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Review: The conservation of Tengger indigenous people's traditional knowledge of biological natural resource-based disease treatments

EMILDA KUSPRANINGRUM[1,♥], THOHIR LUTH[2], YULIATI[2], RACHMAD SAFA'AT[2], HARLINDA KUSPRADINI[3]

[1]Faculty of Law, Universitas Mulawarman. Jl. Sambaliung Kampus Gunung Kelua, Samarinda75123 East Kalimantan, Indonesia.
Tel.: +62-541-7774145, ♥email: emildakuspraningrum@fh.unmul.ac.id
[2]Faculty of Law, Universitas Brawijaya. Jl. MT. Haryono No. 169, Malang 65145, East Java, Indonesia
[3]Faculty of Forestry, Universitas Mulawarman. Jl. Penajam, Kampus Gunung Kelua, Samarinda 75123. East Kalimantan, Indonesia

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Abstract. *Kuspraningrum E, Luth T, Yuliati, Safa'at R, Kuspradini H. 2020. Review: The conservation of Tengger indigenous people's traditional knowledge of biological natural resource-based disease treatments. Biodiversitas 21: 5040-5053.* The indigenous people of Tengger, a community living around Bromo Mountain in East Java, frequently use ethnic knowledge to process biological natural resources into medicines used to cure diseases. These include *Foeniculum vulgare* Mill. tree, *Tithonia diversifolia*/insulin tree, *Mikania cordata* L. and *Bidens pilosa* tree, *Cyphomandra betacea* (Cav.) Sendtn., and *Acorus calamus* L. This intelligence is acquired consciously to solve health problems. In addition, the bond between the community and nature is highly philosophical, hence the presence of respect and maintaining the harmony of Knowledge obtained from nature ensures life continuity. Therefore, the belief is passed on through the generations, and traditional knowledge is attained following the gain of existence. This phenomenon is proven by numerous modern researches with scientific methods that admit the plant healing properties. In addition, traditional knowledge is a significant topic of interest in the United Nations' Convention on Biological Diversity, and was thus ratified by Law Number 5 of 1994. The object of this research is potential medicinal plants for healing and tengger indigenous people's conservation model is to provide a platform to protect the interest of biological resources, including their use in the field of medicines belonging to indigenous peoples. Therefore, the empirical interdisciplinary research involves the compilation of data from the collection of similar scientific journals, for use as evidence. This is important to ascertain the existence of traditional medicine based on natural resources, followed by integrations with other disciplines, including the laws to be developed concerning the best protection methods. Furthermore, this investigation is essential for identifying the philosophical values of Tengger people, the importance of knowledge conservation, and recognizing the laws and regulations-based efforts aimed at protecting information on plant-based medicine production from extinction and biopiracy. These considerations are important because the absence of government intervention, alongside the preservation of plant species and traditional knowledge on treatment predisposes the possibility of destruction.

Keywords: Convention on biological diversity, indigenous people, natural resources, traditional knowledge

INTRODUCTION

Nature basically provides everything needed by humans before technology took control of life, through environmental, especially biological resources. These materials are practically aged, and applied for survival. For example, people in the health sector initially used indigenous plants to cure illnesses.

Local inhabitants are often closer to the universe than other groups of people, and humans are also assumed to be inseparable from the universe, featuring the need for one another as a single entity. This dependency influences the individuals' mindset on the knowledge derived from nature, including the aspect of curing diseases. Furthermore, numerous approaches have been adopted to achieve remediation using plants, as seen in the Tengger indigenous people of East Java, featuring the practice of boiling, brewing, or steaming to attain the most appropriate and acceptable method for the body. Also, there are people known to generate treatment methods using supernatural means (Fanani and Dewi 2014; Kuspraningrum et al.2018; Meyers and Owoeye 2013). This millennium era is characterized by unavoidable modernity, and the individuals that initially entrusted personal health to the surrounding plants sought after chemical medicines sold in the market. The inception of an operating Community Health Center in the area further facilitated the abandonment of traditional methods (Satria 2013; Kuspraningrum et al. 2018; Fitri and Arso 2018), thus causing the extinction of valuable indigenous knowledge. These techniques are currently only practiced by those over the age of fifty, as young people prefer more practical ways. However, increasing government attention towards this wisdom is expected to improve the local economy.

Knowledge is "*justified true belief*" (Nonaka and Tekeuchi 1995), and everything assumed to be real is based on truth. Hence, awareness with an aim to identify objects at hand is considered as a capability of solving life's problems, through certain methods, as part of knowledge. This concept is based on the "tripartite account of knowledge," including

the truth condition and this suggests that an understanding of a proposition is indicative of truth, otherwise, the person has no knowledge of what is claimed. These considerations distinguish opinion from knowledge. The condition requires that knowing a proposition facilitates believes and it is also important to develop practical ways to justify the possible authenticity, (Pritchard and Neta 2009). Moreover, it is part of knowledge to solve life problems and have certain methods (Bolisani and Bratianu, 2018).

Traditional knowledge is interpreted as an amalgamation of the amount of information continuously being developed, obtained, used, performed, and transmitted by communities through generations, supported by the environment, lifestyle, behavior, society, and culture (Daulay 2011; Wiradirja and Munzil 2018;). This was classified into agricultural, scientific, ecological, medicine (including related medicine and remedies), as well as biodiversity knowledge (WIPO). In addition, the world is familiar with various arts, including batik, dance, paintings, sculptures, recipes, traditional home architecture, and concoctions of Indonesian medicinal plants, and this is consistent with the WHO's report on Indonesia, showing the presence of around 20,000 medicinal plant species (Kusmana and Hikmat 2015; Nahdi *et al* 2019; Rohman *et al* 2019), needed to provide adequate welfare. However, the repeated practice of this knowledge allegedly passed down from previous generations, devises the term traditional knowledge (Kusumadara 2011; Janke 2019).

