



The diversity of plant species used in traditional herbal massage oil in Indonesia

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ABSTRACT

Context. The Austronesian peoples, predecessors of most of the population of Indonesia today, discovered and developed many kinds of plant-based medicines and treatments to combat illness and maintain good health. These include massage oils. **Aims.** This study investigated how three tribal communities in Indonesia utilised plants for massage oils with the aim of preserving their traditional methods. **Methods.** Traditional plant-based massage oils used by the western-central Austronesians were studied in three traditional communities in West Java, Lombok Island and Sumbawa Island. **Key results.** Traditional herbal oils contain various active compounds that possess medicinal values. Coconut (*Cocos nucifera*; Arecaceae), which is typical of Austronesian flora, is harvested for milk and is the main ingredient in the production of herbal treatments for massages. Forty-six other plant species have also been recorded being mixed with coconut milk. The main three families of plants are: Fabaceae, Lauraceae and Zingiberaceae. Species such as *Dipterocarpus retusus* (endangered) and *Sindora galedupa* are medicinal plants with high conservation value. **Conclusions.** Changes in land use threaten wild plant species that are used in making herbal oils. Likewise, traditional community knowledge could be eroded by globalisation. Therefore, the cultivation and conservation of wild plants is needed to maintain their presence in nature so that the traditional knowledge can be sustained. **Implications.** Local governments need to play a role in developing and socialising the use of traditional herbal massage oils. It is hoped that the traditional knowledge and wisdom of the local communities can form the basis of developing their territory into a traditional village, like the village of Songak, Lombok Island.

Keywords: agrobiodiversity, coconut, ethnobotany, indigenous communities, Lesser Sunda Islands.

Introduction

Indonesia – with a string of 17 504 islands – lies across the Equator and spans a distance equivalent to one-eighth of the Earth's circumference; thus, it is undoubtedly the largest archipelagic country in the world (Legge 2021). It is estimated that Indonesia consists of more than 500 ethnic, sub-ethnic and community groups (Melalatoa 1995). Consequently, Indonesia is rich in culture and local wisdom that is conspicuously reflected in the diversity of thoughts, attitudes, actions and cultural outcomes (Liliveri 2003).

Anthropologically, Indonesia is mainly composed of Austronesians and Melanesians (Blust 1984, 2013; Bellwood *et al.* 2006), in which the Austronesians mostly inhabit the western and central parts of the archipelago (i.e. the islands of Sumatra to Sulawesi), whereas the Melanesians mainly inhabit the eastern parts (New Guinea). The Moluccas are a kind of a melting pot between the Austronesian and Melanesian civilisations (Blust 1999, 2013).

One type of traditional treatment commonly practiced by the Austronesians, including numerous tribes in Indonesia is massage, where various kinds of massage oils are used, each based on unique concoctions passed down through generations including their compositions, customs, beliefs, local traditions and traditional knowledge. The commonest

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type of massage oil found in Indonesia – as the largest Austronesian and Melanesian country – is the coconut milk-based massage oil. The use of this massage oil is unique to the Austronesians and the presence of the practice in Melanesian territory, such as the Moluccas and north-east of mainland New Guinea (including adjacent islands such as Biak, Yapen and the Solomons) shows the influence of Austronesians on Melanesian culture. This has happened through harmonious trading contacts and alliances between the two civilisations for thousands of years (Sudo 2006) and continues to this day.

Generally, traditional medicine is an alternative medicinal treatment that has been practiced daily in developing countries, including Indonesia and other Austronesian and Melanesian communities. In developed countries, traditional medicine is gradually receiving recognition. This phenomenon is apparently due to environmental changes and the development of disease patterns (Rahmat 2013).

In present-day Indonesia, the practice of traditional medicinal treatment (including use of massage oils) has been legally recognised by the Ministry of Health; thus, an acknowledgment by the Indonesian government that traditional medicine is an indispensable part of health services (Aminah et al. 2016).

The current study is focused on three communities from three tribes: (1) the Sundanese of Cimande (West Java); (2) the Sasak of Songak (Lombok Island); and (3) the Samawa of Batudulang (Sumbawa Island). Cimande village has been known to foreigners as one of the villages where herbal oil is produced for the treatment of fractures, while Songak is one of the traditional villages in Lombok that holds a festival in Maulud month (Islamic calendar) when herbal oil is made. Batudulang is one of the villages in the remote Batulante sub-district where health services are few and far between, but its herbal oil has been recognised for its efficacy by the surrounding community. These three tribes are linguistically classified as belonging to the Western Malayo-Polynesian family (Blust 1999, 2013), which is the lifeblood of the Austronesian civilisation. The Sundanese are regarded as one of the three conspicuous and large tribes of the Austronesians (the others being Javanese and Balinese). The aim of this study is not just to collect data from the three tribes, but also to preserve the existence of both the traditional coconut-based massage oils and the practices particularly in this fast-changing time of globalisation.

Materials and methods

Study area

The study was carried out in three study areas, representing three different tribes: (1) the Sundanese of Cimande (West Java); (2) the Sasak of Songak (Lombok Island); and (3) the Samawa of Batudulang (Sumbawa Island) (Fig. 1). Most of

the population in these three villages are Muslim and earn a living as farmers.

Cimande village has long been known – even to foreigners – as a village that produces herbal oils for healing bone fractures. Songak village is one of the traditional villages on the Indonesian island of Lombok, among others, the village is famous for a traditional ceremony to produce herbal massage oil. In addition to being one of the producers of herbal massage oil on the island of Sumbawa, Batudulang village is also known as a producer of giant wild bee honey (*Apis dorsata*) and organic Robusta coffee (*Coffea canephora*).

Data collection

The study was conducted using semi-structured key-informant interviews. There were nine key informants interviewed (three key informants in each study area). The selection of key informants was purposive. Their occupation is mainly herbal makers ('pengiat' in Sasak; 'sandro' in Samawa; 'herbalist' in Sundanese). All informants were more than 45 years old with six males and three females interviewed. We documented plant species, provided directly by the informants, and their use as the ingredients of herbal oils, including parts used and processing methods. The plant species were identified during the fieldwork and some were vouchered, and then identified in Herbarium Bogoriense, where the voucher specimens were deposited. Before each interview, prior informed consent was verbally requested, and during the interview process, we followed the International Code of Ethics (ISE – International Society of Ethnobiology 2006). The scientific names in this study were verified using an online source; i.e. the Plants of the World Online (POWO 2021).

Data analyses

Ethnobotanical data were processed using Microsoft Excel to produce relevant diagrams, charts and tables. The data underwent descriptive analysis to determine the diversity of plant-based herbal oil ingredients.

Results

This current study recorded 47 plant species used in the making of herbal massage oil by the three tribes (Table 1). All of the species are botanically classified as members of Spermatophytes. There are no member of Gymnosperms, ferns nor any Cryptogamic plants. Unfortunately, the reason for this is still shrouded in mystery.

The Songak people from the Sasak tribe of Lombok Island use 41 species of plants in the making of their herbal massage oil, the most diverse of the three tribes; while the Batudulang people of Sumbawa (Samawa) tribe use four species (Fig. 2).

