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An ethnobotanical study of traditional steam-bathing by the Batak people of North Sumatra, Indonesia

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Abstract. This study aimed to document (1) the Batak people's knowledge of the use of medicinal plants for steam-bathing, (2) the preparation and operation of steam-bathing, and (3) the benefits of steam-bathing. To attain these objectives, data were collected by using ethnobotanical survey and interview methods. The survey was conducted in Kabanjahe and Berastagi traditional markets, in Kaban Tua village, and in Tanjung Julu village. The participants for the interview were nine medicinal plants traders, nine midwives, and 15 mothers. The basic principle of steam-bathing by the Batak people is based on thermotherapy and aromatherapy. A total of 59 species (belonging to 37 genera and to 25 families) have been documented as medicinal plants for their use as steam-bathing materials by the Batak people. The traders, midwives and mothers are all aware of the benefits of steam-bathing. *Gaultheria leucocarpa* Blume and *Cinnamomum porrectum* (Roxb.), the species that produce distinctive aromas and reduce pain, would be interesting to study for their phytochemical and pharmacological properties.

Additional keywords: *Cinnamomum porrectum* (Roxb.), essential oils, *Gaultheria leucocarpa* Blume

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Introduction

More than 80 ethnic groups (Bangun 2010) live on the island of Sumatra, which has ~10 000 species of plants (Anwar *et al.* 1987), many of which have medicinal uses. Various studies have been conducted on the general benefits of medicinal plants used by various ethnic groups on Sumatra, including the Minangkabau (Ardan 2000), Rejang (Darnaedi 1999), Malay (Mahyar *et al.* 1991; Grosvenor *et al.* 1995; Rahayu *et al.* 2000; Susiarti *et al.* 2008), Lahat (Harmida and Yuni 2011), Serampas (Hariyadi and Ticktin 2012), and Batak (Silalahi *et al.* 2013, 2015a; Silalahi 2014) groups. However, these studies have been concerned only with the benefits of medicinal plants in general.

The medicinal herbs consumed during the postpartum period have been widely reported by Abu-Imaileh (16), Afifi (2003) and de Boer and Lamxay (2009). Even though the use of medicinal plants to maintain the health of women after childbirth (postpartum) has been widely reported, the results mostly emphasise the medicinal plants consumed in the form of herbs (Abu-Imaileh and Afifi 2003; de Boer and Lamxay 2009). Steam-bathing, one of the traditional practices of the Batak ethnic groups such as the Minahasa (Zumsteg and Weckerle 2007), West Halmahera (Wakhidah 2015), and the Lao (Lundh 2007; de Boer and Lamxay 2009; Lamxay 2011; de Boer *et al.* 2011), functions to reduce mortality and to restore the health of postpartum

women (Silalahi 2014; Silalahi *et al.* 2015b). Broadly, it is carried out to stimulate postpartum recovery and health, including production of breast milk, improvement of the circulatory system, healing of the reproductive organs (Lundh 2007; Zumsteg and Weckerle 2007; Nasution 2009; Lamxay 2011; Wakhidah 2015), as well as to reduce high blood pressure and to treat asthma (Hannuksela and Ellahham 2001).

It has been reported that medicinal plants used in steam-bathing contain essential oils (Zumsteg and Weckerle 2007; Lundh 2007; Lamxay 2011) in various quantities and species, varying from one ethnic group to another (Zumsteg and Weckerle 2007; Lamxay 2011; Wakhidah 2015). Materials used in steam-bathing are sourced from the surroundings (yards, agroforests, and forests) and markets (Zumsteg and Weckerle 2007; Silalahi *et al.* 2015b). The traditional markets in Kabanjahe and Berastagi in North Sumatra are the centre of trading for medicinal plants and steam-bathing materials (Silalahi 2014; Silalahi *et al.* 2015b).

Ethnobotanical research can be conducted by means of surveys at markets and local communities (Martin 1995; Alexiades and Sheldon 1996). This combined approach is expected to provide comprehensive information about medicinal plants, including their uses and benefits (Martin 1995; Betti 2002; Lee *et al.* 2008), price (Martin 1995; Betti 2002), conservation status (Betti 2002; van Andel *et al.* 2012),

and potential development (van Andel *et al.* 2007, 2012), as well as for the purpose of bioprospecting.

The Batak ethnic groups in northern Sumatra comprise five subethnic groups: Karo, Phakpak, Simalungun, Toba, and Angkola-Mandailing. The Batak Karo subethnic group occupies the highland plateau and central region of the Karo District, while the Batak Angkola-Mandailing subethnic group inhabits the lowland and central regions of the Mandailing District. Both subethnic groups still maintain the culture of steam-bathing, particularly to promote health and recovery postpartum. Cultural and topographic differences (Bangun 2010) affect the way these groups exploit natural resources in connection with the maintenance of good health.

Previous research about steam-bathing has used the local communities as the participants (Zumsteg and Weckerle 2007; Lundh 2007; Lamxay 2011; Wakhidah 2015), or has involved surveys (Nasution 2009). However, in this research, both approaches were combined. The objectives of this study were (1) to document the medicinal plants used by the Batak people for steam-bathing and to document the process of its preparation and operation, and (2) to look for potential new plants as aromatherapy essentials that have not previously been reported.

49 Materials and methods

Study area

The study was conducted during August–December 2012 and in December 2015 at four sites in North Sumatra, Indonesia (Fig. 1). The first site is located in the Kabanjahe traditional market, the second site is in the Berastagi traditional market, the third site is in the Kaban Tua village, and the fourth site is in the Tanjung Julu village (Fig. 1).

This study combined the ethnobotanical approach through communities (the Kabantua and the Desa Tanjung Julu village) with market surveys (the Kabanjahe and the Berastagi traditional markets). The local communities in the Kaban Tua and Tanjung Julu villages have used traditional steam-bathing by using traditional saunas to maintain body fitness, especially for postpartum mothers. The Kabanjahe and the Berastagi traditional markets are the centres of trade for traditional medicinal plants in North Sumatra.

The Kabanjahe traditional market lies at 3°11'N, 98°31'E, ~76 km away from Medan (the capital of North Sumatra). Trading activities in the market take place every day, from 0700 to 1800 hours, but the busiest day (market day) is Monday. The Berastagi traditional market is located at 3°11'25"N, 98°31'05"E, ~66 km away from Medan. Trading is conducted there every day from 0700 to 1800 hours but the market day is Saturday. The medicinal plant traders in both markets were of the Batak Karo subethnic group and comprised eight women and one man. The traders of medicinal plants developed their ability to trade and mix herbs using knowledge inherited from their parents (by being invited, as children, to help in the transactions as well as in gathering activities: Silalahi *et al.* 2015b), from experience, and simply from learning.

Kaban Tua village is located at 3°2'00"N, 98°26'02"E at an altitude of 1100 m above sea level and ~105 km away from Medan. The total area of Kaban Tua village is 4.75 km² and it is

inhabited by people of the Batak Karo subethnic group. The postpartum mothers have used the *oukup* (the Batak Karo term for steam-bathing) to improve fitness and stamina. Steam-bathing materials are obtained from the surrounding forest, home garden or traditional market. Approximately 98% of the villager population comprises farmers who grow various crops, such as sweet orange (*Citrus sinensis*), pepper (*Capsicum annuum*) and eggplant (*Solanum melongena*).

The Tanjung Julu village is located at 0°46'79"N, 99°39'62"E, at an altitude of 200–400 m above sea level and ~601 km away from Medan. The total area of the village is 8.5 km² and the area is inhabited by the Batak Angkola-Mandailing subethnic group, approximately 95% of which are farmers growing a mixture of rubber (*Hevea brasiliensis*) and cinnamon (*Cinnamomum burmannii* (Nees and T.Nees) BL). The local communities in the Tanjung village have used the tradition of *marsidudu* (the name given to steam-bathing by the Batak Angkola-Mandailing) especially for postpartum mothers, but at the time of this research the tradition has been in decline. All of the research sites have a tropical climate with bimodal seasonality (dry season from April to August and rainy season from August to April).

2 Data collection

Information concerning the use of steam-bathing was obtained by means of interviews. Informants consisted of nine traders of medicinal plants, nine midwives, and 32 mothers. The informants in the local community surveys were the mothers who had taken steam-baths and they were selected with purposive snowball sampling methods. (Purposive sampling is a technique of determining informants based on criteria set by researchers, in this case the criteria used were informants who knew the ingredients and processes of steam bathing. Snowball sampling is a technique of determining informants who have been recommended by previous informants.) All traders of medicinal plants in Kabanjahe and Berastagi traditional markets were designated as respondents, while midwives and mothers were selected with purposive snowball sampling method (16 informants in the Kaban Tua village and 16 informants in the Tanjung Julu villages). The midwives had special skills in preparing for steam-bathing and five were selected in Kaban Tua village and four were selected in Tanjung Julu village. The informants were 35–78 years old. Information on the diversity of medicinal plants used as ingredients in steam-baths was obtained from semi-structured and in-depth interviews, as well as from participative observation methods (where researchers participated in community activities). The data obtained were analysed quantitatively according to relative frequency of citation (RCF), use value (UV), and the index of cultural significance (CSI). Guides to conducting interviews (Martin 1995; Alexiades and Sheldon 1996; Silalahi *et al.* 2015b) were followed.