The United Nations' Convention on Biological Diversity, also referred to as CBD, is high-level and is often held in Rio De Janeiro, Brazil, with interest in indigenous traditional knowledge. In addition, Indonesia is one of the countries known to ratify this convention Law Number 5 of 1994, and this was considered a very appropriate step due to the abundant wisdom and utility of natural resources, especially for medicine. Therefore indigenous people are assumed to possess the relevant intelligence and creative abilities needed for production. The extinction of knowledge is an unfortunate outcome, imminent through replacement with chemical treatment products (Syah 2013; Fitrianatsany 2017; Lumintang 2015). A research review on the potential and efficacy of living natural resources, including plants traditionally processed by the Tengger indigenes, reinforces the importance of preserving the expertise. This paper, therefore, focuses on the life of the community, being one of the local peoples in Indonesia to use traditional natural resource-based medical knowledge to date.

IN SITU CONSERVATION OF THE TENGGER COMMUNITY

In situ conservation of medicinal plants is carried out by the Tengger indigenous people with their simple traditional knowledge of allowing the medicinal plants to grow around their natural habitat. They also achieve this by deliberately planting these plants in their yard, garden, and forest, without changing their conditions favorable for their growth (Kidane et al. 2014; Sing et al. 2014). According to Acosta-Vargas et al. (2020) irrespective of the treatment process used to regenerate plants, indigenous people tend to form small groups such as a neighborhood pillar with a program called a dispensary, which encourages each of them to grow medicinal plants on each page of their house (Amsalu et al. 2018; Khan, et al. 2011; Rojas et al. 2010). This process is effective because it enables the availability of medicinal plants when needed. For instance, when the indigenous people of Tengger feel unwell, they cook fennel plants, which warms their stomach and makes them feel well.

UTILIZATION OF TRADITIONAL MEDICINAL PLANTS

Tengger indigenous people are known to use medicinal plants still to cure some local and mild ailments. They tend to utilize traditional healers known as a shaman to receive a cure for various health diseases (Fenethun et al. 2017). Other advantage of community life behavior in Tengger tribe is that shaman do not hide their knowledge rather, the community uses it for their benefit (Ismail et al. 2019; Kuspraningrum et al. 2020b; Mahwasane et al. 2013). Traditional medicinal plants' knowledge is possessed by the Tengger indigenous people, which provides them with three components that are sustainably managed and protected. Firstly, adequate management of medicinal plants and their traditional knowledge increases business opportunities in the field of medicine, which are expected to increase income (Andriamparany et al. 2014; Mathibela et al. 2015). Secondly, few businesses seek potential and traditional knowledge to use medicinal plants (Akankwasah et.al 2012; Astutik et al. 2019). This is because the local and international business world is currently interested in traditional medicines based on plants and associated knowledge. Several countries use traditional, thereby leading to an increase in the production of medicinal plants. For instance, China, Japan, Chile, Colombia, France, Canada, Britain, and the United States use 90%, 60-70%, 70%, 40%, 49%, 70%, 40%, and 42% of medical plants (Khan et al. 2011; WHO, 2013). This data shows that traditional medicine is still very popular in the world market. Thirdly, it obligates the government to encourage economic growth and stability, which in principle increases the community's income and economy. The societies as the main actors of the government are obliged to direct, guide, and protect those that are less aware of the conservation of medicinal plants. This is in a bid to prevent them from destroying medicinal plants and to ensure that irresponsible parties use it to seek profit through its production and trade (Deakin and Reid 2014; López et al. 2016). The inability of the Tengger tribe to properly utilize traditional medicine id detrimental to the community due to the numerous advantages associated with the use of medicinal plants (Mbuni et al. 2020; Verma and Singh 2008).

THE TRADITIONAL KNOWLEDGE OF THE INDIGENOUS PEOPLE OF TENGGER

Tengger is an Indonesian community in Bromo, East Java (Fig. 1), living in several regions, namely the villages of Ngadas, Jetak, Wonotoro, Ngadirejo, and Ngadisari

(Sukapura and Probolinggo Districts), Ledokombo, Pandansari, and Wonokerso (Sumber and Probolinggo Districts), Tosari, Wonokitri, and Sedaeng (Probolinggo district), Ledokombo, Pandansari, and Wonokerso (Sumber and Probolinggo Districts), Tosari, Wonokitri, Sedaeng, Ngadiwono, Podokoyo (Kecamatan Kecamatan) Tosari, Keduwung (Puspo District, and Pasuruan Regency), Ngadas (Poncokusumo District, Malang Regency), and Argosari and Ranu Pani (Senduro District, Lumajang Regency) (Aziz et al 2011). In accordance with other traditional law communities (Table 1), the indigenes of Tengger live in groups, and gynecologically possess traditional rights with their various activities performed based on ancestral knowledge (Jaiswal 2019; Pager 2016; Tang 2016). In addition, Ter Haar helped in the understanding of customary law community, with the stipulation: "Indonesian ethnic groups are associated with layers consisting of hordes, people and natural materials that behave in specific ways (Ter harr 1979), therefore, it is referred as *rechtsgemeenchap* (legal community)" (Bedner and Arizona 2019; Larsen and Gilbert 2020; Moffatt 2012; UNESCO, 2011).

The proximity to the universe is of high philosophical value to indigenous people, and every element of life is permeated and assumed to be driven by an invisible entity. This supports humans, including terrestrial plants and animals, hence maintaining and preserving the gift of nature is perceived as an obligation. Furthermore, indigenous people consider land as the "mother" and provider of life, resulting from the ability to grow plants, which serve as a source for survival (Tang 2016; Kuspraningrum 2018) highlighted the unity between indigenous people and nature.