The Sundanese people of Cimande use the least number of plant species of the three tribes, just two species exclusively;

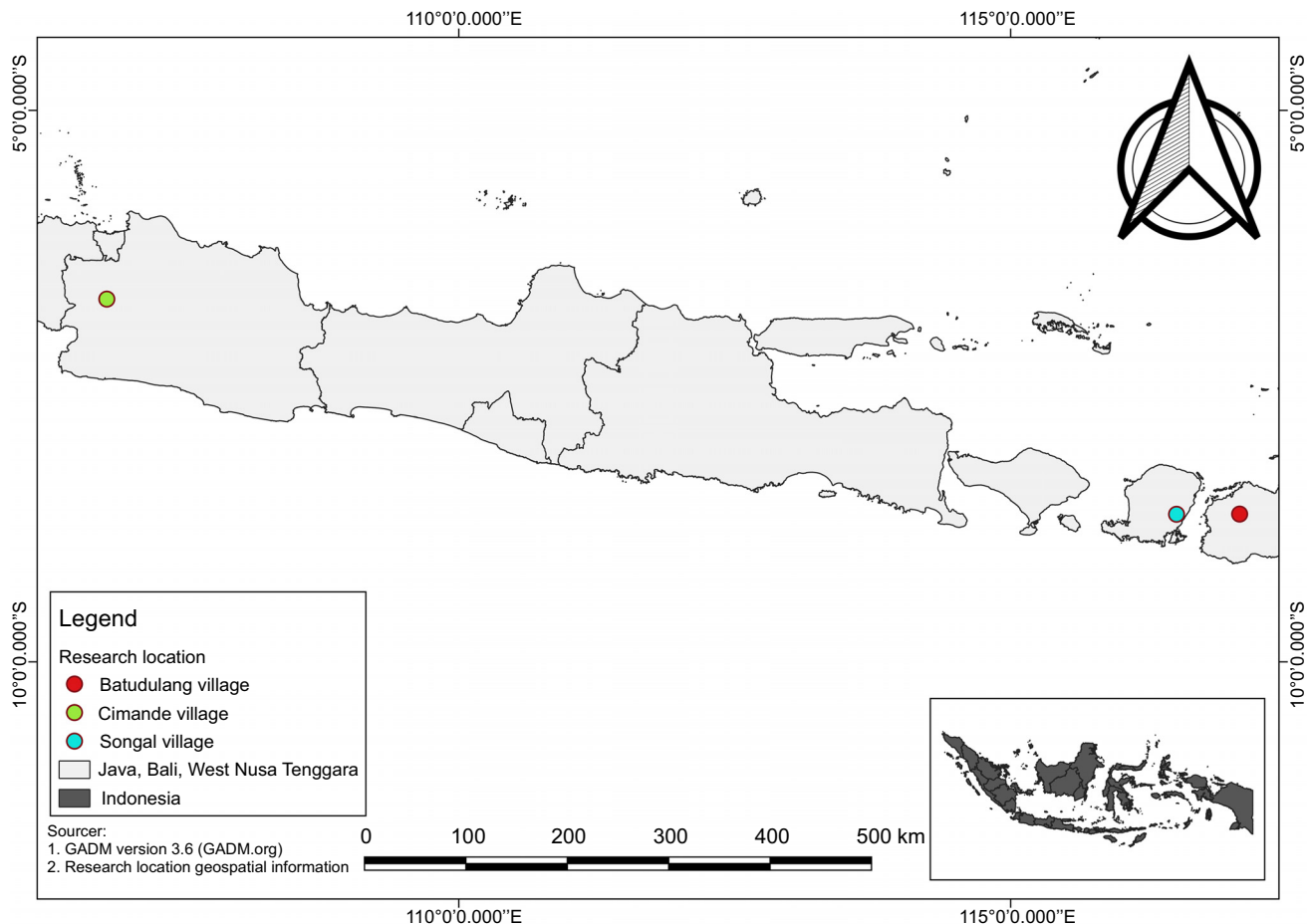


Fig. 1. Study area.

coconut (*Cocos nucifera*) and sugarcane (*Saccharum officinarum*).

The results in this current study showed that the main ingredient of traditional herbal oils in the three local communities – Cimande, Songak, and Batudulang – is coconut (*C. nucifera*) in the form of coconut milk or ‘minyak kelapa’ in Indonesian. Nevertheless, coconuts specifically harvested for the oil are given different names in each tribe. It is called ‘nunggal coconut’ in Cimande, ‘mangku’ or ‘jejaton’ in Songak, and ‘nyiur ijo’ in Batudulang.

The number of coconut fruit harvested for milk is different in each tribe. In Cimande, only single coconuts are harvested, thus it is called ‘kalapa nunggal’, which literary means exactly one coconut. This coconut fruit is special because the coconut bunch only produces a single coconut fruit. In other tribes, there is no special requirement for the coconut and the number can be more than one, such as in Songak, which can reach about 100 fruits.

The method of harvesting coconuts is also different for each tribe. It is called ‘jejaton’ in Songak, which means the fruits have to be taken from the tree. The fruits should not touch the ground. In Batudulang, there is no such tradition.

Nevertheless, the fruits have also been taken directly from the tree as in ‘nunggal’ or ‘jejaton’. In other words, the fruit specifically intended for the herbal oil should be harvested directly from the tree. This is reminiscent of the ancient Austronesian belief that considers coconut a sacred plant (Swan and Trompf 1995; Pawley and Ross 2006).

Apart from the sacred coconut, the other species included in the making of traditional massage herbal oils (Fig. 3) mostly belong to Zingiberaceae (eight species), Apiaceae and Fabaceae (five species), Lauraceae (four species), Elaeocarpaceae (three species), Apocynaceae, Lythraceae, Myrtaceae, Piperaceae, Sapindaceae (two species), and Capparaceae, Combretaceae, Convolvulaceae, Dipterocarpaceae, Ericaceae, Iridaceae, Malvaceae, Poaceae, Ranunculaceae, Rutaceae and Shizandrataceae (one species).

The parts of the plant most frequently used in the making of traditional herbal oils are seeds, as indicated by 17 species harvested (Fig. 4), followed by rhizomes (seven species, exclusively members of Zingiberaceae), twigs, stems or bark (six species, particularly members of Elaeocarpaceae), fruit (five species), tree bark (four species), leaves and flowers (two species), and the flesh of fruit and rind (one species).

Table 1. List of plant species used in the making of herbal massage oils.