Medicinal plants used as ingredients in steam-baths were collected as voucher specimens; notes on local names, uses, life form, treatment, and preparation were prepared for each species. Initial identification of collected voucher specimens was later confirmed by taxonomists at the University of Indonesia in Depok, or at the Herbarium Bogoriense of the Indonesian Institute of Sciences at Cibinong in Bogor, Indonesia. Scientific

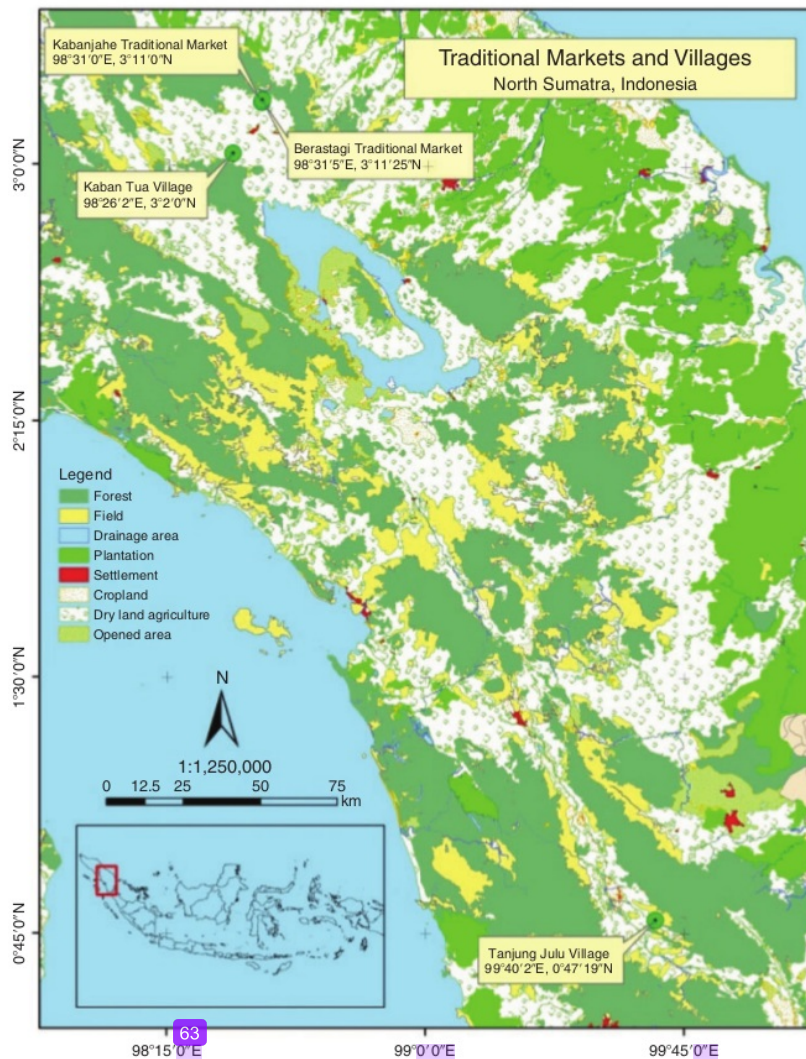


Fig. 1. Study sites at Kabanjahe, Berastagi, Kaban Tua, and Tanjung Julu in North Sumatra, Indonesia.

15 Names of the medicinal plants were verified online with The Plant List 2016 (<http://www.theplantlist.org/>, accessed 2016). Voucher specimens were lodged with the Herbarium of the University of Indonesia, Depok, Indonesia. Qualitative data included species of medicinal plants, organs harvested, supply, and resource acquisition. The data were analysed using descriptive statistics. Qualitative analysis in this study was based on the RFC, the UV and the CSI.

The RFC, proposed by Tardío and Pardo-de-Santayana (2008), shows the local importance of each species, and it is a result of the frequency of citation (FC, the number of informants mentioning the use of the species) divided by the total number of informants (n), without considering the use categories.

This index varies from 0 (where nobody refers to the plant as useful) to 1 (where all informants mention the use of the species).

$$RFC = \frac{FC}{n}$$

35 The relative importance of each plant species known locally 28 used for traditional saunas was expressed as the UV, which was calculated using the following formula (Phillips 1996):

$$UV = \frac{\sum U}{n}$$

where UV is the use value of a species, U is the number of use-reports that are cited by each informant for a given plant species, and n is the total number of informants that are interviewed for a given plant.

Calculation of CSI (Turner 1988) uses three components, namely the quality of use, the intensity of use, and the exclusivity of use with the following formula:

$$CSI = \sum_{i=1}^n (q \times i \times e)ni$$

where CSI is equal to the sum of individual-use values from 1 to n , with n representing the last use described; the subscript k represents the value 1 through n , consecutively. For each use given, q is quality value, i is intensity value, e is exclusivity value (Turner 1988).

For each species, the authors reviewed the available literature for phytochemical profiles using scientific databases (such as Scopus, PubMed, Journal, Science Direct, and Google Scholar). Then, to complete the analysis, secondary data were used (data were obtained from the publications of other researchers).

Results

Local knowledge of traditional steam-bathing by Batak people

The Batak people recognised that pregnancy and the postpartum period may cause deaths. It was believed that keeping the body of postpartum mothers warm through steam-bathing could reduce the risk of postpartum death. The Batak Karo people call steam-bathing *oukup*, while the Batak Angkola-Mandailing people call it *marsidudu*. The postpartum mothers take steam-bathing treatments once or twice 7–14 days after childbirth. During our study in Kabanjahe and Berastagi traditional markets, we found that steam-bathing treatment is not only practiced by postpartum mothers, but also by anyone who wants to be physically fit and healthy.

The medicinal plants used in steam-bathing are mostly plants that produce distinctive aromas when boiled, such as species of Zingiberaceae, Rutaceae and Lamiaceae. The plant materials for steam-bathing are cut into small pieces and then boiled in a thick pot (with a lid), which contains ~20 L of water. The pot is then placed in a special room to allow steam-bathing to take place. A postpartum mother, or anyone who wishes to take a steam-bath, then sits on a chair and is covered with a blanket or a mat made from screw-pine (*Pandanus* sp.) leaves (Fig. 2). The lid of the pot is opened gradually in the closed room so that the room is heated. The temperature is regulated by opening the lid of the pot gradually and at the same time stirring the ingredients in the pot to produce aromatic vapours. The heat in the room will stimulate the body to sweat and the sweating is believed to drive out toxic compounds from the body, producing a relaxing effect, and improving the circulatory system. The steam-bathing lasts for ~20–30 min, depending on the ability of the body to tolerate the heat.

The Batak people believe that steam-bathing by postpartum mothers restores health, increases production of breast milk, improves the blood circulatory system, cleans the reproductive

organs, reduces cholesterol levels, cures diabetes mellitus, smoothes the skin, and cures headaches (Table 1).

Recognition of the benefits of steam-bathing varied among respondents, with each set of respondents recognising different benefits: the traders identified 10 medicinal benefits (mean \pm s.d. = 7.8 ± 2.03), midwives identified six benefits (4.1 ± 1.17) and mothers only five (2.9 ± 1.03) (Table 1). Restoration of stamina by means of a steam-bath is recognised by all informants, whereas the other benefits are known only by some informants (Table 1). Traders know only the following benefits: curing rheumatism, curing polyps, reducing cholesterol levels, and curing diabetes mellitus. The empirical prevention and cure of diabetes mellitus by the Batak people relates to the increase of physical activity which results in sweat release, similar to traditional steam-bathing activity.

Several medicinal plant traders in Kabanjahe and Berastagi traditional markets sell steam-bathing materials in plastic packages, so they look cleaner and more practical than when packaged otherwise (Fig. 3a). Packages of steam-bathing materials vary in terms of the number of species, volume, and price. The price of each package, ~40 000–60 000 rupiah (equivalent to US\$3–5), is directly proportional to the number of species and the volume. Steam-bathing materials in plastic bags can include 15–29 species (depending on prices and traders) and last up to 3–4 months. Prior to packaging, the steam-bathing materials are dried in the sun, or air-dried by hanging them from the ceiling of the store (Fig. 3b); drying is done to avoid spoilage. Small holes are poked into the plastic bags, which are hung from the shop ceiling; the holes in the plastic bags allow air circulation to prevent the materials from becoming mouldy. The rhizomes of Zingiberaceae and fruits of Rutaceae are used fresh for steam-bathing, while leaves and seeds of the others species listed in Table 1 are dried before use.



Fig. 2. The process of steam-bathing in a *Pandanus* mat as practiced by the Batak ethnic groups in North Sumatra.

Diversity of medicinal plants used in traditional steam-bathing

In the present study, 59 species, 37 genera, and 25 families of medicinal plants were recorded as materials used for steam-bathing (Table 2). In total, 58 species were traded, but the number of species traded by each trader varies from 40 to 50 species (mean = 41.78 ± 3.9). Thirty-two species were used by midwives and mothers. The number of medicinal plant species known to midwives varies from 20 to 30 (mean = 26.22 ± 3.40), and 10–20 species were known to mothers (mean = 16.38 ± 3.02). Twenty-seven species of steam-bathing materials are known and used by traders but not used by midwives and mothers, including *Strobilanthes cernua* Blume, *Antrophyum calfolium* Blume, *Adiantum* sp., *Usnea barbata*, *Cinnamomum porrectum* (Roxb.) Kosterm., *Melastoma malabathricum* L., and *Myristica fragrans* Houtt.

Thirty species of medicinal plants sold as steam-bathing materials by traders are also used by midwives and mothers. The main species of medicinal plants used in steam-bathing are two

species of Lamiaceae (*Ocimum americanum* L., *Ocimum basilicum* L.) and Liliaceae (*Allium cepa* L., *Allium sativum* L.), one species of Lauraceae (*Cinnamomum burmannii*), one species of Myrtaceae (*Syzygium aromaticum* (L.) Merril & L.M. Perry), one species of Pandanaceae (*Pandanus amaryllifolius* Roxb.), one species of Piperaceae (*Piper betle*), two species of Poaceae (*Cymbopogon citratus* (DC.) Staft., *Andropogon nardus* L.), seven species of Rutaceae, and the rest are from the Zingiberaceae. In traditional steam-bathing, the leaves (40 species), fruits (14 species), and rhizomes (9 species) constitute the most important parts of the plant (Fig. 4). The materials of steam-bathing are herbs (36 species), trees (14 species), shrubs (14 species), liana (1 species), and lichen (1 species) (Table 2).