Biological resources, including plants, are used for treatment (Rohman *et al* 2019; Zulkarnain et al. 2019) by the Tengger community in the villages of Ngadas and Tosari. This is in agreement with Indriyani et al. concerning Ethnobotany of Medicinal Plants in the National Park of Bromo, Tengger, Semeru. (Indriyani et al. 2012; Kuspraningrum 2018) reported the statement of the community head, stipulating the use of indigenous plants, e.g., fennel, *sempretan*, insulin leaf, Dutch eggplant on the basis of empirical experience. Furthermore, fennel leaf, *Foeniculum vulgare* Mill, is used during cold weather, and also to treat stomach pain, by kneading the leaves and applying to the stomach. The younger leaves are possibly cooked for consumption due to the ability to provide a warm sensation. Also, the insulin tree is easy to find, and the leaves are applied to increase stamina. However, because they are widely used, the supply is large, and the knowledge in packaging is limited, dried insulin leaves are sold outside the area.

The indigenous people simply practice the ancestral teachings, and the government has not paid adequate attention to protect and encourage the utilization of biological resources, necessary to ensure the optimal production of traditional medicines for widespread use (Meyers and Owoeye 2013; Priambodo 2018; Kuspraningrum 2018)

To date, there have been numerous studies on plants in Indonesia, including drugs commonly used by the Tengger community, as shown in Table 1.

These previous studies showed five species with the highest use value in Ngadisari village. These include *Foeniculum vulgare* Mill, *Aloe vera* (L) Burm. F., *Acorus calamus* L, *Apium graveolens* L, and *Allium fistulosum* L (Kurniawan and Jadid 2015), while (Azrianingsih and Kusumahati 2019) reported *Acorus calamus* Linn, *Brugmansia suaveolens* L., and *Foeniculum vulgare* Mill. as the most used medicinal plant in Wonokitri village. In addition, other researchers have highlighted the habitual use of *Pimpinella pruatjan* Molkenb. (forest ginger), *Abrus laevigatus* Lour. (Krangean), *Foeniculum vulgare* Mill., and *Astronia macrophylla* Bl. by Tengger people outside the four villages (Wonokitri, Ranupani, Ngadas, and Ngadisari).

RESEARCH ON MEDICINAL PLANTS

The twenty-two species of Tengger's medicinal plants mentioned in Table 1 do not only grow in Tengger. Several studies and scientific validation about the twenty-two species of medicinal plants that grow in other areas have been published (Table 2).

Two out of twelve plant species (*Astronia macrophylla* L. and *Calvatia* sp.) mentioned in Table 2. have limited information on the scientific validation and traditional knowledge from another area. *F. vulgare*, *A. calamus* L, and garlic (*A. sativum* L) are popular species with frequent application in Indonesia, and also worldwide. *F. vulgare* is an aromatic medicinal plant used to treat respiratory and gastrointestinal disorders, and the seeds have frequently been adopted as food flavorings and as component of herbal mixtures. Modern research proves the presence of anti-microbial, antioxidant, anti-inflammatory, anti-anxiety, anti-lipid, anti-diabetic, and anti-cancer properties (Rather et al. 2012. Kooti et al. 2015; Kuspradini et al. 2019; Kuspradini et al. 2020). Meanwhile, *A. calamus* has long been applied in traditional medicine, and also possesses anti-carcinogenic and anti-angiogenic features (Imam et al. 2013; Haghighi et al. 2017). Garlic (*A. sativum*) is used as a medicinal agent for thousands of years, due to the antimicrobial, antioxidant, anti-inflammatory, and anticancer effects (Harris et al. 2001; Thomson and Ali 2003; Metwally et al. 2018; Rahman et al. 2012).

Searches from the patent website at the World Intellectual Property Organization (WIPO), the ASEAN Intellectual Property Portal (ASEAN IP), and the Intellectual Property of Indonesia Database, show that several plants have been registered and patented (Figure 2).

The data showed *A. sativum* L. as the plant most frequently studied, and developed into various products. In the ASEAN and global context, *P. pruatjan*, *A. laevigatus*, *Calvatia* sp., *A. macrophylla*, *A. reinwardtii*, *B. laevis*, and *E. horsfieldii* have not been technologically patented. These related studies are occasionally developed based on prior public knowledge, although the documented origin is often forgotten. This makes it important to conserve the known and unknown indigenous medicinal plants, to preserve traditional knowledge from going extinct.