No.	Family	Scientific name	Vernacular name	Parts used	Locations
1	Arecaceae	<i>Cocos nucifera</i> L.	Kelapa, Nyiur	Kernel	Cimande, Lombok, and Sumbawa
2	Apiaceae	<i>Anethum graveolens</i> L.	Adas manis	Seed	Lombok
3	Apiaceae	<i>Coriandrum sativum</i> L.	Ketumbar	Seed	Lombok
4	Apiaceae	<i>Cuminum cyminum</i> L.	Inten utih	Seed	Lombok
5	Apiaceae	<i>Foeniculum vulgare</i> Mill.	Adas medi	Seed	Lombok
6	Apiaceae	<i>Trachyspermum ammi</i> (L.) Sprague	Musi	Seed	Lombok
7	Apocynaceae	<i>Alyxia reinwardtii</i> Blume	Pulasari	Tree bark	Lombok
8	Apocynaceae	<i>Urceola laevigata</i> (Juss.) D.J. Middleton & Livsh.	Kayu rapet	Stem	Lombok
9	Capparaceae	<i>Capparis sepiaria</i> var. <i>fisheri</i> (Pax) DeWolf	Kasene	Tree bark	Sumbawa
10	Combretaceae	<i>Terminalia citrina</i> (Gaertn.) Roxb.	Maja keling	Fruit	Lombok
11	Convolvulaceae	<i>Cuscuta australis</i> R.Br.	Maja muju	Stem	Lombok
12	Dipterocarpaceae	<i>Dipterocarpus retusus</i> Blume	Pala kurung	Fruit	Lombok
13	Elaeocarpaceae	<i>Elaeocarpus serratus</i> L.	Ganiti	Seed, tree bark	Lombok
14	Elaeocarpaceae	<i>Elaeocarpus floribundus</i> Blume	Amyang kecil	Seed, tree bark	Lombok
15	Elaeocarpaceae	<i>Elaeocarpus grandiflorus</i> Sm.	Anyang besar	Seed, tree bark	Lombok
16	Ericaceae	<i>Gaultheria fragrantissima</i> subsp. <i>punctata</i> (Blume) Steenis	Gandapura	Leaf	Lombok
17	Fabaceae	<i>Euchresta horsfieldii</i> (Lesch.) Benn.	Purna jiwa	Seed	Lombok
18	Fabaceae	<i>Derris elliptica</i> (Wall.) Benth.	Kanekal	Stem, tree bark	Sumbawa
19	Fabaceae	<i>Parkia timoriana</i> (DC.) Merr.	Kedaung	Seed	Lombok
20	Fabaceae	<i>Sindora galedupa</i> Prain	Saparwantu	Fruit	Lombok
21	Fabaceae	<i>Trigonella foenum-graecum</i> L.	Kelabet	Seed	Lombok
22	Iridaceae	<i>Crocus sativus</i> L.	Kuma muka	Seed	Lombok
23	Lauraceae	<i>Cassytha filiformis</i> L.	Kayu angin	Stem	Lombok
24	Lauraceae	<i>Cinnamomum burmannii</i> (Nees & T.Nees) Blume	Kayu manis	Tree bark	Lombok
25	Lauraceae	<i>Cryptocarya massoy</i> (Oken) Kosterm.	Massoi	Tree bark	Lombok
26	Lauraceae	<i>Litsea elliptica</i> Blume	Trawas	Leaf	Lombok
27	Lythraceae	<i>Punica granatum</i> L.	Jelame	Rind	Lombok
28	Lythraceae	<i>Woodfordia fruticosa</i> (L.) Kurz -	Sidowayah	Fruit	Lombok
29	Malvaceae	<i>Helicteres isora</i> L.	Ije lilit	Seed	Lombok
30	Myrtaceae	<i>Myristica fragrans</i> Houtt.	Pala	Seed	Lombok
31	Myrtaceae	<i>Syzygium aromaticum</i> (L.) Merr. & L.M. Perry	Cengkeh	Flower	Lombok
32	Piperaceae	<i>Piper cubeba</i> -L.f.	Temukus	Seed	Lombok
33	Piperaceae	<i>Piper nigrum</i> L.	Sang putih	Seed	Lombok
34	Poaceae	<i>Saccharum officinarum</i> L.	Tebu	Stem	Cimande
35	Ranunculaceae	<i>Nigella sativa</i> L.	Jinten hitam	Seed	Lombok
36	Rutaceae	<i>Aegle marmelos</i> (L.) Corrêa	Majaan	Seed	Lombok
37	Sapindaceae	<i>Lepisanthes rubiginosa</i> (Roxb.) Leenh.	Kasokal	Stem, tree bark	Sumbawa
38	Sapindaceae	<i>Schleichera oleosa</i> (Lour.) Oken	Kesaming	Stem	Sumbawa
39	Schisandraceae	<i>Illicium verum</i> Hook.f.	Peka	Flower	Lombok
40	Zingiberaceae	<i>Alpinia galanga</i> (L.) Willd.	Laos	Rhizome	Lombok
41	Zingiberaceae	<i>Curcuma longa</i> L.	Kunyit	Rhizome	Lombok
42	Zingiberaceae	<i>Curcuma zanthorrhiza</i> Roxb.	Temu lawak	Rhizome	Lombok
43	Zingiberaceae	<i>Elettaria cardamomum</i> (L.) Maton	Kapulaga	Fruit	Lombok

(Continued on next page)

Table 1. (Continued).

No.	Family	Scientific name	Vernacular name	Parts used	Locations
44	Zingiberaceae	<i>Kaempferia angustifolia</i> Roscoe	Kenem	Rhizome	Lombok
45	Zingiberaceae	<i>Kaempferia galanga</i> L.	Sari putih	Rhizome	Lombok
46	Zingiberaceae	<i>Kaempferia rotunda</i> L.	Kunci pepet	Rhizome	Lombok
47	Zingiberaceae	<i>Zingiber officinale</i> Roscoe	Halia	Rhizome	Lombok

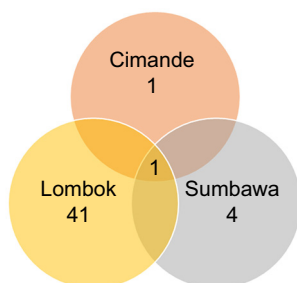


Fig. 2. Number of species used in the making of herbal oil in the three communities: (1) the Sundanese of Cimande (West Java); (2) the Sasak of Songak (Lombok Island); and (3) the Samawa of Batudulang (Sumbawa Island).

In the Songak community of Lombok, the main equipment used in the making of herbal medicinal massage oil is called 'sigon', a large pan specifically used for the making of massage oil. The 'sigon' cannot be used for any other purpose. Similar apparatus such as the 'sigon' are used in the other two communities but are mostly made from pottery.

Firewood from specific species should be used for the cooking process of herbal oils. The wood should be hardwood as it burns slowly, high emitted energy, and does not release unpleasant aromas that can affect the odour of

the oil produced. The common woods used for firewood include *Nephelium lappaceum* (Sapindaceae, mostly twigs), *Durio zibethinus* (Malvaceae, the great Durian), *Garcinia mangostana* (Clusiaceae), *Lannea coromandelica* (Anacardiaceae) and *C. nucifera* (Arecaceae, particularly the leaf sheaths).

The traditional preparation of herbal massage oil is unique for each community. There is no specific time of the day for producing traditional herbal massage oil in the Cimande community, but the process usually happens in the afternoon. The cooking activities should be done by post-menopausal women. The harvesting of the coconut is strictly done by men. It takes 4–6 h to cook traditional herbal massage oil in Cimande.

In the Songak and Batudulang communities, the preparation of traditional herbal massage oil can only be done once a year, usually after the 10th day of the third month in the Islamic calendar known as Rabi' I or 'Rabiul Awal' in Indonesian (Beatty 1999; Muhaimin 2006). This month is widely known by Muslims as the birth month of Prophet Muhammad and is traditionally known as 'Maulid' (Beatty 1999; Moller 2005; Muhaimin 2006). This is related to the dominant religion embraced by the Sasak and Samawa tribes, which is Islam (Rensch 1930).

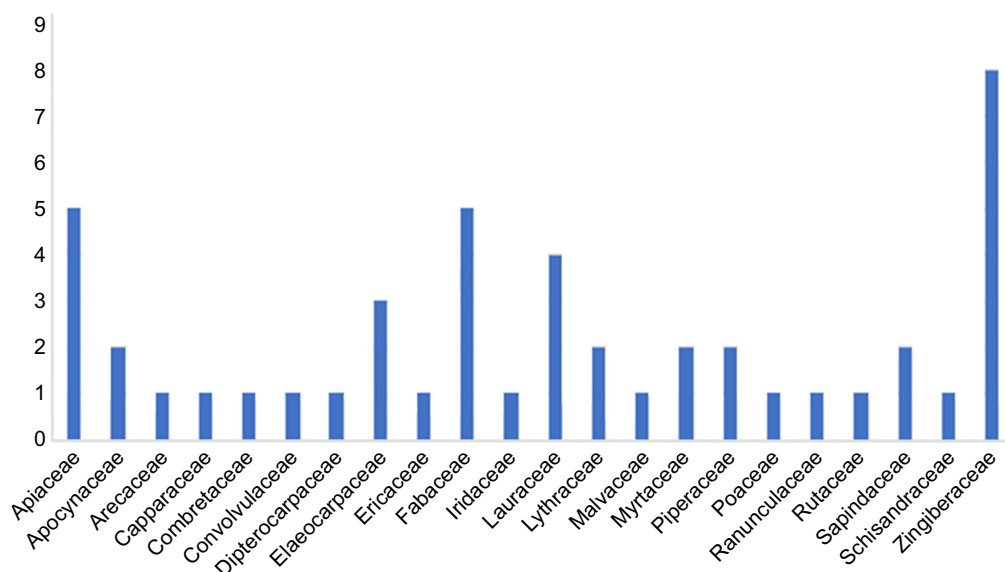


Fig. 3. Number of species within each plant family.