The relative use of medicinal plants as materials for steam-bathing by Batak people is represented as RFC categories (Fig. 5). In total, 10 species of steam-bathing materials have RFC values of 0.80–1.00, 7 species have values of 0.60–0.80, and 10 species have values of 0.40–0.60. Only one steam-bathing ingredient is cited by almost 100% of respondents, whereas 10 species are cited by more than 80% of respondents. *Citrus hystrix* DC, *Zingiber officinale* Rosc, *Etilingera elatior* (Jack.) R.M.Sm., *Curcuma domestica* Val., *Alpinia galanga* (L.) Willd., *Citrus aurantiifolia* (Christm.) Swingle, *Cymbopogon citratus*, and *Pogostemon cablin* (Blanco) Benth. are frequently used by Batak people as steam-bathing materials. The RFC value of a given species is directly dependent on the number of informants who mention its use. Although *Gaultheria leucocarpa* Blume and *Cinnamomum porrectum* have low RFC values of 0.40 and 0.34 respectively, both have been used by all the traders as materials in steam-bathing. Both plants also have a refreshing odour so they have potential for the development of further steam-bathing materials.

The UV range of the medicinal plants as steam-bath material was 0.10–4.14 (Table 2). The plants with the highest UV were species that were considered to be the most important ingredients by the Batak people, as shown by their frequency of use (Table 1). Three of the plants with the highest UV were *Citrus hystrix* (3.8), *Zingiber officinale* (3.56), and *Etilingera elatior* (3.12). The UV is helpful in determining the plants with the highest use (most frequently indicated) in the treatment of an

Table 1. The medicinal benefits of steam-bathing according to the Batak people in North Sumatra

Medicinal benefits	No. of responses		
	Traders of medicinal plants (n = 9)	Midwives (n = 9)	Mothers (n = 32)
Restoring stamina	9	9	32
Cleansing women's reproductive organs	9	9	20
Improving blood circulation	9	9	18
Increasing breast milk production	8	6	12
Curing headache	7	2	11
Smoothing the skin	7	2	0
Curing rheumatism	7	0	0
Curing polyps	6	0	0
Reducing cholesterol levels	5	0	0
Curing diabetes mellitus	4	0	0



Fig. 3. (a) Steam-bathing materials. (b) The stall and traders of medicinal plants in the Kabanjahe traditional market. Photographs by M. Silalahi.

Table 2. The medicinal plants that are used as steam-bathing materials by the Batak people of North Sumatra, Indonesia
 KJ, Kabanjabe; BR, Berastagi; T, traders; K, Batak Karo; M, Batak Angkola-Mandailing; RFC, relative frequency of citation; UV, use value; CSI, cultural significance index

Family	Scientific name (life form)	Local name	Specimen no.	Wild/cultivated	Part used	Use	RFC	UV	CSI	Villages/markets	Floristic region
Acanthaceae	<i>Sirobilanthes cernua</i> Bl. (Herb)	Paris	KJ 27	Wild	Leaves	Oukup, bone fractures	0.14	1.40	9.00	KJ, BR	Malesian
Adiantaceae	<i>Antrophyum callifolium</i> Bl. (Herb)	Dilah hantu hara	BR 135	Wild	Leaves	Oukup	0.01	0.26	1.50	KJ, BR	Indian
Apiaceae	<i>Adiantum</i> sp. (Herb)	Regi-regi	BR 245	Wild	Leaves	Oukup	0.10	0.18	1.50	KJ, BR	Indian
	<i>Coriandrum sativum</i> L. (Herb)	Ketambar	BR 245	Cultivated	Fruits	Oukup, rheumatism	0.015	1.46	6.00	KJ, BR	Caribbean
Araceae	<i>Foeniculum vulgare</i> Mill. (Herb)	Adas		Cultivated	Fruits	Oukup, rheumatism	0.012	1.38	6.00	KB, BR, K	Caribbean, Oceania, North America
	<i>Acorus calamus</i> L. (Herb)	Salin batu (M)	M45	Cultivated	Rhizomes	Oukup, fever, malnutrition	0.40	2.7	12.00	M	North America
Asteraceae	<i>Leontopodium alpinum</i> Colm. ex Cass. (Herb)	Binara rembang	KJ154	Wild	Leaves	Oukup	0.34	0.16	3.00	KJ, BR, K	Eurasia
Ericaceae	<i>Gaultheria leucocarpa</i> Bl. (Tree)	Kalin cathyo	KJ35	Wild	Leaves	Oukup, rheumatism	0.46	0.46	12.00	KJ, BR, K	Malesian
Fabaceae	<i>Desmodium gangeticum</i> (L.) DC (Shurb)	Nahang angin	BR 21	Wild	Leaves	Oukup, rheumatism	0.02	0.16	3.00	KJ, BR	Indochina
Gesneriaceae	<i>Episcia</i> sp. (Herb)	Baruk-baruk	BR31	Wild	Leaves	Oukup, kidney disease	0.10	0.18	4.50	KJ, BR	
Lamiaceae	<i>Coleus amboinicus</i> Lour. (Herb)	Terbangun rata	KJ12	Cultivated	Leaves	Oukup, diarrhoea	0.08	1.34	6.00	KJ, BR	Caribbean, North America
	<i>Ocimum americanum</i> L. (Herb)	Ruku-ruku begu	KJ12	Cultivated	Leaves	Oukup	0.62	0.72	6.00	KJ, BR, K, M	Africa
Lauraceae	<i>Ocimum basilicum</i> L. (Herb)	Kumangi		Cultivated	Leaves	Oukup	0.56	0.96	6.00	KJ, BR, K, M	Oceania, Caribbean, North America
	<i>Ocimum sanctum</i> L. (Herb)	Ruku-ruku	KJ90	Cultivated	Leaves	Oukup	0.32	0.52	1.50	KJ, BR	Caribbean
Liliaceae	<i>Pogostemon cablin</i> Blanco (Benth) (Herb)	Nilam	KJ95	Cultivated	Leaves	Oukup, diarrhoea	0.50	1.48	9.00	KJ, BR, K, M	Malesian, Indochina
	<i>Cinnamomum burmanni</i> (Nees and T.Nees) Bl. (Tree)	Kulit manis		Cultivated	Leaves	Oukup, rheumatism	0.86	1.92	9.00	KJ, BR, K, M	Malesian, Indochina
Liliaceae	<i>Cinnamomum porrectum</i> (Roxb.) Kosterm. (Tree)	Pirawas	KJ101	Wild	Leaves	Oukup	0.34	0.56	9.00	KJ, BR, K	Malesian
	<i>Cinnamomum</i> sp. (Tree)	Gajah menta	KJ176	Wild	Leaves	Oukup	0.10	0.16	1.50	KJ, BR	Malesian
Liliaceae	<i>Allium cepa</i> L. (Herb)	Pia		Cultivated	Bulbs	Oukup, diarrhoea, fever, malnutrition, rheumatism, ulcer	0.54	3.50	24.00	KJ, BR, K	North America
	<i>Allium sativum</i> L. (Herb)	Lasuna		Cultivated	Bulbs	Oukup, cholesterol, diarrhoea, hypertension, rheumatism	0.44	2.70	30.00	KJ, BR, K	North America
Lycopodiaceae	<i>Lycopodium carinatum</i> Desv. ex Poir. (Herb)	Tamtam jumalo	KJ87	Wild	Whole	Oukup, cancer, bone fractures	0.10	0.14	4.50	KJ, BR	Caribbean, North America