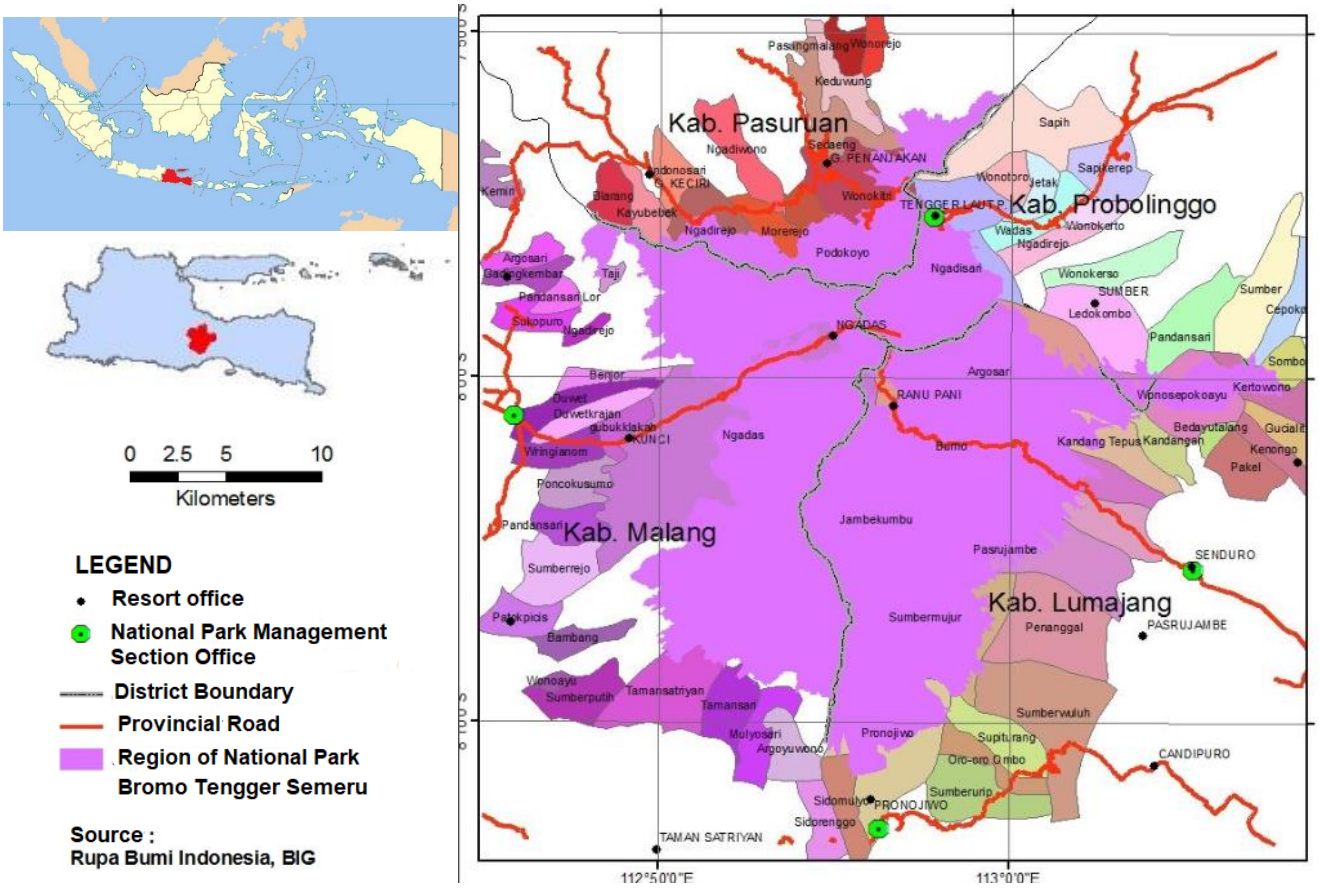

Figure 1. The Map of Bromo Tengger, East Java, Indonesia (Source: Rupa Bumi Indonesia)

INTELLECTUAL PROPERTY PROTECTION FOR THE INDIGENOUS PEOPLE OF TENGGER

The principle guarding the respect for fellow humans, providing balance, and the fulfillment of others' rights are contained in the Holy book of Muslims. In Surah Asy Syuaraa (183) the following "do not harm humanity in their rights and detest from running rampantly on the earth by damaging this surah, exemplifying humans as officers entrusted by God to maintain balance and justice" (Al-Qur'an AlKarim 2015). This is because humans tend to reason and realize a life order consisting of goodness and justice, all levels of society felt that. This divine principle is assumed to be parallel with the philosophical thinking of Aristotle, and Thomas Aquinas, which was used to realize the term "Prima Principia." This encompasses the teachings and rules for carrying out good deeds and avoiding bad things (Dalton et al. 2013; Ginsberg 1963; Luth et al. 2017; Murphy 2019; Obioha 2011; Wibisono et al. 2013). This is similar to the theory presented by Jhon Rawls, in the book "A Theory of Justice," which explained the link between natural and positive law. It is important to attain a balance while placing the cultural interests of the Tengger community and having regulations, is important to achieve. The state apparatus's duty and responsibility are reflected as a blend of justice and morality values (Filippini and Cavana, 2016; Graham et al. 2011; Heryanti 2017; Nurjaya and Safa'at 2016). The spirit to protect traditional knowledge is congruent with the CBD principles, as stipulated in article 8J, where the convention provides an opportunity to member states to form guideline support, through the respective national regulations. This approach is needed to guarantee treatment with quality traditional knowledge. It is assumed to be maintained and preserved for hundreds of years, as one of the cultural reserves, without the need for the replacement with factory processed chemical drugs.

