M. oleifera*. *M. oleifera*, for example, may be planted less if another crop is more easily grown or profitable for farmers. To boost the usage of *M. oleifera* in communities, it is critical to raise awareness of its advantages, provide information on how to cook and consume it, and promote a healthy culture that incorporates this plant into everyday diets. Aside from that, growing the usage of *M. oliefera* requires consideration of availability and economic factors.

Figure 3 demonstrates the variable data of the correlation from the dataset. It can be seen that gender has a negative correlation to all ICI Q1-6. Some correlation between variables was low, such as location and Q1a-b; gender and Q3; age and Q5-6; and education and Q1 and Q4. In addition, the age variable has a strong correlation between Q1b, Q3, and Q4. Based on the interview, it was generally used by older people, and female who like to use *M. oliefera* for food. They use and consume *M. oliefera*, is because of health considerations.

Sources of information about *M. oleifera* in the three village communities are presented in Figure 4A. The primary source of information about the various benefits of moringa is from generational knowledge sources 63%, followed by healers 20% and media 17%, respectively. Media sources can come from various sources, including YouTube videos, online media articles, TV, radio, and social media information. Sources cited vary between locations, gender, and education, as monitored in Figure 4B. For example, in Ngablak village, informants with elementary and junior school education tend to get information from knowledge passed down from generation to generation. Informants with a bachelor/diploma education and are also in the age range of 25-35 tend to obtain information from the media. Female informants aged 36-55 received information from healers.