Melastomaceae	<i>Melastoma malabathricum</i> L. <i>Sandudak</i> (Shrub)	KJ58	Wild	Leaves	Oukup, diarrhoea, bone fractures	0.16	1.28	9.00	KJ, BR	Indochina
	<i>Melastoma sylvaticum</i> Schldl. (Shrub)	KJ67	Wild	Leaves	Oukup, bone fractures, stomach ache	0.08	0.22	15.00	KJ, BR	Indochina
Myristicaceae	<i>Myristica fragrans</i> Houtt. (Tree)		Cultivated	Fruits	Oukup, rheumatism, syphilis, tooth ache	0.10	0.70	18.00	KJ, BR	Malesian
Myrtaceae	<i>Syzygium aromaticum</i> (L.) Merril and L.M. Perry (Tree)		Cultivated	Flower, Leaves	Oukup, bone fractures, rheumatism, syphilis, tooth ache	0.96	2.26	24.00	KJ, BR, K, M	Malesian
Pandanaceae	<i>Pandanus amaryllifolius</i> Roxb. (Herb)		Cultivated	Leaves	Oukup	0.88	2.64	3.00	KJ, BR, K, M	Malesian
Piperaceae	<i>Piper aduncum</i> L. (Liana)	K45	Wild	Leaves	Oukup, eye infection, injury, malnutrition	0.32	0.46	18.00	KJ, BR, K	Caribbean, North America, Oceania
	<i>Piper attenuatum</i> Buch.-Ham. ex Miq. (Liana)	K26	Wild	Leaves	Oukup, injury, malnutrition	0.12	0.86	15.00	KJ, BR	Malesian
	<i>Piper betle</i> L. (Liana)		Cultivated	Leaves	Oukup, eye infection, fever, malnutrition	0.62	2.9	18.00	KJ, BR, K, M	Malesian
	<i>Piper nigrum</i> L. (Liana)		Cultivated	Fruits	Oukup, heart disease, maintenance stamina, rheumatism	0.18	2.24	15.00	KJ, BR	Malesian
Poaceae	<i>Andropogon zizanioides</i> (L.) Urb. (Herb)		Cultivated	Roots	Oukup	0.10	0.16	3.00	KJ, BR	Malesian
	<i>Cymbopogon citratus</i> (DC.) Stapf. (Herb)		Cultivated	Stem, Leaves	Oukup, rheumatism	0.86	1.58	12.00	KJ, BR, K, M	Caribbean, North America, South America
	<i>Andropogon nardus</i> L. (Herb)	KJ 60	Cultivated	Stem, Leaves	Oukup, rheumatism	0.78	0.9	9.00	KJ, BR, K, M	Malesian
Ranunculaceae	<i>Lepapsis</i> sp. 1 (Herb)	KJ75	Wild	Leaves	Oukup, kidney disease	0.015	0.1	3.00	KJ, BR	Malesian
Rutaceae	<i>Nigella arvensis</i> L. (Herb)		Cultivated	Fruits	Oukup, rheumatism	0.20	0.24	4.50	KJ, BR, K	
	<i>Citrus hystrix</i> DC. (Tree)		Cultivated	Leaves, Fruits	Oukup, headache, aphrodisiac, fever, rheumatism, diabetes mellitus	1.00	4.08	30.00	KJ, BR, K, M	Indian
	<i>Citrus medica</i> L. (Tree)	K21	Cultivated	Leaves, Fruits	Oukup	0.60	0.52	6.00	KJ, BR, K, M	Indian
	<i>Citrus nobilis</i> Lour. (Tree)	K35	Cultivated	Leaves, Fruits	Oukup	0.72	0.86	6.00	KJ, BR, K, M	Indian
	<i>Citrus aurantifolia</i> (Christm.) Swingle (Tree)	M54	Cultivated	Leaves, Fruits	Oukup, cough, cholesterol	0.80	1.16	12.00	KJ, BR, K, M	Indian
	<i>Citrus</i> sp. 1 (Tree)	M76	Cultivated	Leaves, Fruits	Oukup, cholesterol	0.60	0.24	6.00	KJ, BR, K, M	Indian
	<i>Citrus</i> sp. 2 (Tree)	M98	Cultivated	Leaves, Fruits	Oukup, cholesterol	0.40	0.3	3.00	KJ, BR, K, M	Indian
	<i>Citrus</i> sp. 3 (Tree)		Cultivated	Leaf, Fruits	Oukup, cholesterol	0.42	0.24	3.00	KJ, BR, K	Indian
Stereuliaceae	<i>Helicteres isora</i> L. (Herb)		Cultivated	Fruits	Oukup, aphrodisiac, syphilis, rheumatism	0.08	0.7	12.00	KJ, BR	Indian

(Continued)

Table 2. (Continued)

Family	Scientific name (life form)	Local name	Specimen no.	Wild/cultivated	Part used	Use	RFC	UV	CSI	Villages/markets	Floristic region
Usneaceae	<i>Usnea barbata</i> (Lichen)	<i>Tai angin</i>	KJ 45	Wild	Whole	Oukup, aphrodisiac, rheumatism, syphilis	0.12	0.26	15.00	KJ, BR	Malesian
Styracaceae	<i>Styrax benzoin</i> Dryand. (Tree)	<i>Kemeyan</i>		Cultivated	Sap	Oukup, fever, headache, malnutrition	0.10	1.9	18.00	KJ, BR	Malesian
Verbenaceae	<i>Vitex trifolia</i> L. (Shrub)	<i>Salagundi</i>	KJ44	Cultivated	Leaves	Oukup, cough, fever	0.08	0.5	12.00	KJ, BR	Malesian
Zingiberaceae	<i>Alpinia galanga</i> L. (Willd.) (Herb)	<i>Kelawas</i>		Cultivated	Leaves	Oukup, itch, headache, rheumatism	0.98	2.86	24.00	KJ, BR, K, M	Malesian
	<i>Boesenbergia rotunda</i> (L.) Mansf. (Herb)	<i>Temu kanci</i>		Cultivated	Rhizomes	Oukup, maintenance staminal, fever	0.560	2.18	18.00	KJ, BR, K	Indian
	<i>Curcuma longa</i> L. (Herb)	<i>Kuning gersing</i>		Cultivated	Leaves	Oukup, diarrhoea, stomach ache, injury	0.80	2.14	24.00	KJ, BR, K, M	Malesian
	<i>Curcuma heyneana</i> Val. and Zipp. (Herb)	<i>Kuning gajah</i>		Cultivated	Rhizomes, Leaves	Oukup	0.18	0.12	6.00	KJ, BR	Malesian
	<i>Curcuma zanthorrhiza</i> Roxb. (Herb)	<i>Temulawak</i>		Cultivated	Leaves	Oukup, stomach ache, malnutrition	0.108	2.56	18.00	KJ, BR	Malesian
	<i>Etilingera elatior</i> (Jack.) R.M.Sm. (Herb)	<i>Cekala</i>	K16	Cultivated	Leaves, fruits	Oukup, headache, cough, cholesterol, fever	0.92	3.12	24.00	KJ, BR, K, M	Malesian
	<i>Kaempferia galanga</i> L. (Herb)	<i>Keciwir</i>		Cultivated	Rhizomes	Oukup, diarrhoea, malnutrition, rheumatism, stomach ache	0.60	2.06	24.00	KJ, BR	Malesian, Indochina
	<i>Zingiber aromaticum</i> Val. (Herb)	<i>Lempayang wangi</i>		Cultivated	Rhizomes	Oukup, headache	0.44	1.14	9.00	KJ, BR, K, M	Malesian, Indian
	<i>Zingiber amaricans</i> Bl. (Herb)	<i>Lempayang</i>		Cultivated	Rhizomes	Oukup	0.18	0.46	6.00	KJ, BR	Malesian, Indian
	<i>Zingiber officinale</i> Rosc. (Herb)	<i>Bahing</i>		Cultivated	Leaves, Rhizome	Oukup, cough, fever, injury, headache, rheumatism	0.86	3.56	24.00	KJ, BR, K, M	Indian
	<i>Zingiber purpureum</i> Roscoe (Herb)	<i>Bangle</i>		Cultivated	Rhizome	Oukup, rheumatism	0.18	0.7	9.00	KJ, BR	Malesian, Indian
	<i>Zingiber zerumbet</i> (L.) Roscoe ex Sm (Herb)	<i>Lempayang gajah</i>		Cultivated	Rhizomes	Oukup, rheumatism	0.08	0.46	9.00	KJ, BR	Malesian, Indian
	<i>Zingiber</i> sp. (Herb)	<i>Alia</i>	KJ12	Cultivated	Leaves	Oukup	0.12	0.24	9.00	KJ, BR	Malesian

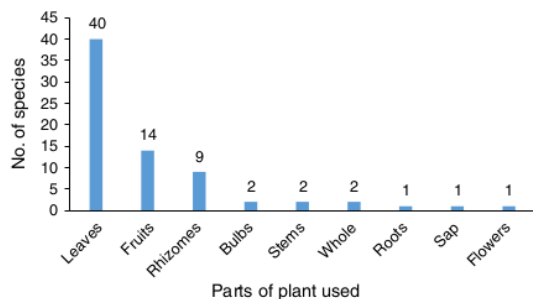


Fig. 4. The relationship between the number of species and the parts of the plant used for preparing steam-baths.

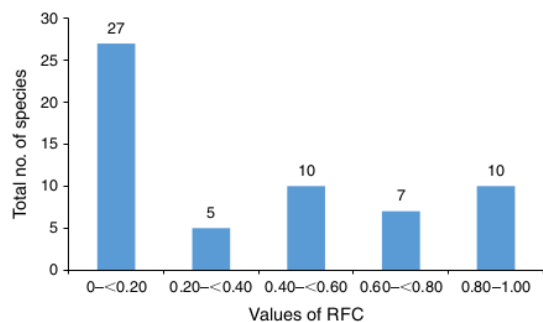


Fig. 5. The number of species for each RFC group of steam-bathing materials by Batak people in North Sumatra, Indonesia.

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 ailment. UVs are high when there are many use-reports for a plant and low when there are few reports related to its use.

In the present study, the CSIs of the medicinal plants were ~1.50–30.00. The group of plants with CSI values of 30 are the main steam-bathing materials, which are recognised by almost all respondents, such as *Citrus hystrix* and *Allium sativum*, whereas the plants that are recognised by few of the respondents have CSI values of 1.5–24.00 (Table 2).

The essential oils contained in medicinal plants and used as steam-bathing materials

Most of the medicinal plants used in steam-bathing are rich in essential oils or volatile oils. From the published literature, we found that there are at least 167 types of essential oils in *Alpinia galanga*, 136 types in *Citrus hystrix*, 88 types in *Cymbopogon citratus*, 77 types in *Andropogon nardus*, 154 types in *Etingera elatior*, 207 types in *Ocimum basilicum*, and 137 types in *Zingiber officinale* (Appendix 1). The main function of steam-bathing is the aromatherapy, which promotes relaxation. Although much research has been conducted on essential oils in various steam-bathing materials, some species that contain volatile oils, such as *Cinnamomum porrectum*, *Gaultheria leucocarpa*, and *Strobilanthes cernua*, have not been studied. Since they empirically afford a distinctive aroma that is expected to provide a relaxing effect, we need further research

concerning the essential oils in these plants, especially *Gaultheria leucocarpa* and *Cinnamomum porrectum*. Nevertheless, several steam-bathing materials, such as *Melastoma malabathricum* and *Melastoma sylvaticum* Schldl., which are used as additional materials, have few or no essential oils.