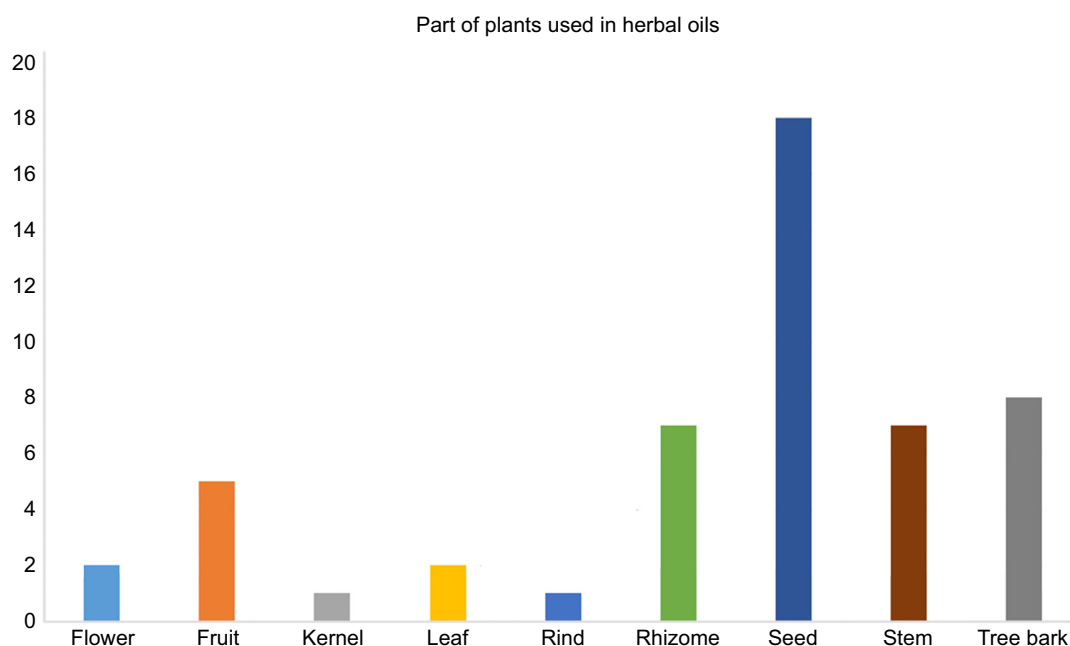


Fig. 4. Parts of the plants incorporated into the making of herbal massage oils.

The entire process is started by harvesting the coconut, followed by cleaning, grating and preparing the grated coconut to be extracted to produce oil. All of this is prepared by men. The rest of the processes, from extracting the coconut milk to the finishing touches are done exclusively by men. As the entire process is done only once a year, approximately 50 L of coconut milk is required, which is obtained from approximately 100 coconuts.

The time required for the whole production process ranges between 8 and 11 h. This time-consuming process requires physical endurance and strength. The making of herbal massage oil in the Songak community is unique in that, to this day, women are not allowed to even enter the room, where the oil is being cooked. This phenomenon is to avoid disruption to the cooking process. The steps for making traditional herbal oil seen in the Songak community are as follows:

1. One or two green coconut fruits or 'jejaton' are shredded manually using conventional shredding equipment.
2. The grated coconut is then mixed with other grated coconut; some water is added and the mix is squeezed to extract approximately 50 L of thick coconut milk from 100 coconuts.
3. The coconut milk is then cooked (boiled) by constantly stirring it for 6–8 h until the colour changes from creamy white to brownish-yellow.
4. Coconut dregs known as 'tahi kelapa' are separated from the vegetable oil.
5. Yeast is added to the oil produced to form a kind of mixture simplicia locally known as 'isi kantong' (literary means the contents of the pocket), containing 40 or more species

(Table 1) that is continuously mashed and stirred into a bluish-yellow oily solution.

6. The continuous stirring process takes 2–3 h.
7. This gives us the final result, traditional herbal massage oil, which is cooled and put into bottles.

The ingredients of 'isi kantong' are also used as medicinal ingredients in postpartum treatment (Rahayu et al. 2002, 2016).

The method of making traditional herbal massage oil followed by the Batudulang community is similar to the Songak community; however, only five species of plants are incorporated (Table 1). Nevertheless, these five species have to meet several unique requirements imposed by traditional regulation (Permatasari 2013; Rahayu and Rustiami 2017), such as:

1. The vernacular name of the plant in the Samawa language has to start with the letter K.
2. The plants should be taken from the same habitat (i.e. same place of collecting).
3. They should also be taken from the wild, not from gardens or cultivated plantings.

An explanation for these requirements is still shrouded in mystery. Further study is essential. The ethnobotany of this region is still largely unknown, the best so far was provided by Rensch (1930).

In the Cimande community, the only other element employed to create the mixture is the burned stalks of sugarcane (*S. officinarum*) from a specific cultivar – the cultivar with yellow stems. Despite there being at least two

other cultivars of sugarcane in the vicinity (red and green stemmed), only the yellow cultivar is used. The reason for this preference is still unclear. The mixture is then pounded manually by hand or by wooden clubs. The juice that is produced is collected and fermented by leaving it for 1 or 2 days. The fermented juice is known locally as ‘sugar cane vinegar’.

The method employed to produce traditional herbal massage oil in the Cimande community is approximately similar to those in the other two communities. The coconut milk harvested from the coconut meat – which is the endosperm of the coconut fruit – is heated to extract vegetable oil. The ‘sugar cane vinegar’ is then added while the oil is continuously, gently stirred.

Discussion

Knowledge of herbal oil production has been passed from generation to generation. Only selected descendants have access to this knowledge. This may come from the first or second generation of the former herbal maker. Therefore, not all villagers have the ability to make these oils. In Songak and Batudulang, the knowledge of making herbal oil is only transferred to male descendants, while in Cimande it is primarily transferred to men but women who have reached the age of menopause can be involved in the cooking process.

Coconut oil that is used as the main ingredient for these three massage oils are considered a part of life, not only because it is a sacred fruit but also has many benefits and a high economic value in meeting the needs of daily life. Moreover, many modern studies have revealed that coconut oil contains several medicinal properties.

The sacredness of the coconut in the Austronesian civilisation is directly connected to their great oceanic journeys, particularly into the Pacific, as the staple food of the Austronesians gradually shifted from rice to other plants, particularly coconut (Pawley and Ross 2006). The sacredness of the coconut can still be seen in the heartland of the Austronesian civilisation; Java and Bali (Geertz 1960; Hooykaas 1973), and also in various religions in Oceania (Swan and Trompf 1995).