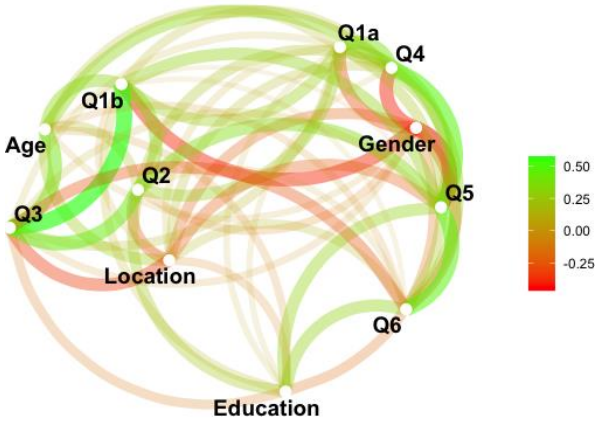

Figure 3. Correlation among variables

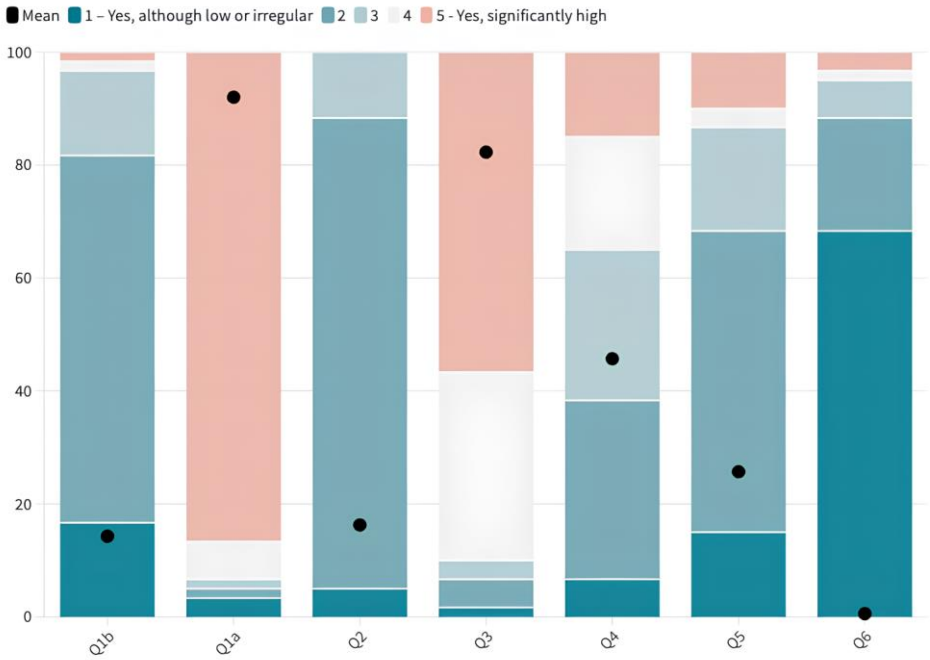

Figure 2. Participants' ratings of *Moringa oleifera* with regards ICI rating based on the six criteria used to evaluate cultural keystone species status

According to informant interviews at the study locations, *M. oleifera* has been growing in the area where they have resided for a long time. *M. oleifera* had been used for decades by their forefathers, however its specific location is unknown. According to the informants, *M. oleifera* that flourished in different agroecosystems was unidentified when it was grown. The informants also reported that the existence or development of *M. oleifera* on their grounds might at some time have a family member ever planted or removed the remaining seeds or stem *M. oliefera*. Several informants informed that maybe someone else dumped the remaining seeds of *M. oleifera* on their grounds. Figure 5 details the frequency of the most frequently used words during the interviews conducted with biocultural importance of *M. oliefera*. These words were organized into the code groups used in interpreting these interviews. During the interview, Indonesian was used so that the interview results were translated into English without reducing its meaning.

Figure 5. Word cloud from interviews biocultural importance of *Moringa oleifera*

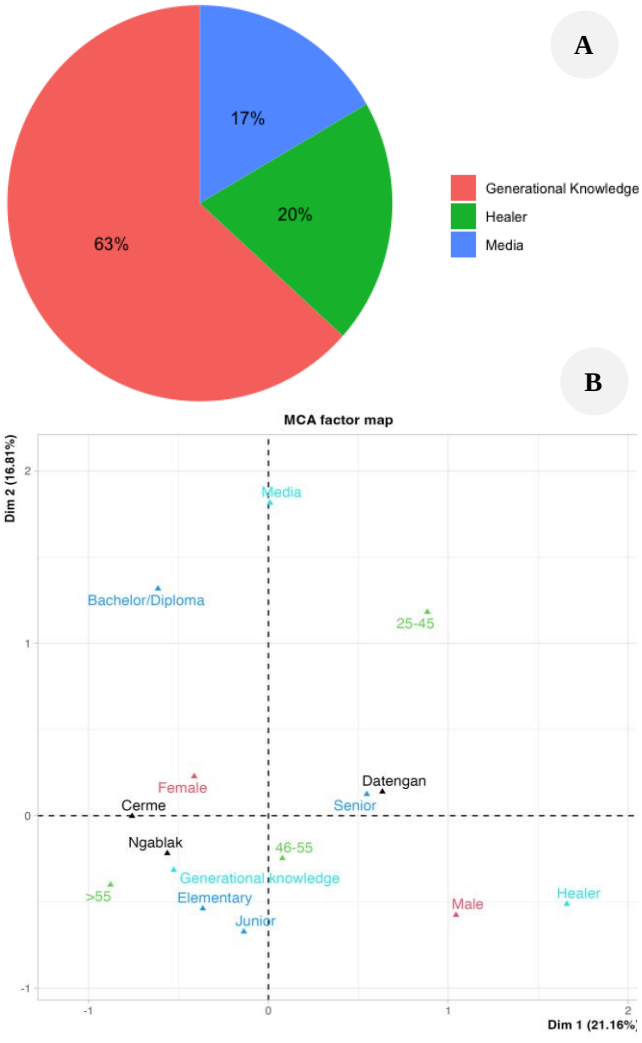

Figure 4. Sources of knowledge in sampled sites. A. Pie chart of the knowledge sources proportion. B. MCA showing the influence between community profiles and knowledge sources