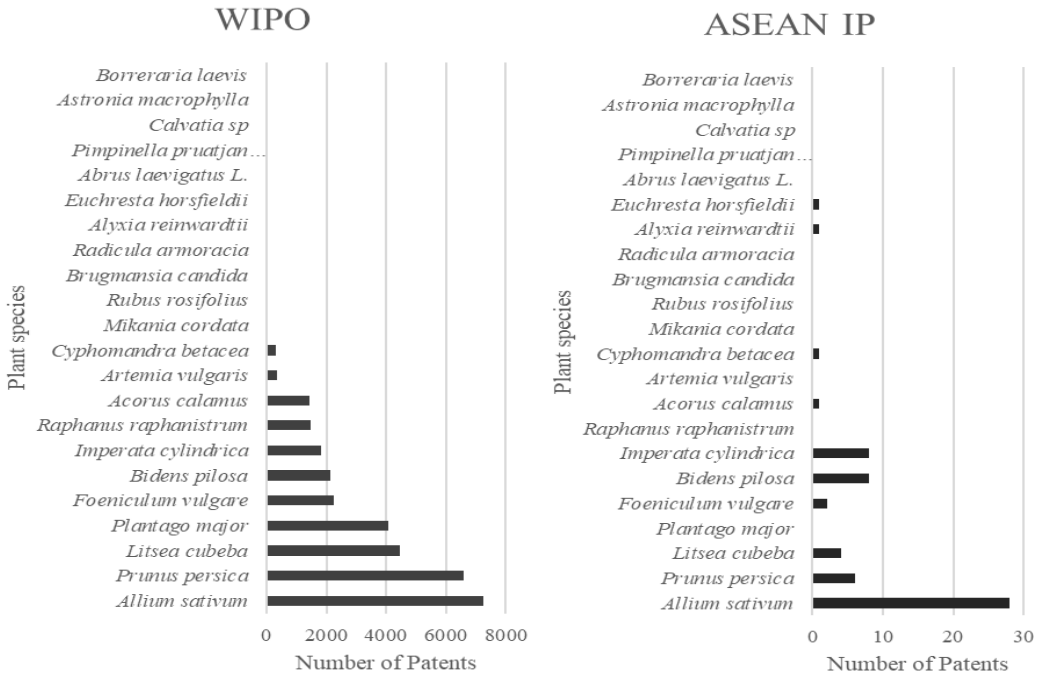

Figure 2. Plant Patents Database (until 2019) (Searching method: Based on plants used by Tengger Community)

Table 1. Medicinal plants used by Tengger community, East Java, Indonesia

Scientific name	Local name	Usage of plant	Part of plant	Reference
Allium sativum L.	Bawang putih (garlic)	For reducing fever, common cold, and flatulence	-	Batoro et al. (2011) Indriyani et al. (2012)
Brugmansia x candida Pers.	Air kuncup kecubung gunung	For treating sore eye	-	Batoro et al. (2011)
Prunus persica (L.) Batsch	Jambu wer	For treating diarrhea and gonorrhea	-	Batoro et al. (2011); Listiyana et al. (2017); Aziz et al. (2019)
Imperata cylindrica (L.) P. Beauv	Alang-alang	For remediating wounds	-	Batoro et al. (2011)
Plantago major L.	Suripandak	For handling sprain and muscle ache	-	Batoro et al. (2011)
Carica pubescens Lenne & K.Koch	Pepaya (papaya)	For reducing constipation and treating sprues		Batoro et al. (2011)
Pimpinella pruatjan Molk.	Purwoceng	For uplifting stamina	All plant parts	Batoro et al. (2011)
Abrus laevigatus L.	Krangean	For treating high blood pressure	Leaf, bark	Indriyani et al. (2012)
Litsea cubeba Pers.		-	-	Listiyana (2017)
Foeniculum vulgare Mill.	Adas (Fennel)	For reducing cough and asphyxiation	Leaf, seed, root	Indriyani et al. (2012)
		For treating cough, itchy, bloating, smallpox pus, toothache	-	Aziz et al. (2019)
		For reducing stomachache	Leaf	Kuspraningrum (2018)
Astronia macrophylla Blume	Kayu ampet	For treating diarrhea	Young leaf, bark	Indriyani et al. (2012)
Alyxia reinwardtii Blume	Pulosari	For reducing cough, fever, headache	Leaf, bark, root, seed	Indriyani et al. (2012)
Acorus calamus L.	Dringu	For treating fever and common cold	Leaf, all plant parts	Indriyani et al. (2012)
Mikania cordata (Burm.f.) .L.Rob.	Sempretan	For remediating cough, muscle ache, common cold	Rhizome, root	Indriyani et al. (2012)
Bidens pilosa L.				
Calvatia sp.	Jamur impes	For reducing swells	Fruit body	Indriyani et al. (2012)
Euchresta horsfieldii (Lesch.) Benn	Pronojiwo	For treating muscle ache, rheumatism	Fruit, seed	Indriyani et al. (2012)
Borreria laevis (Lam.) Griseb.	Tepung otot	For treating muscle ache and sprain	All plant parts	Listiyana et al. (2017)
Radicula armoracia B.L. Rob.	Asem Tengger	For remediating cough	-	Aziz et al. (2019)
Artemisia vulgaris L.	Ganjan	For treating nosebleed	-	Aziz et al. (2019)
Rubus rosaefolius Sm	Grunggung	For remediating diarrhea	-	Aziz et al. (2019)
Raphanus raphanistrum L.	Lobak Tengger	For treating gonorrhea, diarrhea, typhus For increasing sexual desire	-	Aziz et al. (2019)
Cyphomandra betacea (Cav.) Sendtn	Terong belanda	For increasing sexual desire	Fruit	Aziz et al. (2019)

Table 2. The scientific validation and worldwide traditional usage of medicinal plants