Some of the plants used in steam-bathing have been documented to have ethnomedicinal uses in several tropical regions but are understudied for their potential pharmacological activity. *Citrus hystrix* oil causes a significant increase in blood pressure and a significant decrease in skin temperature (Hongratanaprasit and Buchbauer 2007) and inhibits the growth of bacteria that cause skin diseases such as *Bacillus subtilis*, *Staphylococcus epidermis*, *Escherichia coli*, *Pseudomonas aeruginosa* and *Staphylococcus aureus* (Kongtun et al. 2009). *Alpinia galanga* has also been found to be beneficial in the treatment of bronchitis, heart disease and diabetes (Indrayan et al. 2009; Rao et al. 2010). *Etingera elatior* has antioxidant activity (Abdelwahab et al. 2010; Jackie et al. 2011; Adliani et al. 2012) and antiangiogenic properties (Ismail et al. 2004; Allaith 2008; Nithitanakool et al. 2014). This species contains essential oils dominated by mono- and sesquiterpenoids (Wong et al. 2010; Abdelwahab et al. 2010; Abdelmageed et al. 2011), which are volatile (Zulak and Bohlmann 2010) and remove body odour (Chan et al. 2011). Essential oils in the leaves of *Etingera elatior* can reduce body odour (de Guzman and Siemonsma 1999; Wijesingha et al. 2011) because they inhibit the growth of microbes (de Guzman and Siemonsma 1999; Lachumy et al. 2010).

Discussion

The steam-bathing practised by the Batak people is based on thermotherapy and aromatherapy. Hence, plants used for steam-bathing are those that produce aromatic compounds. Steam-bathing is a local knowledge of the Batak people in which essential oils of plants are used for improving human health, i.e. for restoring stamina of postpartum mothers and treating different ailments. Compared with other advanced extraction methods, the steam distillation process is still preferred because of its low system cost, cleanliness, high production and low operational cost (Masango 2005) to obtain essential oils from plants (Dhobi et al. 2009; Andrade et al. 2013).

The room temperature in steam-bathing is regulated through the open pot lid, and the aroma is regulated by stirring the ingredients. Thermotherapy and aromatherapy are believed to affect the psychological and emotional conditions of postpartum mothers (Zumsteg and Weckerle 2007; Lamxay 2011), leading to improved stamina. Fragrances affect physiological and psychological aspects, such as: changes in autonomic heart rate, breathing rate, blood pressure, eye-blinks, skin temperature, and skin conductance (Brauchli et al. 1995; Bensafi et al. 2002), change brain wave activities, and changes in mood, which makes people feel more relaxed (Field et al. 2005).

The maximum effect of steam-bathing is achieved in carried out for 15–30 min. Xu et al. (2015) stated that heat-stimulating times of 30 and 60 min may be more effective for relieving lower back pain. Steam-bathing by the Batak people is capable of restoring the stamina of postpartum mothers through improved blood circulation and reduced pain, as confirmed by

Campbell *et al.* (2004), Hannuksela and Ellahham (2001), and Chaichian *et al.* (2009). Warming the body reduces pain because it stimulates the body to release endocrine hormones and endogenous opioid peptides, resulting in relaxation of the cells of the body and reducing the sensitivity of nerve cells (Chaichian *et al.* 2009). Campbell *et al.* (2004) stated that if the body is warm it will activate receptors that cause blood vessels to become vasodilated. Warming the body will improve oxygen transportation systems (circulatory O₂), which will open the pores of the skin and activate sweat glands instantly, in turn releasing toxic compounds from the body.

The essential oils reduce body odour and pain through stimulation of endocrine, respiratory and nervous systems. Essential oils such as limonene, pinene and methyl chavicol possibly enhance the stimulating effect on sympathetic activity, whereas kaffir lime oil causes a significant increase in blood pressure and a significant decrease in skin temperature (Hon-gratanaworakit and Buchbauer 2007). Terpinen-4-ol, 1,8-cineole, fenchol derivatives are used for inhalation of the oils when suffering from respiratory diseases (Kubota *et al.* 1999; Mallavarapu *et al.* 2002; Jirovetz *et al.* 2003), and camphor and camphene are used for rheumatic pain (Kubota *et al.* 1999; Mallavarapu *et al.* 2002; Jirovetz *et al.* 2003; Indrayan *et al.* 2009; Rao *et al.* 2010). Linalool has a sedative effect on the central nervous system, and hypotensive, anticonvulsant and hypothermic properties (Elisabetsky *et al.* 1995).

The essential oils derived from some of the steam-bathing ingredients have great potential in research and commercialisation for aromatherapy and spa practices; these include: *Citrus hystrix* (Chaisawadi *et al.* 2007; Chan *et al.* 2009), *Curcuma domestica*, *Cymbopogon citratus* (Sureechatchaiyan *et al.* 2011), *Gaultheria leucocarpa* and *Cinnamomum porrectum*. *Gaultheria leucocarpa* and *Cinnamomum porrectum* in this study produced distinctive aromas and reduced pain. Thus, it will be interesting to study these plants for their phytochemical and pharmacological properties.

Although most of the steam-bathing ingredients contained essential oils, *Melastoma malabathricum* and *Melastoma sylvaticum* had no essential oils. These plants were utilised to control or reduce the evaporation rate through chemical binding or attraction, or simply by increasing the mass of additional plant material in the boiling water or on the glowing embers, so the aromas from the essential oils would be stable and last longer (de Boer and Lamxay 2009). To obtain the optimum effect of steam-bathing, the temperature of the ingredients must be regulated because, on the one hand, warming helps the evaporation of essential oils but, on the other hand, high temperatures damage essential oils (Kasuan *et al.* 2013; Wu *et al.* 2014). For example, in uncontrolled temperatures, some important volatile compounds, such as terpinolene, linalool and terpinen-4-ol, are absent due to thermal degradation from fast heating of extracted material (Kasuan *et al.* 2013).

In this study, the traders took 56 species as steam-bathing ingredients, which has cost implications. The concentration and types of the essential oils of the plants are different, so the ingredients are complementary. *Alpinia galanga* rhizomes mainly contain eucalyptol (Wu *et al.* 2014) and 1,8-cineole (Jirovetz *et al.* 2003) whereas the leaves mainly contain 1,8-cineole and camphor (Jirovetz *et al.* 2003). The leaves of

Etilingera elatior mainly contain β -pinene, whereas its stem mainly contains 1,1-dodecanediol diacetate (Jaafar *et al.* 2007). The leaves of *Citrus hystrix* mainly contain β -citronellal (Loh *et al.* 2011), whereas its fruits mainly contain sabinene (Tinjan and Jirapakkul 2007; Kasuan *et al.* 2013) and limonene (Hon-gratanaworakit and Buchbauer 2007). Although the essential oils in the steam-bathing materials are complementary, it is possible for them to be overlapping. The steam-bathing materials could be made more economical by reconstructing the inclusion of complementary materials so that the number of plant species is reduced. The number of species from the Zingiberaceae and Rutaceae could probably be decreased. However, further analysis is necessary to ensure the efficacy of such reductions.

Conclusions

This study showed that the Batak people still preserve a rich ethnobotanical knowledge. The study provides detailed description of 59 plants and species that are used in traditional steam-bathing by Batak people. The steam-bathing practiced by the Batak people is based on the principles of thermotherapy and aromatherapy. The steam-bathing materials that have high RFC values (0.08–1.00), such as *Citrus hystrix*, *Zingiber officinale*, *Etilingera elatior*, *Curcuma domestica*, *Alpinia galanga*, *Citrus aurantifolia*, *Cymbopogon citratus*, and *Pogostemon cablin*, are frequently used by Batak people as steam-bathing materials. Some of the species (e.g. *Gaultheria leucocarpa*, *Cinnamomum porrectum*) would be interesting to study for their phytochemical and pharmacological properties.

Conflicts of interest

The authors declare no conflicts of interest.

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References

- Abdelmageed, A. H. A., Faridah, Q. Z., Nur Amalina, A., and Yaacob, M. (2011). The influence of organ and post-harvest drying period on yield and chemical composition of the essential oils of *Etilingera elatior* (Zingiberaceae). *Journal of Medicinal Plants Research* 5, 3432–3439.
- Abdelwahab, K. S. I., Zaman, F. Q., Mariod, A. A., Yaacob, M., Abdelmageed, A. H. A., and Khamis, S. (2010). Chemical composition, antioxidant and antibacterial properties of the essential oils of *Etilingera elatior* and *Cinnamomum pubescens*. *Journal of the Science of Food and Agriculture* 90, 2682–2688. doi:10.1002/JFSA.4140
- Abena, A. A., Gbenou, J. D., Yayi, E., Moudachirou, M., Ongoka, R. P., Ouamba, J. M., and Silou, T. (2007). Comparative chemical and analgesic properties of essential oils of *Cymbopogon nardus* (L.) Rendle of Benin and Congo. *African Journal of Traditional, Complementary, and Alternative Medicines* 4, 267–272.
- Abu-Irmaileh, B. E., and Afifi, F. U. (2003). Herbal medicine in Jordan with special emphasis on commonly used herbs. *Journal of Ethnopharmacology* 89, 193–197. doi:10.1016/S0378-8741(03)00283-6