Ethnobotany of *M. oleifera*

M. oleifera consumption patterns in rural communities are irregular (Q1a = 2). The communities in the all villages mentioned that *M. oleifera* was often used for various purposes: foods (98.33%), rituals (81.67%), medicine (76.67%), live fence (26.33%), firewood (13.33%), and animal feed (6.67%) (Figure 6A and Table 2), which conducted informants to disseminate *M. oleifera* a perfect score for the second criterion used to consider CKS status (Q1b = 4.72). These utilizations are almost the same as in several world regions. *M. oleifera* is a multipurpose plant in Malawi for live fence, medicine, food, moringa oil, and water treatment (Sagona et al. 2019). Meanwhile, *M. oleifera* is also used for fodder, firewood, gum, and coagulants in Nigeria (Popoola and Obembe 2013). *M. oleifera* is used by the local people only for two parts, such as stems (10%) and leaves (90%). Table 2 shows the reason for use and use method for each type of utilization.

The potions are administered orally (95% of informants) (Figure 6B). Leaves utilized as disease treatments are commonly prepared in decoction (98.33% of informants) (Figure 6C). For food, *M. oleifera* leaves were consumed as *sayur bening* (Indonesian vegetable soup) (Table 2). The ingredients of *sayur bening* were water, salt, sugar, garlic cloves (finely chopped), onions (thinly sliced), *M. oleifera* leaves (washed), and tomatoes. The cooking method is as follows, (i) in a pot, heat the water over medium-high heat; (ii) add the garlic and onions for about two minutes until translucent; (iii) add the tomatoes and stir-fry for around three minutes until tomatoes are slightly softened; (iv) add *M. oleifera* leaves and stir-fry for about five minutes until the leaves are wilted; (v) add the water, salt, and sugar, then boil, the last step; (vi) reduce the heat to low, cover the pot, and let simmer until the soup is fully cooked. The nutritional content of *M. oleifera* is immense. It is also often referred to as a superfood. The leaves of *M. oleifera* contain minerals (magnesium, potassium, calcium, copper, iron, zinc), vitamins A, B, C, D, and E, and a low calorific value. (Kasolo et al. 2010; Mbikay 2012; Berkovich

et al. 2013). Furthermore, the communities of the villages studied the decoction *of M. oleifera* leaves for beverages. Some also dry the leaves and brew them like tea without sweeteners like sugar. But for those who cannot tolerate the bitter taste, they add sugar or honey. The bitter taste may make some people reluctant to consume it consistently. Ammar et al. (2021) also stated that the communities of Pacitan District, East Java, drink it with decoction and oral application. Fresh *M. oleifera* leaves can also be administered for skin care treatment (shower bath and local application) and used by the healers for traditional/spiritual medication. There were four forms of *M. oleifera* products: soup, tea, soap, and capsule (Figure 6.D).

In the three study areas, the leaves were used the most intensively for food, fodder feed, and live fence, and ritual (Figure 7). Locally, leaves were used to treat cholesterol and soreness. The polyphenol extract of *M. oleifera* leaves has been reported to decrease cholesterol by inhibiting HMG CoA reductase activity and fecal bile acid binding (Reddy et al. 2017). In rats' experiments, lowering serum triglyceride levels and serum cholesterol levels between leaves extract of *M. oleifera* and atenolol in adrenaline was highly significant (Ara et al. 2008). Based on interviews, 22 plant species are associated with *M. oleifera* for soup and soap, as shown in Figure 8.

Local people have a particular name in their language for the Moringa (*kelor*). There is no specific name for various parts of the tree, which makes the CKS status rate very low Q2 = 2.07 (Table 1). In Indonesia, *M. oleifera* has several local names, namely *kelor* (Javanese), *keloro* (Bugis), *murong* (Sumatra), and *maronggih* (Madura). However, an Indonesian proverb related to *M. oleifera* leaves is *dunia tidak selebar daun kelor* (the world is not as wide as a *M. oleifera* leaves). This proverb means don not give up quickly because there are many other opportunities. It is a reminder that the world is not narrow and there are many other opportunities if you fail. This refers to the small morphology of *M. oleifera* leaves.