Scientific name	Usage	Part	Reference
Allium sativum L.	Antimicrobial activity against *Klebsiella pneumoniae*, *Escherichia coli*, *Streptococcus pyogenes*, *Pseudomonas aeruginosa*, *Enterobacter aerogenes*, *Staphylococcus aureus*, *Proteus vulgaris*, *Salmonella typhi*, *Bacillus typhi*, and *Aeromonas hydrophila*	Bulb	Lekhsmi et al. (2015); Khashan (2014)
	Antioxidant activity using DPPH radical	Plant	Lenkova et al. (2016)
	Antioxidant, anti-inflammatory, antibacterial, antifungal, immunomodulatory, cardiovascular protective, anticancer, hepatoprotective, digestive system protective, anti-diabetic, anti-obesity, neuroprotective, and renal protective properties	-	Shang et al. (2019)
Brugmansia x candida Pers.	An antispasmodic and a nodyne	-	Kaewklom et al. (2018)
	Anticholinergic activity and for cigarette assortment, have relaxed effect	Leaves	Ibrahim et al. (2017)
Prunus persica (L.) Batsch	Antibacterial activity against *Escherichia coli*, *Klebsiella pneumoniae*, *Enterococcus faecalis*, *Staphylococcus aureus*, *Bacillus subtilis*, *Salmonella typhi* and *Shigella flexenari*, antifungal activity against *Candida albicans*, *Aspergillus flavus*, *Microsporum canis*, *Fusarium solani* and *Candida glabrata*, phytotoxic activity against *Lemna minor*, insecticidal activity against *Tribolium castaneum*, *Rhyzopertha dominica* and *Callosbruchus analis*.	Bark	Aziz and Rahman (2013)
	Antioxidant activity against DDPH, oxygen (ORAC), ABTS, PFRAP radicals, chelating activity for ferrous ions Fe^{2+}, fibril aggregation (Amyloid-β and α-synuclein) inhibitory activity, Protective effects against Ab-induced cytotoxicity on PC12 cells	Fruit	Mokrani et al. (2015)
	Antioxidant activity by oxygen radical absorbance capacity (ORAC), anti-lipase activity, anti-dementia activity	Mature fruit, green fruit peel, green fruit flesh, branch, bud, flower	Nakagawa et al. (2018)
Imperata cylindrica (L.) P. Beauv	Anti-hypersensitive activity	Root	Ruslin et al. (2013)
	Anticancer	Leaves	Keshava et al. (2020)
	Antifertility agent	Root	Widyastuti et al. (2018)
Plantago major L.	Immune modulating property, anticarcinogenic, antidiabetic, anti-inflammatory, analgesic activity	-	Vandana et al. (2017)
	Wound healing, antipyretic, antitussive, anti-infective, anti-hemorrhagic, diuretic, laxative, astringent and hemostatic	-	Najafian et al. (2018)
	Antiulcerative, antidiarrhoeal, antinociceptive, antibacterial (*Bacillus subtilis*, *Staphylococcus aureus*, *Candida albicans*, *Candida tropicalis*, and *Escherichia coli*), antiviral agent (herpes virus and adenoviruses), treatment for fatigue and cancer, antioxidant and a free radical scavenger (DPPH-radical), treatment for common cold, conjunctivitis and viral hepatitis	Leaves, seed, flower, and root	Adom et al. (2017)
	Antiinflammatory activity on oral epithelial cells	Leaves	Zubair et al. (2019)
Carica pubescens Lenne & K.Koch	Antioxidant activity against oxygen radical absorbance capacity (OPRAC), DPPH radical	Fruit, stem and leaves	Pavan et al. (2014); Rahayu et al. (2019)

Pimpinella pruatjan Molk.	Antibacterial activity against *Staphylococcus aureus* and *Pseudomonas aeruginosa*	Root	Purwestri et al. (2016)
	Antimicrobial activity against *Bacillus subtilis, Staphylococcus aureus, Streptococcus pyogenes, Staphylococcus epidermis, Enterococcus faecalis*, vancomycin-resistant *Enterococcus faecalis*, and methicillin-resistant *Staphylococcus aureus*, Gram-negative bacteria included *Escherichia coli, Pseudomonas aeruginosa*, and *Klebsiella pneumonia*, and yeast including *Candida albicans, Candida parapsilosis*, and *Candida glabrata*	Root, Essential oil from aerial parts	Nurcahyanti et al. (2016)
	Increase of aggressiveness, but not libido, in male mice	Root	Kanedi et al. (2017)
Abrus laevigatus L.	Healing of scratches, sores, and wounds caused by dogs, cats, and mice	-	Chinnappan and Rathinam (2011)
Litsea cubeba Pers.	Healing of leucoderma, tetanus and rabies	-	Garaniya and Bapodra (2014)
	Treatment for gonorrhea, jaundice, and hemoglobinuria bile	Root	Garaniya and Bapodra (2014)
	Promotion of the growth of human hair	Seed oil	Acharya and Roy (2013)
	Anti-suppurative properties, in leucoderma, itching, and other skin diseases	Leaves	Manisha et al. (2013); Arora et al. (2011)
	Healing of painful swellings	The juice is employed as a cure for hoarseness; mixed with oil	Manisha et al. (2013)
	Graying of hair	paste of leaves and seeds is applied	Garaniya and Bapodra (2014)
	Effect on milk-induced leucocytosis and eosinophilia in the management of asthma, produced dose-dependent bronchodilator activity	Leaves	Taur and Patil (2011); Mensah et al. (2011); Shourie and Kalra (2013)
	Antiallergic	-	Taur and Patil (2011)
	Antimicrobial activity against *Bacillus subtilis, Staphylococcus aureus*, and *Saccharomyces cerevisiae*	Essential oil from bark, leaf, root, fruit, and stem	Hammid and Ahmad (2015)
	Insecticidal activities against cigarette beetles and booklice (for stored products)	Essential oil of fruit	Yang et al. (2014)
Foeniculum vulgare Mill.	Anti-termite activity and repellent against *Heterotermes indicola*	Seed	Aihetasham et al. (2017)
	Anti-inflammatory, antispasmodic, antiseptic, carminative, diuretic, and analgesic effect and is effective in gastrointestinal disorder treatment	-	Delaram et al. (2011)
	Antifungal activity against various fungal species such as *Candida albicans*, species of Aspergillus, and dermatophytes, fungi in food waste such as *Aspergillus niger* and *Fusarium oxysporum*	-	Rahimi and Ardekani (2013); Badgujar et al. (2014)
	Antioxidant activity on DPPH, hydrogen peroxide radical, reducing ability (FRAP)	Essential oil, seed	Chatterjee et al. (2012); Shahat et al. (2011)
	Antimycobacterial activity against *Mycobacterium tuberculosis*	Stem and leaves	Esquivel-Ferriño et al. (2012)
	Anti-anxiety activity, hold promising effects in the treatment of anxiety and stress, anti-stress proceeding, increase in memory and antioxidant effects may reduce stress and stress-related disorders	-	Pourabbas et al. (2011); Mesfin et al. (2014); Koppula and Kumar (2013)
	Gastro-protective activity	-	Al-Mofleh et al. (2013)
	estrogenic effects for treatment of infertile women	-	Mirabolghasemi and Alizadeh (2014)
	Anti-diabetic activity	Essential oil	El-Soud et al. (2011)
	Hepatoprotective activity	-	Qiang (2011)
	Enhancement of memory and intelligence	-	Badgujar et al. (2014)