- Adliani, N., Nazliniwaty, and Purba, D. (2012). Lipstick formulation using natural dye from *Etilingera elatior* (Jack) R.M.Sm. extract. *Journal of Pharmaceutics & Pharmacology* 1, 87–94.
- Alexiades, M. N., and Sheldon, J. W. (1996). 'Selected Guidelines for Ethnobotanical Research: A Field Manual.' (The New York Botanical Garden Press: New York.)
- Allaith, A. A. A. (2008). Antioxidant activity of Bahraini date palm (*Phoenix dactylifera* L.) fruit of various cultivars. *International Journal of Food Science & Technology* 43, 1033–1040. doi:10.1111/J.1365-2621.2007.01558.X
- Andrade, M. A., Cardoso, M. D. G., de Andrade, J., Silva, L. F., Teixeira, M. L., Resende, J. M. V., Figueiredo, A. C. D. S., and Barroso, J. G. (2013). Chemical composition and antioxidant activity of essential oils from *Cinnamodendron dinisii* Schwacke and *Siparuna guianensis* Aublet. *Antioxidants* 2, 384–397. doi:10.3390/ANTIOX2040384
- Anwar, J., Damani, S. J., Hisyam, N., and Whitten, A. J. (1987). 'The Ecology of Sumatera Ecosystem.' (Gajah Mada University Press: Yogyakarta.)
- Ardan, A. S. (2000). The use of medicinal plants by the villagers Kubang Nan Rao, in West Sumatra. In 'Proceedings of the Ethnobotany III National Seminar, Denpasar, 5–6 May 1998'. (Eds Y. Purwanto and E. B. Walujo.) pp. 132–139. (Indonesian Institute of Sciences: Bogor, Indonesia.)
- Bangun, P. (2010). Culture Batak. In 'Humans and Culture in Indonesia'. (Ed. Koentjaraningrat.) pp. 94–117. (Djambatan: Jakarta, Indonesia.)
- Barman, K. L., and Kumar, D. J. (2013). Comparative chemical constituents and antimicrobial activity of normal and organic ginger oils (*Zingiber officinale* Roscoe). *Journal of Applied Biology and Pharmaceutical Technology* 4, 259–266.
- Beatovic, D., Krstic-Milošević, D., Trifunovic, S., Šiljegovic, J., Glamoclija, J., Ristic, M., and Jelacic, S. (2015). Chemical composition, antioxidant and antimicrobial activities of the essential oils of twelve *Ocimum basilicum* L. cultivars grown in Serbia. *Records of Natural Products* 9, 62–75.
- Bensafi, M., Roubly, C., Farget, V., Vigouroux, M., and Holley, A. (2002). Autonomic nervous system responses to odours: the role of pleasantness and arousal. *Chemical Senses* 27, 703–709. doi:10.1093/CHEMSE/27.8.703
- Betti, J. L. (2002). Medicinal plants sold in Younde market, Cameroon. *African Study Monographs* 23, 47–64.
- Brauchli, P., Ruegg, P. B., Etzweiler, F., and Zeier, H. (1995). Electro-cortical and autonomic alteration by administration of a pleasant and an unpleasant odor. *Chemical Senses* 20, 505–515. doi:10.1093/CHEMSE/20.5.505
- Carvalho Filho, J. L. S., Blank, A. F., Alves, P. B., Ehlert, P. A. D., Melo, A. S., Cavalcanti, S. C. H., Arrigoni-Blank, M. D. F., and Silva-Mann, R. (2006). Influence of the harvesting time, temperature and drying period on basil (*Ocimum basilicum* L.) essential oil. *Brazilian Journal of Pharmacognosy* 16, 24–30. doi:10.1590/S0102-695X2006000100007
- Chaichian, S., Aklaghi, A., Rousta, F., and Safavi, M. (2009). Experience of water birth delivery in Iran. *Archives of Iranian Medicine* 12, 468–471.
- Chaisawadi, S., Thongbut, D., and Kulamai, S. (2007). Clean production process of freeze dried Kaffir lime powder for medicinal herb and cosmetic use. *Acta Horticulturae* 786, 193–200. doi:10.17660/ACTA HORTIC.2008.786.21
- Chan, E. W. C., Lim, Y. Y., and Wong, S. K. (2011). Phytochemistry and pharmacological properties of *Etilingera elatior*: a review. *Pharmacognosy Journal* 3(22), 6–10. doi:10.5530/PJ.2011.22.2
- Campbell, N. A., Reece, J. B., and Mitchell, L. G. (2004). 'Biologi.' 5th edn. (Erlangga: Jakarta, Indonesia.)
- Chan, S. W., Lee, C. Y., Yap, C. F., Aida, W. M., and Ho, C. W. (2009). Optimisation of extraction conditions for phenolic compounds from limau purut (*Citrus hystrix*) peels. *International Food Research Journal* 16, 203–213.
- Darnaedi, S. Y. (1999). The Rejang's traditional knowledge of medicinal plant. Magister Thesis, Biology Department, Universitas Indonesia.
- de Boer, H., and Lamxay, V. (2009). Plants used during pregnancy, childbirth and postpartum healthcare in Lao PDR: a comparative study of the Brou, Saek and Kry ethnic groups. *Journal of Ethnobiology and Ethnomedicine* 5, 25. doi:10.1186/1746-4269-5-25
- de Boer, H. J., Lamxay, V., and Bjork, L. (2011). Steam bath and mother roasting in Lao PDR: practices and chemical constituents of essential oils of plant species used in postpartum recovery. *BMC Complementary and Alternative Medicine* 11, 128. doi:10.1186/1472-6882-11-128
- de Guzman, C. C., and Siemonsma, J. S. (1999). 'Plant Resources of South-East Asia. No. 13. Spices.' (Backhuys Publishers: Leiden.)
- De Pooter, H. L., Omar, M. N., Coolsaet, B. A., and Schamp, N. M. (1985). The essential oil of greater galanga (*Alpinia galanga*) from Malaysia. *Phytochemistry* 24, 93–96. doi:10.1016/S0031-9422(00)80814-6
- Dhobi, M., Mandal, V., and Hemalatha, S. (2009). Optimization of microwave assisted extraction of bioactive flavonolignan-silybinin. *Journal of Chemical Metrology* 3, 13–23.
- Dzida, K. (2010). Biological value and essential oil content in sweet basil (*Ocimum basilicum* L.) depending on calcium fertilization and cultivar. *Acta Scientiarum Polonorum. Hortorum Cultus* 9, 153–161.
- Ekpenyong, C. E., Akpan, E. E., and Daniel, N. E. (2014). Phytochemical constituents, therapeutic applications and toxicological profile of *Cymbopogon citratus* Stapf (DC) leaf extract. *Journal of Pharmacognosy and Phytochemistry* 3, 133–141.
- Ekundayo, O., Laakso, I., and Hiltunen, R. (1988). Composition of ginger (*Zingiber officinale* Roscoe) volatile oils from Nigeria. *Flavour and Fragrance Journal* 3, 85–90. doi:10.1002/FFJ.2730030207
- El-Baroty, G. S., El-Baky, H. H. A., Farag, R. S., and Saleh, M. A. (2010). Characterization of antioxidant and antimicrobial compounds of cinnamon and ginger essential oils. *African Journal of Biochemistry Research* 4, 167–174.
- Elisabetsky, E., Marschner, J., and Souza, O. D. (1995). Effects of linalool on glutamatergic system in the rat cerebral cortex. *Neurochemical Research* 20, 461–465. doi:10.1007/BF00973103
- Field, T., Diego, M., Hernandez-Reif, M., Cisneros, W., Feijo, L., Vera, Y., Gil, K., Grina, D., and Claire, H. Q. (2005). Lavender fragrance cleansing gel effects on relaxation. *The International Journal of Neuroscience* 115, 207–222. doi:10.1080/00207450590519175
- Fuselli, S. B., de la Rosa, G., Eguaras, M. J., and Fritz, R. (2010). *In vitro* antibacterial effect of exotic plants essential oils on the honeybee pathogen *Paenibacillus* larvae, causal agent of American foulbrood. *Spanish Journal of Agricultural Research* 8, 651–657. doi:10.5424/SJAR/2010083-1261
- Grosvenor, P. W., Gothard, P. K., Mc. William, N. C., Supriono, A., and Gray, D. O. (1995). Medicinal plants from Riau Province, Sumatra, Indonesia. Part 1: Uses. *Journal of Ethnopharmacology* 45, 75–95. doi:10.1016/0378-8741(94)01209-1
- Hannuksela, M. L., and Ellaham, S. (2001). Benefits and risks of sauna bathing. *The American Journal of Medicine* 110, 118–126. doi:10.1016/S0002-9343(00)00671-9
- Hariyadi, B., and Tickin, T. (2012). Uras: medicinal and ritual plants of Serampas, Jambi Indonesia. *Ethnobotany Research and Applications* 10, 133–150. doi:10.17348/ERA.10.0.133-149
- Harmida, S., and Yuni, V. F. (2011). The study ethnophytomedicinal in the village of Lawang Agung District Lahat, south Sumatra, Indonesia. *Jurnal Penelitian Sains* 14, 1–5.
- Hassanpouraghdam, M. B., Gohari, G. R., Tabatabaei, S. J., and Dadpour, M. R. (2010). Inflorescence and leaves essential oil composition of hydroponically grown *Ocimum basilicum* L. *Journal of the Serbian Chemical Society* 75, 1361–1368. doi:10.2298/JSC100311113H