Table 2. Utilization of *Moringa oleifera*

Utilization	Reason for use	Use method
Food	It is fresh and nutritious	Cooked *sayur bening*
Medicine	Can reduce cholesterol, soreness, and as a skin care	Boiled, made as a body soap
Ritual	Hereditary beliefs	Foliage is swept to the sick or dead person
Animal feed	The leaves can grow 1-5 kg per tree annually	Leaf cut; It is directly given to animals
Live fence	Fast growth and do not need intensive management	Planted in the front yard, behind the house, on garden dividers, or nearby
Firewood	Cheap and easy to harvest	Cut and remove the leaves

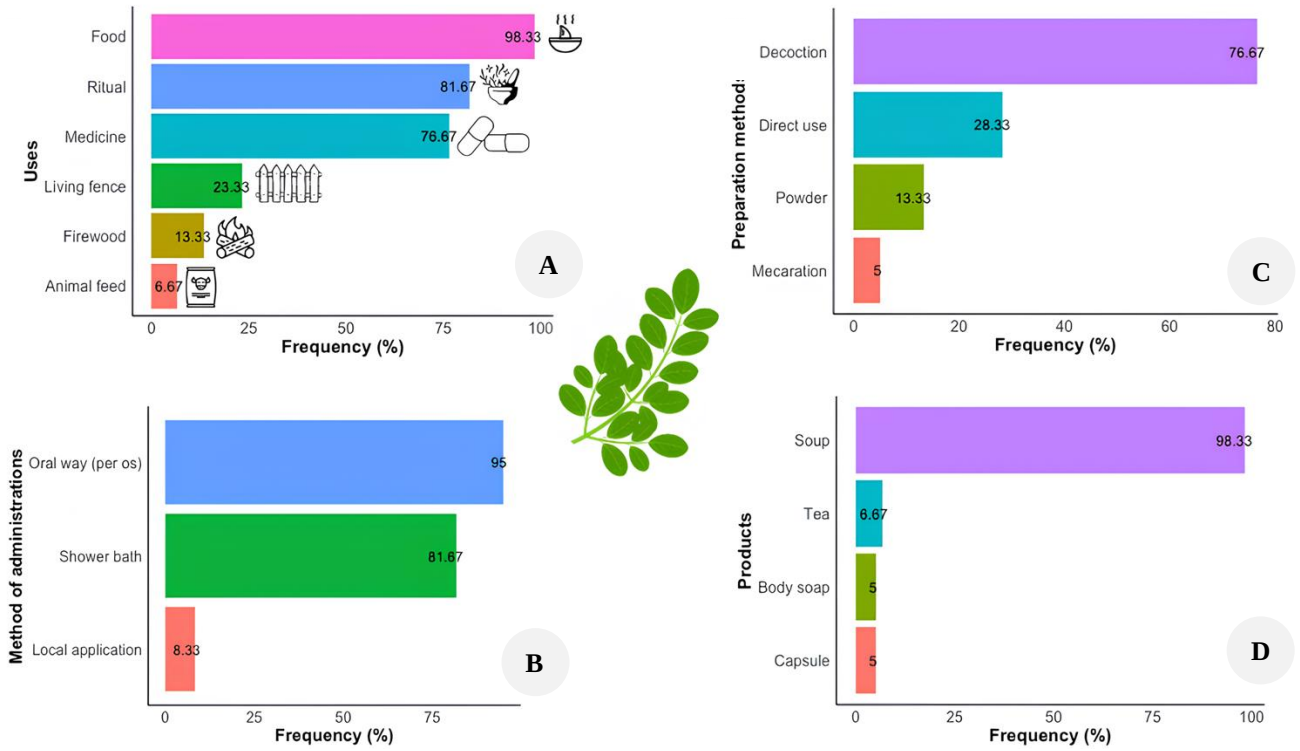

Figure 6. Ethnobotany of *Moringa oleifera*. A. Use, B. Administration methods, C. preparations, D. Products