The important position and sacredness of the coconut has never disappeared from Java, even after the arrival of Islam. As Islam became the dominant religion embraced by the Javanese – the largest tribe within the Austronesian realm – the coconut continued to be incorporated into traditional Javanese rituals, conspicuously showing their deep Austronesian roots (Beatty 1999; Muhaimin 2006).

Therefore, the results of this study regarding the phenomenon of harvesting coconut fruit for use in herbal massage oil supports the sacred position of coconuts in the Austronesian civilisation. Furthermore, the belief in the sacredness of coconut existed before the great Austronesian

journeys to the Pacific and beyond. In other words, the tradition has long been upheld in the homeland of the Austronesians, the Indonesian Archipelago, or at least Sundaland. The sacredness of coconut also comes from historical Hindu mythology. According to the Vedic scriptures, coconut is a sacred, heavenly plant, playing an important role in human life.

Pharmaceutically, coconut oil has long been known as containing antioxidants and having antiviral, antibacterial and antifungal properties (Ross 2005; Seneviratne and Jayathilaka 2016; Suryani *et al.* 2020). According to Ngampeerapong and Chavasit (2019), several bioactive compounds such as phenolic compounds and phytosterols were found in coconut meat as well as antioxidant activity. The total amount of phytosterol content in Indonesian coconuts is higher than coconuts from Thailand and Vietnam, and β -sitosterol is the main phytosterol making up more than 50% of the total content. These medicinal properties of the coconut have long been understood by Austronesians as can be seen by the diversity of medicinal uses of the coconut by communities across Indonesia. The most diverse use of coconut anywhere in the world can be found in Indonesia.

In Indonesia, coconut oil is generally applied externally to treat wounds and injuries by the ethnic group of Ngada (Sachs *et al.* 2002; Ross 2005). The shell is used as incense (Sangat-Roemantyo 1990). A hot water extract of the root is taken orally for fever, bloody diarrhoea and dysentery. The fruit milk is taken orally by adults to treat poisoning (Hirschhorn 1983) and the milk is also taken orally by females as a contraceptive (Brondegaard 1973). Coconut juice is believed to diminish libido or fertility (de Laszlo and Henshaw 1954). Seed oil with lemon juice and various tree roots is taken orally as an abortifacient (Devereux 1976). Fruit ointment is applied externally for swollen legs. Fresh flowers, chewed with *Borassus flabellifer*, are used for gonorrhoea (Hirschhorn 1983).

The results of this current study indicate the significance of the coconut (i.e. coconut milk) in the making of traditional herbal massage oils. Coconuts have an amazing variety of uses in Indonesia, further evidence of the importance and thus, sacredness of the fruit to Austronesian communities and societies, in which Indonesia is the backbone.

The origin and first domestication of coconut itself most likely took place on the islands of Southeast Asia, in which Indonesia has the largest number of islands (Gunn *et al.* 2011). The coconut has been proven to have a strong link with the journeys of the Austronesians to the Pacific and beyond believed to America long before the arrival of the Vikings and Columbus (Baudouin and Lebrun 2009).

In this study, it is suggested that the Sundanese tribe, represented here by studying the Cimande community, maintains the original or purest form of Austronesian massage oil; that is, coconut oil or milk combined with sugarcane juice. The Sundanese are indeed considered one of the three

dominant tribes within the Austronesians or at least Western Malayo Polynesians (Blust 1999, 2013), who retain much of the original heritage of the Austronesian civilisation, including its medicinal heritage.

Concerning the production of their valuable traditional massage oils, the communities in this study conserve their oil-producing varieties of coconut by continuously planting the varieties, usually in exclusive locations separated from other non-oil producing varieties. This is noticeably observed in the Sundanese Cimande community, where their 'nunggal' variety is so highly prized, that the variety has its own plantations.

Making a distinction between the different varieties of coconut is common and practiced throughout Indonesia (Tammes 1955) and the rest of the Austronesian realm, including the Pacific (Chan and Elevitch 2006). This also indicates the antiquity of coconut domestication in the Austronesian dominion and how the traditional Austronesian communities conserve the different varieties. Certainly, it is done through traditionally recognising, naming, classifying and constantly planting them; in other words, conservation by utilisation.

As in the case of coconut described above, the three communities in this current study also actively conserve and protect the species involved in the making of traditional herbal oils, providing them with extra income, particularly plants from three families: Fabaceae, Lauraceae and Zingiberaceae. This finding is consistent with Cahyaningsih et al. (2021), who studied the conservation of medicinal plants in Indonesia.

Plants from the Zingiberaceae family are known for their medicinal value in both south Asia and south-east Asia, especially the genera *Alpinia*, *Curcuma*, *Elettaria*, *Kaempferia* and *Zingiber* (Heyne 1927a; Ravindran and Madhusoodanan 2002; Ravindran and Babu 2005; Seidemann 2005; Simpson 2006; Khare 2007; Ravindran et al. 2007). Most of them are also known as important spices (Peter 2001, 2004, 2006; Seidemann 2005). Ginger (*Zingiber officinale*) has many bioactive compounds such as phenolic compounds and terpenes, and other biological activities such as antioxidant, anti-inflammatory, antimicrobial and anticancer activities (Mao et al. 2019), and turmeric (*Curcuma longa*) is known as an insecticide, has bioactive phenolic compounds and possesses antioxidant, antitumour, antimicrobial, anticancer, anti-inflammatory, healing and gastroprotective properties (de Oliveira Filho et al. 2020).

The significance of the Zingiberaceae family in both the spice trade and traditional medicines of the people of Indonesia was botanically recorded for the first time by Rumphius in his 18th Century monumental work, *Herbarium Amboinense* (Rumphius 1747; Rumphius 2011b). The significance of the Zingiberaceae family for Indonesians is conspicuous by the fact that the diversity of Zingiberaceae is high in the Indian Subcontinent and Indo-Malaysian (i.e. Flora Malesiana) tropical rainforests (Seidemann 2005).

Indonesia has some of the highest plant diversity of the Indo-Malaysian or Flora Malesiana's tropical rainforests; thus, it is reasonable that the daily use of members of Zingiberaceae is immense. This statement is supported by the results of the current study (Table 1). The use of Zingiberaceae as essential elements in making traditional herbal oil is also reported throughout Indonesia. For example, 'minyak Karo' is made by the Karo community in the Batak tribe of North Sumatra, where seven of the 42 species from 24 families of plants used in the making of the oil are members of the Zingiberaceae family (Nasution et al. 2020).

The people throughout Indonesia – including the three communities in this present study – protect and conserve the beneficial members of Zingiberaceae by continuously planting them in their home gardens and in the vicinity of their rice fields and plantations of other plants, such as coconut. The plant species commonly found include *Curcuma longa*, *C. zanthorrhiza*, *Kaempferia galanga* and *Z. officinale*; species that are also found in this current study, especially in Lombok (Table 1).

Another interesting observation regarding the diversity of plant species used in the production of herbal massage oil in Lombok (Table 1) is related to the position of Lombok Island in the Lesser Sunda Islands. Geographically, Lombok is located close to the island of Bali, which adheres to Hinduism. Traditional medicine in Bali is heavily influenced by Ayurveda (an alternative medicine system with historical roots in the Indian subcontinent). This system influences the surrounding islands including Lombok. Generally, the Balinese community uses quite a lot of simplicia in traditional medicine. Although the Sasak tribe is Muslim, their cultural activities are still influenced by Hindu culture (Sujarwo et al. 2015).