Alyxia reinwardtii Blume	Antioxidant activity using DPPH, superoxide, and lipid peroxidation	Stem	Rattanapan et al. (2012)
Acorus calamus L.	cancer chemoprevention	-	Das et al. (2019)
	Allelopathic activity, cytotoxic activity and antifungal activity against *Aspergillus niger*	Essential oil of leaves and rhizomes	Satyal et al. (2013)
	Wound healing, mitogenic, insecticidal, anthelmintic, antiepileptic, antispasmodic and inhibitor of acetylcholinesterase	-	Ganjewala and Srivastava (2011)
Mikania cordata (Burm.f.) B.L.Rob.	Antibacterial activity against *Staphylococcus aureus, Bacillus subtilis, Bacillus cereus, Bacillus megaterium, Salmonella typhi, Shigella dysenteriae, Escherichia coli, Shigella flexneri,* and cytotoxic activity	Leaves	Ali et al. (2011)
Bidens pilosa L.	Antinociceptive activity, antibacterial activity against *Staphylococcus epidermidis, Enterococci, Shigella sonnei, Streptococcus pyogenes, Pseudomonas aeruginosa*	Leaves	Nayeem et al. (2011)
	Antioxidant activity using DPPH radical and TEAC (Trolox Equivalent Antioxidant Capacity)	Flower	Lee et al. (2013)
	Antioxidant activity against ABTS radical, antimicrobial activity against *Candida albicans, E. coli, P. aeruginosa, S. aureus, B. subtilis, M. luteus*, and larvacidal activity against *C. quinquefasciatus*	Leaves	Singh et al. (2017)
Calvatia sp.	Sources of food and/or traditional medicine.	Fungal	Coetzeel and Van Wyk (2009)
Euchresta horsfieldii (Lesch.) Benn.	Antibacterial activity *S. aureus* and *E. Coli*	Batang, akar, biji	Prihatin et al. (2018)
	Prevention of oxidative stress	Leaf	Gunawan et al. (2016)
Borreria laevis (Lam.) Griseb.	Treatment of kidney and prevent of menstruation problems	Decoction of the leaves	Conserva and Junior (2012)
Radicula armoracia B.L. Rob.	Antibacterial activity against *Staphylococcus aureus, Bacillus subtilis, Pseudomonas aeruginosa, Salmonella typhi, Candida albicans*	Leaves	Aziz (2019)
Artemisia vulgaris L.	Antioxidant activity against DPPH radicals and antibacterial activity against *Staphylococcus aureus, Bacillus subtilis, Klebsiella pneumonia, Enterococcus* sp.	Leaves, essential oil from leaves	Pandey et al. (2017)
	Antibacterial activity against *Escherichia coli* and *Staphylococcus aureus*, antifungal activity against *Candida albicans*, and antihelmintic activity against *Haemonchus contortus*	Essential oil of leaves	Malik et al. (2019)
Rubus rosaefolius Sm	Antioxidant activity using DPPH free radical and FRAP reduction capability	Leaves	Desmiaty et al. (2018)
Raphanus raphanistrum L.	Hepatoprotective activity, cardioprotective activity, antiurolithiatic activity, anti-tyrosinase and antioxidant activity on DPPH, anti-cancer and antimicrobial activity against *Escherichia coli, Pseudomonas pyocyaneus, Salmonella typhi, Bacillus subtilis,* and many foods born pathogenic and food spoilage bacteria such as *Listeria, Micrococcus, Enterococcus, Lactobacillus,* and *Pedicoccusspps,* gastroprotective activity	-	Mohammed and Hameed (2018); Jdey et al. (2017)
	Antioxidant activity using DPPH and minerals of natural origin, antiproliferative properties	-	Küçükboyaci et al. (2012); Marrelli et al. (2015)
	Antidiabetic effects	-	Banihani (2017)
Cyphomandra betacea (Cav.) Sendtn	Antiproliferative activity, potential as an effective agent in cancer therapy	Fruit	Mutalib et al. (2017); Mutalib et al. (2016)
	Anthocyanin and antioxidant activity using CUPRAC (Cupric ion-Reducing Antioxidant Capacity), FRAP (Ferric Reducing Ability of Plasma), ABTS decolorization, DPPH radicals	Fruit	Hassan and Bakar (2013); Atiqah et al. (2014); Diep et al. (2020)

Indonesia is known as one of the megadiverse countries, characterized by a wealth of natural resources, with failure to translate the biodiversity into economic wealth. In addition, there is a huge potential to advance medical knowledge (Senanayake 2006; Costanza 2013; Mahendradhata et al. 2017), which is very interesting and also anxious about western countries. Therefore the protection is needed to avoid exploitation by western society, especially without permission, and subsequently patented and developed in these countries, including America (Mgbeoji 2007; Kobayashi 2009; Banarjee and Alavalapati 2010; Blackeney 2019).