Aside from that, mythically, in the all-site areas, *M. oleifera* is also associated with fantastical elements (Q3 = 4.38). Many myths about *M. oleifera* include a countermeasure for newly built houses, repel spirits, and fade implants's magical power (Dani et al. 2015). Even though most people have embraced Islam today, this knowledge is still being passed down and practiced to the next generation. *M. oleifera* was believed to be able to release its magic. The sick person was usually was topical with *M. oleifera* leaves until they could finally die peacefully. When the body of people who died was washed, the person had also been swept again with *M. oleifera* leaves so that it was clear from all creatures and mystical objects still attached to them. In addition, the myth of *M. oleifera* leaves was also believed repel spirits' arrival. The findings of Bahriyah et al. (2015) also revealed that the Madurese in Indonesia also uses *M. oleifera* for rituals.

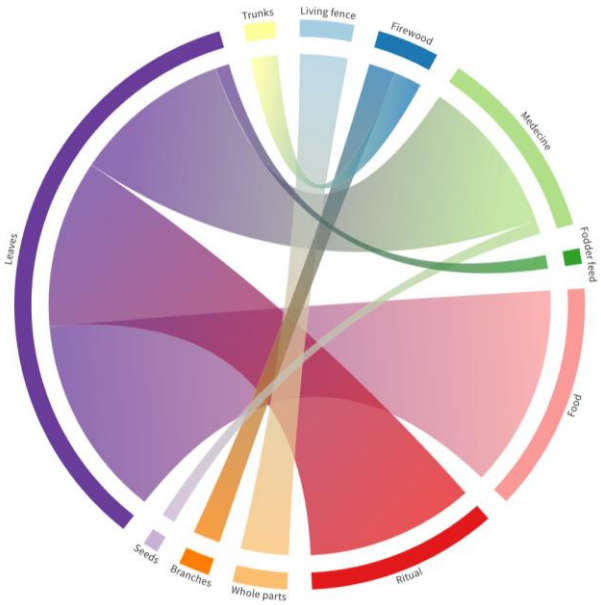

Figure 7. Plant parts used of *Moringa oleifera*

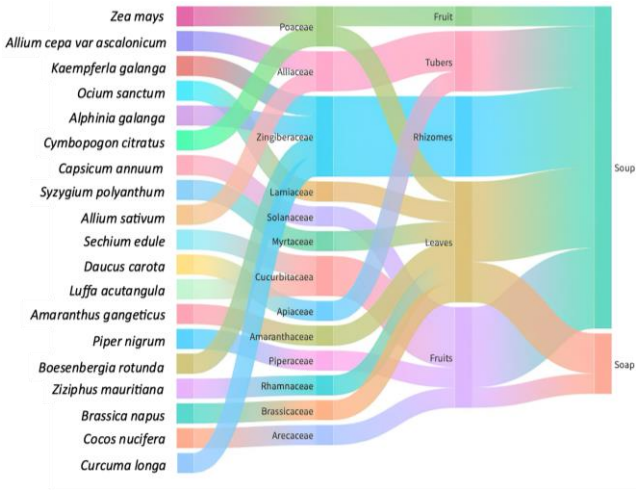

Figure 8. Relationship between species associated with *M. oleifera*

In some houses, they grow *M. oleifera* for living fences. *M. oleifera* was planted in the front yard, behind the house, on garden dividers, or nearby. It was used for walls because the leaves proliferate and turn green which will give a fresh effect. However, according to the informant, *M. oleifera* was often trimmed once a month because the leaves need to be thicker, and sometimes *M. oleifera* disturbs the neighbors' yard. In addition, when they turn yellow, more fallen leaves of *M. oleifera* end up in the landfill, so the communities have to clean the yard more often. Using *M. oleifera* for living fences has been reported to absorb high levels of carbon dioxide and improve the condition of soil fauna (Hernández et al. 2015). This traditional living fence practice also has a role in biodiversity conservation (Panda et al. 2018). Using *M. oleifera* as a live fence has become a sustainable choice in delimiting land areas and providing various environmental benefits. With its fast growth and dense foliage, *M. oleifera* can be used as an effective living fence to protect crops, livestock, or property boundaries. In addition, *M. oleifera* also has properties resistant to disturbing animals, such as wild animals or livestock that are out of control. It also provides economic benefits because it can reduce the cost of building and maintaining conventional fences. With all its benefits, using *M. oleifera* as a living fence is a step that is sustainable step supporting environmental sustainability.