Even though Lombok Island is floristically included in the flora of Western Malesiana (Rensch 1930) supported by the obvious presence of Laurasian flora such as the Laurasian tree genera *Cinnamomum* and *Dipterocarpus*, the presence of floristic elements from eastern Malesiana (i.e. Gondwanic) is also noticeable, such as the presence of genera *Gaultheria* and *Myristica*. However, the presence of both nutmeg (*Myristica fragrans*) and cloves (*Syzygium aromaticum*) might have been introduced from the Moluccas, as reported by Rumphius (1741); Rensch 1930; Rumphius 2011a).

Dipterocarpus retusus is an obvious example of the Laurasian floristic element and the species is reported on Lombok Island (Rensch 1930; Mawry-Lechon and Curtet 1998). The resin of this tree is known to be used as medicine, which is applied to wounds (Chancerel 1920). However, the use of the fruit as medicine has never been reported before. There is no known information that the fruit of *D. retusus* is edible. Thus, it is a new ethnobotanical report.

The vernacular name for *D. retusus* (Dipterocarpaceae) is 'pala kurung' (meaning 'bracket nutmeg' in English) but, interestingly, the species is not at all phylogenetically close to 'pala' (nutmeg in English or scientifically *M. fragrans*

(Myristicaceae)). Neither is it morphologically similar, especially as it does not possess arils, which characterises nutmeg fruit. One possible explanation is that the shape of the fruit very much resembles nutmeg fruit, but it is bracketed by winged calyces.

Dipterocarpus retusus is a species of Indonesian medicinal plants with a high conservation value (Cahyaningsih *et al.* 2021). The current IUCN status of the species is Endangered (Nanthavong *et al.* 2017). Nevertheless, a healthy population of the species – known locally as ‘keruing gunung’ – is still found well protected in the Mount Rinjani National Park (Azis 2015).

Sindora galedupa (Fabaceae) is also reported in the Lesser Sunda Islands, including Lombok (Rensch 1930; Sosef 1993). This species has long been recognised for its resin which has been harvested primarily for incense (Langenheim 2003). The use of the resin is most popular in Sulawesi where it is intensively used as incense by numerous tribes, so much so that the species is known as the incense of Sulawesi (Rumphius 1741; Keim *et al.* 2020). The use of the fruit of *S. galedupa* for medicinal purposes has never been reported before; thus, it is a new ethnobotanical record for Lombok Island and the rest of the Lesser Sunda Islands. Neither the fruits have been harvested in Sulawesi for the same purposes. *Sindora galedupa* is a member of Fabaceae, a family that includes medicinal plants of high conservation value in Indonesia (Cahyaningsih *et al.* 2021). Traditionally, the species are protected primarily by the people of southern Sulawesi, especially the Bugis (Keim *et al.* 2020).

The use of *Cinnamomum burmannii* for medicinal purposes by the western Austronesian people – particularly Indonesians, being the largest bulk of Austronesians – is legendary and the plant is referred to frequently in Indonesia. It even has the international trade name ‘Indonesian Cinnamon’, ‘Padang Cassia’ or ‘Korintji Cinnamon’, which refers to the largest production centre of this species, the Kerinci area (spelt Korintji in Dutch) of Western Sumatra, where the city of Padang is the main harbour (Ravindran *et al.* 2004; Sujarwo and Keim 2021). Cinnamon is known for its essential oil and has the potential as an antidiabetic (Plumeriastuti *et al.* 2019). The most recent study of the phytochemistry and biocultural information of *C. burmannii* is presented by Sujarwo and Keim (2021).

Black cumin or *Nigella sativa* – known in Indonesian as ‘jinten hitam’ – is undoubtedly an introduced species and the use of this species in Indonesia presumably began as early as the 8th Century AD with the arrival of Islam and Arab traders to the spice islands of Indonesia, (von der Mehden 1995; Martin 2004). The Arabs and many people of the Middle East use black cumin in many of their medicines and cuisines.

The bark from members of Elaeocarpaceae, particularly from the genus *Elaeocarpus*, are well known for their medicinal use in Asia and the Pacific (thus also by Austronesians), especially *Elaeocarpus floribundus* and

Elaeocarpus grandiflorus (Merrill 1951; Wiard 2006; Quattrocchi 2012), two species that are used by the Songak community of the Sasak tribe in Lombok. Other principles of interest in Elaeocarpaceae are indolizidine alkaloids, which have attracted a great deal of interest on account of their ability to inhibit the enzymatic activity of glucosidases due to a structural similarity with glucose; hence, there is some potential to explore it further in the treatment of human immunodeficiency virus, diabetes and cancer (Wiard 2006). While an infusion of bark and leaves is used as a mouthwash for inflamed gums in Sumatra (Heyne 1927b; Merrill 1951; Wiard 2006), the use of tree bark of any member of Elaeocarpaceae and genus *Elaeocarpus* for traditional herbal massage oil has never been reported before. Thus, the result of this study is a new ethnobotanical record for the genus and at least the three species; *E. floribundus*, *E. grandiflorus* and *Elaeocarpus serratus*. This finding can also be regarded as the novelty of this present study. The presence of the two Asiatic (including Indonesia and most of the countries that used to be part of Sundaland) medicinal species of *Elaeocarpus* (*E. floribundus* – found in this current study and *E. obtusus*) in the Pacific raises the possibility that these two species might have been dispersed to the Pacific by the Austronesians during their legendary maritime journeys to the Pacific (Bellwood *et al.* 2006). Generally, the process of producing traditional herbal massage oil is done during the night, preferably on a Thursday night, which is regarded as sacred by Muslims in Indonesia (Geertz 1960; Beatty 1999; Moller 2005; Muhaimin 2006). This indicates the strong influence of the Fassiya branch of the 13th Century Shadhili order (Fassiyatush shadhili Sufi order; Aziz 2011). This branch probably came to Indonesia from Yemen and arrived in Lombok presumably around the 13th Century as well; thus, starting the tradition of making herbal massage oil in both Muslim dominated communities of Songak and Batudulang.

The similarity in the method and the noticeable importance of the coconut in the three communities indicate that the three communities are undoubtedly Austronesian. Furthermore, the simplest contents of plant species involved in the making of traditional massage oil in the Cimande community is suggested here as indicating the Sundanese are undoubtedly one of the three tribes that are still somehow preserving the purest form of Austronesian civilisation.

The difficulty of making traditional herbal massage oil lies not in the supply of plant-based materials but more in the rituals passed down for generations, including the incantations accompanying it. The rituals must be done prior to and while the oil is being produced and not everyone can perform such rituals. These rituals are kept well by the people of the three communities alongside the coconut cultivations and conservation of their sacred forests. The blessed wisdom is inherited from their Austronesian ancestors. Traditional herbal massage oil is not commercially produced by the three communities. The main purpose of herbal oil production is

exclusively for its medicinal uses and as a way of connecting and preserving the value of their Austronesian heritage.

The people of Cimande, Songak and Batudulang will happily assist anyone who asks for help by providing medicinal treatment using the herbal oils or by selling the oil at a modest price, most of the time only for the cost of making the oil.

Conclusion

Traditional herbal massage oils of Cimande, Songak and Batudulang are a source of local knowledge and wisdom of the local community, which has been passed through the generations. The manufacturing process is not complicated, and the material used both as main and secondary ingredients are easy to obtain, but not just anyone can make it. During the production, rituals are carried out with the aim that the herbal oils produced are efficacious and beneficial in healing or treatment.

Local governments need to play a role in developing and socialising the use of traditional herbal massage oils. It is hoped that the traditional knowledge and wisdom of the local communities can form the basis of developing their territory into a traditional village, such as the village of Songak in Lombok.