Support and efforts are needed to realize uniformity in the protection of traditional knowledge related to indigenous medicine, at the world level. In addition, it is necessary to make efforts regarding the security and recognition of biological diversity-based traditional medicine knowledge belonging to indigenous peoples (Safa'at 2013; Qodriyatun 2016; Arizona and Bedner 2019), and provide certainty to modern researchers developing biodiversity potential. Also, attention and concern is needed in the aspect of biopiracy, resulting from the illegal invasion of resources (Blackeney 2004; Zainol et al. 2011; Danley 2012; Vega 2018; Ageh and Lall 2019;). This was described by the CBD Secretariat as a practice that "exploits" biodiversity for commercially valuable genetic and biochemical reserves (UNEP 2000; Battacharya 2014; Das 2020).

A famous biopiracy and patent case is the patent on Neem (*Azadirachta indica*) extract, from India, by the US company W.R. Grace & Company, and the US Department of Agriculture, at the US Patent and Trademarks Office (USPTO), and European Patent Office (EPO), in 1994. The patent was concerned with the method of extracting azadirachtin from Mimba seeds, for use as an insecticide. In addition, traditional knowledge was only considered as an inspiration, and the findings were assumed to be novel, and distinct from the original products of nature. This was, therefore, opposed by an environmental NGO, on the grounds that traditional knowledge held by Indian people is a novelty that is not possessed by western societies and the fungicide effect of Mimba seeds has been exploited for a long time in Indian society for 2000 years (Shiva 2013; Sharma et al 2018; Kumar 2019). Another example is in Australia, where the preparation of dried powder of *Terminalia ferdinandiana*, a source of food and traditional medicine for indigenous Northern Australian (Gorman et al. 2006; Bosse 2016; Robinson and Raven 2017), was patented through the US patent office. This right issued for lack of novelty, and the lawsuit is strengthened by the statements on prior application as medicine by the Aboriginal Society in Australia, for over 40,000 years. Therefore, the objection was communicated to the US applicants, and then the Australian application was withdrawn (Robinson 2010). The cases of biopiracy show the role of traditional community knowledge in identifying genetic resources.

Intellectual property in this aspect is actually facilitated by the Convention of Biological Diversity. Furthermore, Article 8 (J) shows the need for holders to participate in the "equitable sharing of benefits resulting from the application of knowledge, innovations, and practices," while article 16 of the CBD stipulated that "holders must participate in" equitable sharing of benefits arising from the utility ". Moreover, article 27 of the TRIPs reported on the possibility to grant patents in all matters related to the field of technology, including biotechnology, identified through the traditional assistance of public knowledge. Therefore, preservation is achievable by combining two elements, including; (i) the application of specific indigenous wisdom requires permission from the local community, as well as an agreement (Persoon and Minter 2011; Palar and Rasiah 2019; Ahyar and Kristiyanto 2017). "The preparation of this arrangement requires the user to have access permission, and a follow up on information obtained, involves an agreement between both parties with the help of a government agency. This is a document to be included in the application for use permits, and is needed to exercise prudence because natural resources are a source of income, as well as the main capital (Saleng 2013, Rinaldi 2015; Kuspraningrum et al. 2020) to be preserved (ii) through research collaboration (Conley and Moote 2003; Ushie 2013; Thomas et al. 2016; Packer et al. 2019) between the indigenes and researchers. The approach is performed for the scientific method not to obstruct traditional identity and claim authenticity of genetic material used during the research, (Braye et al. 2006; Joshi and Chelliah 2013; Blackeney 2019). This is in accordance with Article 15 of the CBD, where the goals derived from contracts include "create conditions facilitating the access to genetic resources for environmentally-friendly purposes," achieved using mutually agreed terms and conditions, based on "information-based agreement". (iii) To open access and provide a place where the government supports an opportunity by facilitating traditional knowledge (Alshehri and Drew 2010; Aisyah 2013; Lazuardini et al. 2014; Abyot et al. 2014; Dilksawan et al. 2018; Reny et al. 2020.) for adequate performance and recognition of companion treatment besides the existing modern treatments. (iv) In addition, a new breakthrough is also needed to accommodate traditional medical knowledge derived from natural resources, to ensure the safe entry into the intellectual property rights protection system (Correa 2001; Subramanian and Shaver 2011; Safa'at 2011; Safa'at 2013; Kuspraningrum 2018; Moh-ud-din et al. 2019). This concern is important to strengthen the existence of indigenous peoples and the wisdom in the field of herbal medicine, while enhancing permit access and benefit-sharing, as expected, through conventions on biological diversity, and automatically preserving the indigenous information on herbal medicine.

In conclusion, the local people of Tengger, East Java, have identified the genetic resources with possible applications in medicine. Therefore, it is necessary to obtain regulations with the guarantee of justice for both the indigenes as the first indigenous people to discover genetic resources and researchers on a mission to explore intrinsic potentials, using modern laboratory methods. The results showed a need to attain an appropriate formula to protect and preserve the existence of traditional medical knowledge. This is also needed to accommodate the direction of the

convention on biological cities, to ensure a fair distribution of benefits for the indigenes. Furthermore, the blueprint needs to be incorporated into the intellectual property rights protection system to enable all parties to realize suitable benefits in the future, including the general public, and especially the indigenes known to have not received justice following the long term exploitation of knowledge. Meanwhile, it is also possible for the intellectual property rights system to serve as a media for accommodating these aspirations by creating more friendly entitlements in communities, as commonly found in customary law systems. It is also essential to determine the potential for knowledge of traditional medicine based on medicinal plants, such as garlic, mountain amethyst water, Jambu wer, Alang-alang, Suripandak, Papaya (papaya, Purwoceng, Krangean, Fennel, Kayu ampet, Pulosari, Dringu, Sempretan, Mushroom impes, Pronojiwo, Muscle flour, Muscle flour, Asem Radak Tengger, and Dutch eggplant. Future research of this review has the ability to strengthen the formation of policies to protect traditional medicine knowledge based on biological natural resources.

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