The communities' livestock were the ruminants (cows and goats), the non-ruminant animals (quails, ducks, chickens, sticks, and geese), and fish farming. One of the advantages of *M. oleifera* leaves for feed is that the leaves can grow 1-5 kg per tree annually (Kholif et al. 2016). Moreover, the content of crude protein, crude lipid, crude fiber, and ash from *M. oleifera* also showed a higher level compared to several other types of feed, including *Morus alba*, *Broussonetia papyrifera*, *Caragana korshinskii*, alfalfa meal, soybean meal, and cornmeal (Pi and Shen 2018). Dry matter of *M. oliefera*, according to research, is a crude protein (23.0-30.30), crude lipid (7.09%), crude fiber (5.9%), and ash (7.6-12%). *M. oleifera* for animal feed was usually only fresh without processing. If on a large production scale, this will cause the plants to still contain anti-nutrients, such as tannins, saponins, and phytic acid (Shi et al. 2018). Thus, it is highly recommended to perform proper processing (Su and Chen 2020).

M. oleifera was used for fuel wood by the communities. The communities were still quite traditional. Apart from gas stoves, they also use wood-fired stoves daily. The local people's reason was to save money. According to Popoola and Obembe (2013), Nigerian women also use *M. oleifera* wood as fuel wood. However, other parts of *M. oleifera* (pod husks, seed peels, and pies) can also be used as materials for making energetic biomass (biodiesel and briquettes) (Pereira et al. 2015).

Ethno-ecological of *M. oleifera*

M. oleifera can grow in various environmental conditions. *M. oleifera* is categorized as a semi-wild or wild plant. The wild or semi-wild plant differs from plants cultivated by the communities, where the seed origin and growth time are generally known or treated. This species can live in

places with less fertile soils (Sagone et al. 2019). According to Leone et al. (2015), it has high morphological variability, so the communities have an excellent opportunity to develop and utilize it. The agronomic stages of *M. oleifera* cultivation include land availability, seedling preparation, planting, maintenance, and harvesting (Aluko and Okuwa 2018). According to informants, this plant will grow well at moderate temperatures. This plant species can also grow on all soil types, including marginal soils. *M. oleifera* also demonstrates intolerance to shade and is tolerant of low rainfall.

This species grows in several agroecosystems in the village, such as monoculture gardens and home gardens (Figure 9). *M. oleifera* can grow with myriad plants classified as herbs, shrubs, or trees in the identical area, such as *Carica papaya* L., *Musa ×paradisiaca* L., *Mimosa pudica* L., *Cyperus rotundus* L., *Ageratum conyzoides* L., *Colocasia esculenta* (L.) Schott, *Manihot esculenta* Crantz, *Leucaena leucocephala* (Lam.) de Wit, *Cocos nucifera* L., *Psidium guajava* L., *Averrhoa bilimbi* L., *Pandanus amaryllifolius* Roxb. ex Lindl., and others. The interviews informed local terminology of several things that define environmental requirements for growing *M. oliefera*, i.e., *asrep* or cold, *benter* or hot, *mbuka* or opened, and *iyup* or canopied. *Asrep* means a cold or low-temperature place, while *benter* is a hot or high-temperature place. *Mbuka* means an open area without a canopy or exposed to direct sunlight. *Iyup* is an area blocked by a canopy from exposure to direct sunlight.