- Hassanpouraghdam, M. B., Gohari, G. R., Tabatabaei, S. J., Dadpour, M. H., and Shirdel, M. (2011). NaCl salinity and Zn foliar application influence essential oil composition of basil (*Ocimum basilicum* L.). *Acta Agriculturae Slovenica* **97**, 93–98. doi:10.2478/V10014-011-0004-X
- Hazwat, M. M., Man, H. C., Abidin, Z. Z., and Jamaludin, H. (2014). Comparison of citronella oil extraction methods from *Cymbopogon nardus* grass by ohmic-heated hydro-distillation, hydro-distillation, and steam distillation. *BioResources* **9**, 256–272.
- Hongratanaworakit, T., and Buchbauer, G. (2007). Chemical compositions and stimulating effects of *Citrus hystrix* oil on humans. *Flavour and Fragrance Journal* **22**, 443–449. doi:10.1002/FFJ.1820
- Indrayan, A. K., Agrawal, P., Rathi, A. K., Shatru, A., Agrawal, N. K., and Tyagi, D. K. (2009). Nutritive value of some indigenous plan rhizomes resembling ginger. *Natural Product Radiance* **8**, 507–513.
- Ismail, A., Marjan, Z. M., and Foong, C. W. (2004). Total antioxidant activity and phenolic content in selected vegetables. *Food Chemistry* **87**, 581–586. doi:10.1016/J.FOODCHEM.2004.01.010
- Jaafar, F. M., Osman, C. P., Ismail, N. H., and Awang, K. (2007). Analysis of essential oils of leaves, stems, flowers and rhizomes of *Etilingera elatior* (Jack) R. M. Smith. *The Malaysian Journal of Analytical Sciences* **11**, 269–273.
- Jackie, T., Haleagrahara, N., and Chakravarthi, S. (2011). Antioxidant effects of *Etilingera elatior* flower extract against lead acetate-induced perturbations in free radical scavenging enzymes and lipid peroxidation in rats. *BMC Research Notes* **4**, 67. doi:10.1186/1756-0500-4-67
- Jirovetz, L., Buchbauer, G., Shafi, M. P., and Leela, N. K. (2003). Analysis of the essential oils of the leaves, stems, rhizomes and roots of the medicinal plant *Alpinia galanga* from southern India. *Acta Pharmaceutica (Zagreb, Croatia)* **53**, 73–81.
- Kandil, M. A. M., Khatib, M. E., Ahmed, S. S., and Schnug, E. (2009). Herbal and essential oil yield of Genovese basil (*Ocimum basilicum* L.) grown with mineral and organic fertilizer sources in Egypt. *Journal für Kulturpflanzen* **61**, 443–449.
- Kasuan, N., Muhammad, Z., Yusoff, Z., Rahiman, M. H. F., Taib, M. N., and Haiyee, Z. A. (2013). Extraction of *Citrus hystrix* D.C. (kaffir lime) essential oil using automated steam distillation process: analysis of volatile compounds. *The Malaysian Journal of Analytical Sciences* **17**, 359–369.
- Kerchoechuen, O., Laohakunjit, S., and Singkornard, S. (2010). Essential oils from six herbal plants for biocontrol of the maize weevil. *HortScience* **45**, 592–598.
- Klimánková, E., Holádova, K., Hajslova, J., Cajka, T., Poustka, J., and Koudela, M. (2008). Aroma profiles of five basil (*Ocimum basilicum* L.) cultivars grown under conventional and organic conditions. *Food Chemistry* **107**, 464–472. doi:10.1016/J.FOODCHEM.2007.07.062
- Koba, K., Sanda, K., Guyon, C., Raynaud, C., Chaumont, J., and Nicod, L. (2009). *In vitro* cytotoxic activity of *Cymbopogon citratus* L. and *Cymbopogon nardus* L. essential oils from Togo. *Journal of the Bangladesh Pharmacological Society* **4**, 29–34.
- Kongtun, S., and Suracherdkaiti, W. (2009). Herbal antibacterial liquid soap development against bacterial skin diseases. In 'Current Research Topics in Applied Microbiology and Microbial Biotechnology'. (Ed. A. Mendez-Vilas.) pp. 497–500. (World Scientific Publishing: Singapore.)
- Kpoviessi, S., Bero, J., Agbani, P., Gbaguidi, F., Kpadonou-Kpoviessi, B., Sinsin, B., Accrombessi, G., Frédéric, M., Moudachirou, M., and Quetin-Leclercq, J. (2014). Chemical composition, cytotoxicity and *in vitro* antitrypanosomal and antiplasmodial activity of the essential oils of four *Cymbopogon* species from Benin Salomé. *Journal of Ethnopharmacology* **151**, 652–659. doi:10.1016/J.JEP.2013.11.027
- Kubota, K., Someya, Y., Yoshida, R., Kobayashi, A., Morita, T., and Koshino, H. (1999). Enantiomeric purity and odor characteristics of 2- and 3-acetoxy-1,8-cineoles in the rhizomes of *Alpinia galanga* Willd. *Journal of Agricultural and Food Chemistry* **47**, 685–689. doi:10.1021/JF9807465
- Kumari, J. A., Venkateshwarlu, G., Choukse, M. K., and Anandan, R. (2014). Effect of essential oil and aqueous extract of ginger (*Zingiber officinale*) on oxidative stability of fish oil-in-water emulsion. *Journal of Food Processing & Technology* **6**, 412. doi:10.4172/2157-7110.1000412
- Lachumy, S. T. J., Sasidharan, S., Sumathy, V., and Zuraini, Z. (2010). Pharmacological activity, phytochemical analysis and toxicity of methanol extract of *Etilingera elatior* (torch ginger) flowers. *Asian Pacific Journal of Tropical Medicine* **3**, 769–774. doi:10.1016/S1995-7645(10)60185-X
- Lamxay, V. (2011). The genus *Amomum* (Zingiberaceae) in Cambodia, Laos and Vietnam: taxonomy and ethnobotany, with special emphasis on women's health. PhD Thesis, Faculty of Science and Technology, Uppsala University, Sweden.
- Lee, S., Xiao, C., and Pei, S. (2008). Ethnobotanical survey of medicinal plants at periodic markets of Honghe Prefecture in Yunnan Province, S. W. China. *Journal of Ethnopharmacology* **117**, 362–377. doi:10.1016/J.JEP.2008.02.001
- Loh, F. S., Awang, R. M., Omar, D., and Rahmani, M. (2011). Insecticidal properties of *Citrus hystrix* DC leaves essential oil against *Spothoptera litura* Fabricius. *Journal of Medicinal Plants Research* **5**, 3739–3744.
- Lundh, E. C. S. (2007). Plant use in ante and postpartum health care in Lao PDR. PhD Thesis, Department of Systematic Botany, Uppsala University, Sweden.
- Mahyar, U. W., Burley, J. S., Gyllenhaal, C., and Soejarto, D. D. (1991). Medicinal plants of Seberida (Riau Province, Sumatra, Indonesia). *Journal of Ethnopharmacology* **31**, 217–237. doi:10.1016/0378-8741(91)90007-Z
- Maimulyanti, A., and Prihadi, A. R. (2015). Chemical composition, phytochemical and antioxidant activity from extract of *Etilingera elatior* flower from Indonesia. *Journal of Pharmacognosy and Phytochemistry* **3**, 233–238.
- Mallavarapu, G. R., Rao, L., Ramesh, S., Dimri, B. P., Rao, B. R., Kaul, P. N., and Bhattacharya, A. K. (2002). Composition of the volatile oils of *Alpinia galanga* rhizomes and leaves from India. *The Journal of Essential Oil Research* **14**, 397–399. doi:10.1080/10412905.2002.9699900
- Martin, G. J. (1995). 'Ethnobotany. A People and Plants Conservation Manual.' (Chapman and Hall: London.)
- Masango, P. (2005). Cleaner production of essential oils by steam distillation. *Journal of Cleaner Production* **13**, 833–839. doi:10.1016/J.JCLEPRO.2004.02.039
- Nakahara, K., Alzoreky, N. S., Yoshihashi, T., Nguyen, H. T. T., and Trakoontivakorn, G. (2013). Chemical composition and antifungal activity of essential oil from *Cymbopogon nardus* (citronella grass). *Japan Agricultural Research Quarterly* **37**, 249–252. doi:10.6090/JARQ.37.249
- Nampoothiri, S. V., Venugopalan, V. V., Joy, B., Sreekumar, M. M., and Menon, A. N. (2012). Comparison of essential oil composition of three ginger cultivars from sub Himalayan region. *Asian Pacific Journal of Tropical Biomedicine* **2**(Suppl), S1347–S135. doi:10.1016/S2221-1691(12)60414-6
- Nasution, J. (2009). Oukup: Karo traditional herb for postnatal health: an analysis of bioprospecting in tropical vegetation of Indonesia. Magister Thesis, Biology Department, Bogor Agricultural Institute, Indonesia.
- Nithitanakool, S., Teeranachaideekul, V., Ponpanich, L., Nopporn, N., Junhunkit, T., Wanasawas, P., and Chulasiri, M. (2014). *In vitro* and *in vivo* skin whitening and anti-aging potentials of hydroglycolic extract from inflorescence of *Etilingera elatior*. *JAASP* **3**, 314–325.