It is feared that the increasing changes in land use will result in the disappearance of certain wild plant species used in the making of herbal oils. Likewise, the traditional knowledge of the local community could be eroded. Therefore, the cultivation and conservation of wild plants is needed to maintain their presence in nature, so that the traditional knowledge of local communities can be sustained.

References

- Aminah S, Wadenaar E, Muflihati (2016) Tumbuhan Obat yang Digunakan oleh Battrra di Desa Sejahtera Kecamatan Sukadana, Kabupaten Kayong Utara. *Jurnal Hutan Lestari* 4(3), 299–305.
- Azis A (2015) Karakteristik populasi dan potensi bioprospeksi keruing gunung (*Dipterocarpus retusus* Bl.) di Taman Nasional Gunung Rinjani, Provinsi NTB. MSc thesis, IPB University, Bogor.
- Aziz MA (2011) 'Religion and mysticism in early Islam: theology and sufism in Yemen.' (I.B. Tauris: New York)
- Baudouin L, Lebrun P (2009) Coconut (*Cocos nucifera* L.) DNA studies support the hypothesis of an ancient Austronesian migration from Southeast Asia to America. *Genetic Resources and Crop Evolution* 56, 257–262. doi:10.1007/s10722-008-9362-6
- Beatty A (1999) 'Varieties of Javanese religion: an anthropological account.' (Cambridge University Press: Cambridge)
- Bellwood P, Fox JJ, Tryon D (2006) The Austronesians in history: common origins and diverse transformations. In 'The Austronesians: historical and comparative perspectives'. (Eds P Bellwood, JJ Fox, D Tryon) pp. 1–16. (The Australian National University Press: Canberra)
- Blust RA (1984) Indonesia as a 'field of linguistic study'. In 'Unity in diversity: Indonesia as a field of anthropological study. Vol. 103'. (Ed PE de Josselin de Jong) pp. 21–37. (Verhandelungen van het Koninklijk Instituut voor Taal-, Land-en Volkenkunde)
- Blust R (1999) Subgrouping, circularity, and extinction: some issues in Austronesian comparative linguistics. In 'Selected papers from the eighth international conference on Austronesian linguistics'. (Eds E Zeitoun, P Jen-Kuei Li) pp. 1–54. (Academia Sinica Taiwan: Taipei)
- Blust R (2013) 'Austronesian languages', Rev. edn. Asia-Pacific linguistics. (Research School of Pacific and Asian Studies, Australian National University: Canberra)
- Brondegaard VJ (1973) Contraceptive plant drugs. *Planta Medica* 23, 167–172. doi:10.1055/s-0028-1099428
- Cahyaningsih R, Magos Brehm J, Maxted N (2021) Setting the priority medicinal plants for conservation in Indonesia. *Genetic Resources and Crop Evolution* 68, 2019–2050. doi:10.1007/s10722-021-01115-6
- Chan E, Elevitch CR (2006) *Cocos nucifera* (coconut): Ver. 2.1. In 'Species profiles for Pacific island agroforestry'. (Ed. CR Elevitch) pp. 1–27. (Permanent Agriculture Resources: Holualoa)
- Chancerel L (1920) 'Flore forestière du Globe.' (Gauthier-Vilars: Paris)
- de Laszlo H, Henshaw PS (1954) Plant materials used by primitive peoples to affect fertility. *Science* 119, 626–631. doi:10.1126/science.119.3097.626
- de Oliveira Filho JG, de Almeida MJ, Sousa TL, dos Santos DC, Egea MB (2020) Bioactive compounds of turmeric (*Curcuma longa* L.). In 'Bioactive compounds in underutilized vegetables and legumes'. Reference series in phytochemistry. (Eds. HN Murthy, KY Paek). (Springer: Cham) doi:10.1007/978-3-030-44578-2_37-1
- Devereux G (1976) 'A study of abortion in primitive societies.' (Julian: New York)
- Geertz C (1960) 'The religion of Java.' (University of Chicago Press: Chicago)
- Gunn BF, Baudouin L, Olsen KM (2011) Independent origins of cultivated coconut (*Cocos nucifera* L.) in the old world tropics. *PLoS ONE* 6(6), e21143. doi:10.1371/journal.pone.0021143
- Heyne K (1927a) 'De nuttige planten van Nederlandsch Indië. Vol. 1.', 2nd edn. (Departement van Landbouw. Nijverheid and Handel in Nederlandsch Indië: Batavia, Jakarta)
- Heyne K (1927b) 'De nuttige planten van Nederlandsch Indië. Vol. 3.', 2nd edn. (Departement van Landbouw. Nijverheid and Handel in Nederlandsch Indië: Batavia, Jakarta)
- Hirschhorn HH (1983) Botanical remedies of the former Dutch East Indies (Indonesia). Part I: eumycetes, pteridophyta, gymnospermae, angiospermae (monocotyledons only). *Journal of Ethnopharmacology* 7(2), 123–156. doi:10.1016/0378-8741(83)90016-8
- Hooykaas C (1973) 'Religion in Bali.' (Brill: Leiden)
- ISE – International Society of Ethnobiology (2006) International society of ethnobiology code of ethics (with 2008 additions). Available at www.ethnobiology.net/ethics.php. [Accessed 12 March 2021]
- Keim AP, Nikmatullah M, Arifah N, Adi TR, Wardah W, Sujarwo W (2020) Bone, Matompang Arajang, 'Kayu Galadupa' (*Sindora galedupa*; Fabacea) dan jejaring Bugis Nusantara. *Journal of Tropical Ethnobiology* 3(1), 11–27. doi:10.46359/jte.v3i1
- Khare CP (2007) 'Indian medicinal plants: an illustrated dictionary.' (Springer: Heidelberg)
- Langenheim JH (2003) 'Plant resins: chemistry, evolution, ecology, and ethnobotany.' (Timber Press: Portland)
- Legge JD (2021) 'Indonesia: facts, people, and points of interest.' (Encyclopaedia Britannica: London)
- Liliveri A (2003) 'Dasar-dasar Komunikasi Antar Budaya.' (Pustaka Pelajar: Yogyakarta)
- Mao Q-Q, Xu X-Y, Cao S-Y, Gan R-Y, Corke H, Beta T, Li H-B (2019) Bioactive compounds and bioactivities of Ginger (*Zingiber officinale* Roscoe). *Foods* 8(6), 185. doi:10.3390/foods8060185
- Martin RC (2004) 'Encyclopedia of Islam and the Muslim world. Vol. 2.' (Macmillan: London)
- Mawry-Lechon G, Curtet L (1998) Biogeography and evolutionary systematics of Dipterocarpaceae. In 'A review of Dipterocarps: taxonomy, ecology, and silviculture'. (Eds S Appanah, JN Turnbull). (Center for International Forestry Research (CIFOR): Bogor)
- Melalatoa MJ (1995) 'Ensiklopedi Suku Bangsa.' (Departemen Pendidikan dan Kebudayaan RI: Jakarta)
- Merrill ED (1951) Notes on *Elaeocarpus* Linnaeus. *Journal of the Arnold Arboretum* 32(2), 157–200.
- Moller A (2005) 'Ramadan in Java: the joy and jihad of ritual fasting.' (Lünd University Press: Lünd)
- Muhaimin AG (2006) 'The Islamic traditions of Cirebon: ibadat and adat among Javanese Muslims.' (Australian National University: Canberra)