Ethno-agricultural of *M. oleifera*

The communities in study sites cultivated *M. oleifera* as a semi-wild tree. Management for cultivation is very low or almost non-cost. The communities also planted itself without the need for labor. Planting was also done in limited quantities. According to informants, 1-5 trees were usually planted in one house. Table 3 shows the management of *M. oleifera* cultivation.

M. oleifera was still cultivated intentionally, mainly by stem cuttings. It is rare to plant using seeds because it takes longer to produce. According to the informants, *M. oleifera* was not specifically treated, such as fertilizing or pest control, and it was harvested when needed by the owner. Vegetative propagation is a common method that the people of India, Indonesia, and parts of West Africa often practice. *M. oleifera* planted from seeds tends to have low fruit quality (Ramachandran et al. 1980). Planting from seeds also requires soaking before planting (about 12 hours) (Ojiako et al. 2011). On the other hand, the disadvantage of using vegetative propagation techniques is that it will shorten root development. This circumstance will be detrimental to access and stabilization of water (Animashaun and Toye 2013).

There were no unique treatments for nurseries, such as giving fungicides, soaking, or others. Sources of *M. oleifera* seedlings were usually obtained from family or neighbors. This propagation requires a mother stem 0.5 to 1.5 m tall and about 4 to 5 cm in diameter. The bigger the cuttings used will increase the chances of survival. The parent stems must come from a healthy plant and be more than one year old. Healthy brood stocks were selected and cut diagonally to expand the root growth area. Then, the stems were perforated to a depth of 10 to 15 cm, avoiding the direct digging of the main stem into the ground. The branches were planted in the hole by letting a third of it be buried in the ground. There was no specific fertilization or pest/weed control.

According to the local people, the cutting preparation process was essential in planting *M. oliefera*. The plants can grow well if the cutting technique is proper. The way to do this was to take prospective buds, usually located in the axils of the leaves. It was then slashed obliquely at the base of the stems, embedded in the planting medium to expand the area for root growth. Obliquely was scored at the top so that water or rainwater does not settle on the stems, which can cause stem cutting to rot. Land preparation for *M. oleifera* cultivation follows the practice of land for other crops. *M. oleifera* is suitable for plants in lowland areas (Ebert 2014). Land preparation was carried out in the following three stages. First, the land was cleared of weeds. Second, the cleared land was ploughed with a hoe. Finally, the soil was excavated at a distance of 50 cm from the others. This planting method is ideal for semi-intensive crops (Gandji et al. 2018). Planting for intensive harvesting can use agroforestry methods (Leone et al. 2015).

People do not carry out weed control. The communities do not also conduct pest and disease management. There had been no reports of severe pests and diseases on *M. oliefera*. However, several pests and diseases have been reported, such as *Noorda blitealis*, *Eupterote mollifera*, *Euproctis pasteopa*, *Ulopeza phaeothoracica*, mistletoe *Phoradendron quadrangulare*, and *Dendrophthoe falcata* (Thriveni et al. 2010; Joshi and David 2016; Kotikal and Math 2016; Moreno-Ramírez et al. 2018). Usually, in a month, harvesting is done two times. *M. oleifera* leaves were harvested to be cooked. There has yet to be a harvest for commercial purposes or in large quantities. The leaves used for cooking were fresh leaves. However, according to Islam et al. (2021), that dry leaves (29.4 g/100 g plant materials) contain higher protein than fresh leaves (6.7 g/100 g plant materials).