- Nanthavong V, Pooma R, Luu HT, Nguyen HM, Vu VD, Homg VS, Khou E, Newman M (2017) '*Dipterocarpus retusus*.' (IUCN Red List of Threatened Species: London)
- Nasution J, Suharyanto A, Dasopang ES (2020) Study ethnobotany of Minyak Karo. *Budapest International Research in Exact Sciences Journal* 2(1), 96–100. doi:10.33258/birex.v2i1.740
- Ngampeerapong C, Chavasit V (2019) Nutritional and bioactive compounds in coconut meat of different sources: Thailand, Indonesia and Vietnam. *CMU Journal of Natural Sciences* 18(4), 562–573. doi:10.12982/CMUJNS.2019.0037
- Pawley A, Ross M (2006) The prehistory of Oceanic languages: a current view. In 'The Austronesians: historical and comparative perspectives'. (Eds P Bellwood, JJ Fox, D Tryon) pp. 43–80. (The Australian National University Press: Canberra)
- Permatasari I (2013) Etnobotani Tumbuhan Bahan Dasar Minyak Sumbawa di Kabupaten Sumbawa Besar Propinsi Nusa Tenggara Barat (NTB). MSc thesis, Universitas Maulana Malik Ibrahim, Malang.
- Peter KV (2001) 'Handbook of herbs and spices.' (CRC Press: Boca Raton)
- Peter KV (2004) 'Handbook of herbs and spices. Vol. 2.' (CRC Press: Boca Raton)
- Peter KV (2006) 'Handbook of herbs and spices. Vol. 3.' (CRC Press, Boca Raton)
- Plumeriastuti H, Budiastuti, Effendi MH, Budiarto (2019) Identification of bioactive compound of the essential oils of *Cinnamomum burmannii* from several areas in Indonesia by gas chromatography–mass spectrometry method for antidiabetic potential. *National Journal of Physiology, Pharmacy and Pharmacology* 9(4), 279–283. doi:10.5455/njppp.2019.9.1236702022019
- POWO (2021) Plants of the world online. Available at <http://www.plantsoftheworldonline.org/>. [Accessed 12 March 2021]
- Quattrocchi V (2012) 'CRC world dictionary of medicinal and poisonous plants: common names, scientific names, eponyms, synonyms, and etymology.' (CRC Press: Boca Raton)
- Rahayu M, Rustiami H (2017) Etnobotani masyarakat Samawa Pulau Sumbawa. *Scripta Biologica* 4(4), 235–245. doi:10.20884/1.sb.2017.4.4.605
- Rahayu M, Rugayah, Praptiwi, Hamzah (2002) Keragaman Pemanfaatan Tumbuhan Obat oleh Masyarakat Suku Sasak, di Taman Nasional Gunung Rinjani, Lombok – NTB. In 'Prosiding Simposium Nasional II Tumbuhan Obat dan Aromatik, 8–9 Agustus 2001, Bogor'. pp. 116–123. (KEHATI, LIPI, APINMAP dan JICA: Bogor)
- Rahayu M, Rustiami H, Rugayah (2016) Ethnobotanical study of Sasak Ethnic, East Lombok, West Nusa Tenggara. *Journal of Tropical Biology and Conservation* 13, 85–99.
- Rahmat D (2013) Peran Battrra dalam Pengobatan Tradisional pada Komunitas Dayak Agabag di Kecamatan Lumbis Kabupaten Nunukan. *Journal Sosiologi Konsentrasi* 1(4), 50–61.
- Ravindran PN, Babu KN (2005) 'Ginger: the genus Zingiber.' (CRC Press: Boca Raton)
- Ravindran PN, Madhusoodanan KJ (2002) 'Cardamon: the genus *Elettaria*.' (CRC Press: Boca Raton)
- Ravindran PN, Babu KN, Shylaja M (2004) 'Cinnamon and cassia: the genus *Cinnamomum*.' (CRC Press: Boca Raton)
- Ravindran PN, Babu KN, Sivaraman K (2007) 'Turmeric: the genus *Curcuma*.' (CRC Press: Boca Raton)
- Rensch B (1930) 'Eine biologische reise nach den Kleinen Sunda-Inseln.' (Gebrüder Borntraeger: Berlin)
- Ross IA (2005) 'Medicinal plants of the world: chemical constituents, traditional, and modern medicinal uses. Vol. 3.' (Humana Press: New Jersey)
- Rumphius GE (1741) 'Herbarium amboinense. Vol. 1.' (François Changuion: Amsterdam)
- Rumphius GE (1747) 'Herbarium amboinense. Vol. 3.' (François Changuion: Amsterdam)
- Rumphius GE (2011a) 'The ambonese herbal. Being a description of the most noteworthy trees, shrubs, herbs, land- and water-plants which are found in amboina and the surrounding islands according to their shape, various names, cultivations and uses: together with several insects and animals. Vol. 1.' (Transl. EM Beekman) (Yale University Press: New Haven)
- Rumphius GE (2011b) 'The Ambonese herbal. Being a description of the most noteworthy trees, shrubs, herbs, land- and water-plants which are found in Amboina and the surrounding islands according to their shape, various names, cultivations and uses: together with several insects and animals. Vol. 3.' (Transl. EM Beekman). (Yale University Press: New Haven)
- Sachs M, von Eichel J, Asskali F (2002) Wound management with coconut oil in Indonesian folk medicine. *Chirurg* 73(4), 387–392. doi:10.1007/s00104-001-0382-4
- Sangat-Roemantyo H (1990) Ethnobotany of the Javanese incense. *Economic Botany* 44(3), 413–416. doi:10.1007/BF03351034
- Seidemann J (2005) 'World spice plants: economic usage, botany, taxonomy.' (Springer: Heidelberg)
- Seneviratne KN, Jayathilaka N (2016) 'Coconut oil chemistry and nutrition.' (Lakva Publishers: Battaramulla)
- Simpson MG (2006) 'Plant systematics.' (Elsevier: Amsterdam)
- Sosef MSM (1993) *Sindora*: selection of species. In 'Timber tress: major commercial timbers. Vol. 5.', Part 1. Plant resources of South East Asia (PROSEA). (Eds I Soerianegara, R Lemmens) pp. 438–442. (Backhuys: Leiden)
- Sudo K (2006) Hierarchy and routes of migration: chieftainship and ranking in the Central Caroline Islands. In 'Proceedings of the comparative Austronesian conference on hierarchy, ancestry, and alliance'. (Australian National University: Canberra)
- Sujarwo W, Keim AP (2021) *Cinnamomum burmannii* (Nees & T. Nees) Blume. In 'Ethnobotany of the mountain region of Southeast Asia', Ethnobotany of Mountain Regions. (Ed FM Franco) pp. 289–295. (Springer: Heidelberg)
- Sujarwo W, Keim AP, Savo V, Guarrera PM, Caneva G (2015) Ethnobotanical study of Loloh: traditional herbal drinks from Bali (Indonesia). *Journal of Ethnopharmacology* 169, 34–48. doi:10.1016/j.jep.2015.03.079
- Suryani S, Ariani S, Earnestly F, Marganof M, Rahmawati R, Sevindrajuta S, Mahlia TMI, Fudholi A (2020) A comparative study of virgin coconut oil, coconut oil and palm oil in terms of their active ingredients. *Processes* 8, 402. doi:10.3390/pr8040402
- Swan T, Trompf G (1995) 'The religions of Oceania: library religious beliefs and practice.' (Routledge: London)
- Tammes PLM (1955) Review of coconut selection in Indonesia. *Euphytica* 4, 17–24. doi:10.1007/BF00042411
- von der Mehden FR (1995) Indonesia. In 'The Oxford encyclopedia of the modern Islamic world.' (Ed. JL Esposito). (Oxford University Press: Oxford)
- Wiard C (2006) 'Medicinal plants of Asia and Pacific.' (CRC Press: Boca Raton)

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