Threats to *M. oleifera*

The younger generations have less knowledge knowledge about *M. oliefera*. This means could indicate that the erosion of traditional ecological knowledge (Q4 = 3.1). Traditional knowledge could shift due to several factors, namely formal education, bilingualism, and subsistence mode (Iskandar et al. 2018). Ethnobotany regarding a plant and its uses is usually obtained from generation to generation from their ancestors or based on personal experiences in intensively interacting with the plants (Mutaqin et al. 2020 a, b). The communities use *M. oleifera* less than other plants (Q5 = 2.4). Another reason is that this plant is rarely sold in markets or vegetable shops, so it is difficult for some people to get it (Q6 = 1.52). The primary reason the plant underutilized is because of no economic value (Kour et al. 2018). According to the informant, people get this plant by planting themselves or asking neighbors (for free).

Most participants (60%) stated that communities are less used and preserved of *M. oleifera* nowadays because of the socio-economic changes. Most participants (80%) said the young generation did not know *M. oliefera*. Some participants said, *young people today may not know which* Moringa *plant they are*. The availability of *M. oleifera* in their habitat is based on an abundance scale (4: Dominant, 3: Common, 2: Less common, 1: Irregular). 80% participants chose that the abundance of *M. oleifera* has decreased to the point that the species is now less common (abundance score: 2) (Figure 10). However, the government has carried out a movement to introduce *M. oilefera* as a nutritious plant, especially for treating stunting. The reduction can also be caused by the association of this plant with mystical things compared to its benefits.

The communities report that there is a need for efforts to conserve *M. oleifera*, especially considering that the potential possessed by them is abundant. The communities have unknowingly made conservation efforts by planting *M. oleifera* on their land, even though it is non-intensive. According to the IUCN, *M. oleifera* is classified as Least Concern (Roland 2020). Sustainable use can also be a reasonable conservation effort because more *M. oleifera* plants will be planted.

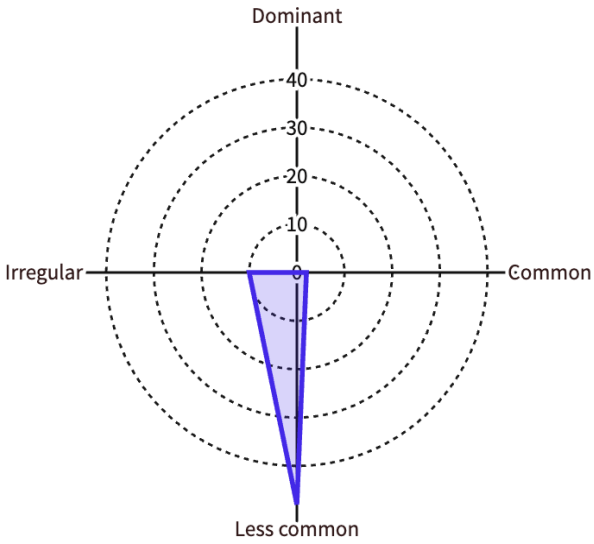

Figure 10. The availability of *Moringa oleifera*

Table 3. Cultivation stage of *Moringa oleifera* in Kediri Regency, East Java, Indonesia

Stages	Processing	Cost
Seedling	Conducted by family members	No cost needed
Land preparation	Conducted by family members	No cost needed
Planting and maintenance	Conducted by family members	No cost needed
Harvest	Conducted by family members	No cost needed

Figure 9. *Moringa oleifera* planted in home gardens

In conclusion, the low ICI shows the CKS status of *M. oleifera* for the three villages. *M. oleifera* has been known and used by the communities, where knowledge is passed down from generation to generation. Based on local knowledge, *M. oleifera* can grow in various environmental conditions. *M. oleifera* can be utilized for multi-purposes, such as food ingredients, animal feed, rituals, firewood, live fence, and medicine, and the UV is high. Older adults or homemakers generally use *M. oliefera.* This species is cultivated limitedly due to its low economic value. However, *M. oleifera* in Indonesia has enormous economic potential because this species is one of the most sought-after tropical plants in the international market.

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