- Nor, O. M. (1999). Volatile aroma compounds in *Citrus hystrix* oil (Sebatian aroma meruap dalam minyak *Citrus hystrix*). *Journal of Tropical Agriculture and Food Science* **27**, 225–229.
- Ozcan, M., and Chalchat, J. C. (2002). Essential oil composition of *Ocimum basilicum* L. and *Ocimum minimum* L. in Turkey. *Czech Journal of Food Science* **2**, 223–228.
- Phanthong, P., Lomarat, P., Chomnawang, M. T., and Bunyaphratharsara, N. (2013). Antibacterial activity of essential oils and their active components from Thai spices against foodborne pathogens. *ScienceAsia* **39**, 472–476. doi:10.2306/SCIENCEASIA1513-1874.2013.39.472
- Phillips, O. (1996). Some quantitative methods for analyzing ethnobotanical knowledge. In 'Selected guidelines for ethnobotanical research: a field manual.' (Eds M. N. Alexiades, J. W. Sheldon.) pp. 171–197. (New York Botanical Garden: New York.)
- Politeo, O., Jukic, M., and Milos, M. (2007). Chemical composition and antioxidant capacity of free volatile aglycones from basil (*Ocimum basilicum* L.) compared with its essential oil. *Food Chemistry* **101**, 379–385. doi:10.1016/J.FOODCHEM.2006.01.045
- Rahayu, M., Siagian, M. H., and Wiriadinata, H. (2000). The use of plants as traditional medicine by the local communities in Bukit Tigapuluh National Park, Riau. In 'Proceedings of the National Congress of Indonesian Traditional Medicine, Surabaya.' (Ed. XVII.) pp. 98–110. (P30 Centre: Surabaya, Indonesia.)
- Raina, V. K., Srivastava, S. K., and Syamasunder, K. V. (2002). The essential oil of 'greater galangal' [*Alpinia galanga* (L.) Willd.] from the lower Himalayan region of India. *Flavour and Fragrance Journal* **17**, 358–360. doi:10.1002/FFJ.1105
- Raina, V. K., Kumar, A., and Aggarwal, K. K. (2005). Essential oil composition of ginger (*Zingiber officinale* Roscoe) rhizomes from different place in India. *Journal of Essential Oil Bearing Plants* **8**, 187–191. doi:10.1080/0972060X.2005.10643442
- Raina, A. P., Verma, S. K., and Abraham, Z. (2014). Volatile constituents of essential oils isolated from *Alpinia galanga* Willd. (L.) and *A. officinarum* Hance rhizomes from North East India. *The Journal of Essential Oil Research* **26**, 24–28. doi:10.1080/10412905.2013.822430
- Ranitha, M., Nour, A. H., Sulaiman, Z. A., Nour, A. H., and Raj S., T. (2014). A comparative study of lemongrass (*Cymbopogon citratus*) essential oil extracted by microwave-assisted hydrodistillation (MAHD) and conventional hydrodistillation (HD) method. *International Journal of Chemical Engineering and Applications* **5**, 104–108. doi:10.7763/IJCEA.2014.V5.360
- Rao, K. C., Narasu, L. M., and Giri, A. (2010). Antibacterial activity of *Alpinia galanga* (L.) Willd crude extract. *Applied Biochemistry and Biotechnology* **162**, 871–884. doi:10.1007/S12010-009-8900-9
- Said-Al Ahl, H. A. H., and Mahmoud, A. A. (2010). Effects of zinc and/or iron foliar application on growth and essential oil of sweet basil (*Ocimum basilicum* L.) under salt stress. *Ocean of Journal Applied Sciences* **3**, 97–111.
- Sajjadi, S. E. (2006). Analysis of the essential oils of two cultivated basil (*Ocimum basilicum* L.) from Iran. *Daru: Journal of Faculty of Pharmacy, Tehran University of Medical Sciences* **14**, 128–130.
- Sato, A., Asano, K., and Sato, T. (1990). The chemical composition of *Citrus hystrix* DC (Swangi). *The Journal of Essential Oil Research* **2**, 179–183. doi:10.1080/10412905.1990.9697857
- Setiawati, W., Murtiningsih, R., and Hasyim, A. (2011). Laboratory and field evaluation of essential oils from *Cymbopogon nardus* as oviposition deterrent and ovicidal activities against *Helicoverpa armigera* Hubner on chili pepper. *Indonesian Journal of Agricultural Science* **12**, 9–16. doi:10.21082/IJAS.V12N1.2011.P9-16
- Silalahi, M. (2014). The ethnobotany of the medicinal plants in sub-ethnic Batak North Sumatra and the conservation perspective. PhD Thesis, Biology Department, University of Indonesia.
- Silalahi, M., Supriatna, J., Walujo, E. B., and Nisyawati. (2013). Local knowledge and diversity of medicinal plants in sub-ethnic Batak Karo, North Sumatra. In 'Proceedings of The National Seminary Biodiversity and Indonesia Tropical Ecology'. pp. 146–153. (Biology Department, Andalas University: Padang, Indonesia.)
- Silalahi, M., Nisyawati, Walujo, E. B., and Supriatna, J. (2015a). Local knowledge of medicinal plants in sub-ethnic Batak Simalungun of North Sumatra, Indonesia. *Biodiversitas (Surakarta)* **16**, 44–54. doi:10.13057/BIODIV/D160106
- Silalahi, M., Nisyawati, Walujo, E. B., Supriatna, J., and Mangunwardoyo, W. (2015b). The local knowledge of medicinal plants trader and diversity of medicinal plants in the Kabanjane traditional market, North Sumatra, Indonesia. *Journal of Ethnopharmacology* **175**, 432–443. doi:10.1016/J.JEP.2015.09.009
- Sivasothy, Y., Chong, W. K., Hamid, A., Eldeen, I. M., Sulaiman, S. F., and Awang, K. (2011). Essential oils of *Zingiber officinale* var. *rubrum* Theilade and their antibacterial activities. *Food Chemistry* **124**, 514–517. doi:10.1016/J.FOODCHEM.2010.06.062
- Srisukh, V., Bunyaphratharsara, N., Pongpan, A., Tunggrugsasut, W., Puttipipatkachom, S., Oniam, W., Karawamit, T., Bunsiriluk, S., and Thongbainoi, W. (2012). Fresh produce antibacterial rinse from kaffir lime oil. *University Journal of Pharmaceutical Sciences* **39**, 15–27.
- Subramanian, P., Imanina, C. W., Takwa, C. W., Emelia, N., and Zubair, A. (2015). Chemical composition and antibacterial activity of essential oil of *Cymbopogon citratus* and *Cymbopogon nardus* against *Enterococcus faecalis*. *International Journal of Biosciences* **6**, 9–17. doi:10.12692/IJB/6.9.9-17
- Sultan, M., Bhatti, H. N., and Iqbal, Z. (2005). Chemical analysis of essential oil of ginger (*Zingiber officinale*). *Pakistan Journal of Biological Sciences* **8**, 1576–1578. doi:10.3923/PJBS.2005.1576.1578
- Sureechachaiyan, P., Pootakham, K., and Duangsamom, L. (2011). Chemical marker identification of mixed essential oil formulation. *Journal of Nature and Science* **10**, 81–87.
- Suri, R., Radzali, M., Marziah, M., and Aspollah, S. M. (2002). Analysis of flavour compounds in leech lime (*Citrus hystrix*) flower and yield improvement in callus. *Journal of Tropical Agriculture and Food Science* **30**, 239–247.
- Susarti, S., Purwanto, Y., and Walujo, E. B. (2008). Medicinal plant diversity in The Tesso Nilo National Park, Riau, Sumatra, Indonesia. *Reinwardtia* **12**, 383–390.
- Tardío, J., and Pardo-de-Santayana, M. (2008). Cultural importance indices: a comparative analysis based on the useful wild plants of southern Cantabria (northern Spain). *Economic Botany* **62**, 24–39. doi:10.1007/S12231-007-9004-5
- Tinjan, P., and Jirapakkul, W. (2007). Comparative study on extraction methods of free and glycosidically bound volatile compounds from kaffir lime leaves by solvent extraction and solid phase extraction. *Withayasan Kasetsat Withayasad* **41**, 300–306.
- Turner, N. J. (1988). The importance of a Rose: evaluating the cultural significance of plants in Thompson and Lilloet Interior Salish. *American Anthropologist* **90**, 272–290. doi:10.1525/AA.1988.90.2.02A00020
- Unnithan, C. R., Dagnaw, W., Undrala, S., and Ravi, S. (2013). Chemical composition and antibacterial activity of essential oil of *Ocimum basilicum* of northern Ethiopia. *International Research Journal of Biological Sciences* **2**, 1–4.
- van Andel, T., Behari-Ramdass, J., Havinga, R., and Groenendijk, S. (2007). The medicinal plant trade in Suriname. *Ethnobotany Research and Applications* **5**, 351–372. doi:10.17348/ERA.5.0.351-372
- van Andel, T., Myren, B., and van Onselen, S. (2012). Ghana herbal market. *Journal of Ethnopharmacology* **130**, 1–11.
- Waikredre, J., Dugay, A., Barrachina, I., Herrenknecht, C., Cabalion, P., and Fournet, A. (2010). Chemical composition and antimicrobial activity of the essential oils from New Caledonian *Citrus macroptera* and *Citrus hystrix*. *Chemistry & Biodiversity* **7**, 871–877. doi:10.1002/CBDV.200900196

- Wakhidah, A. W. (2015). Ethnobotany welcoming ceremony of girl maturity (*oke sou*) at the village community Lako Akediri and Bobanehena in West Halmahera. Bachelor Thesis, Biology Department, Universitas Indonesia.
- Wang, W., Zhang, L., Li, N., and Zu, Y. (2012). Chemical composition and *in vitro* antioxidant, cytotoxicity activities of *Zingiber officinale* Roscoe essential oil. *African Journal of Biochemistry Research* **6**(6), 75–80.
- Werker, E., Putievsky, E., Radiv, U., Duda, N., and Katzir, I. (1993). Glandular hairs and essential oil in developing leaves of *Ocimum basilicum* L. (Lamiaceae). *Annals of Botany* **71**, 43–50. doi:10.1006/ANBO.1993.1005
- Wijekoon, M. M. J. O., Karim, A. A., and Bhat, R. (2011). Evaluation of nutritional quality of torch ginger (*Etilingera elatior* Jack.) inflorescence. *International Food Research Journal* **18**, 1415–1420.
- Wong, K. C., Yap, Y. F., and Ham, L. K. (1993). The essential oils of flower shoot of *Phoemia speciosa* Koord. *The Journal of Essential Oil Research* **5**, 135–138. doi:10.1080/10412905.1993.9698191
- Wong, K. C., Sivasothy, Y., Boey, P. L., Osman, H., and Sulaiman, B. (2010). Essential oils of *Etilingera elatior* (Jack) R.M. Smith and *Etilingera littoralis* (Koenig) Giseke. *The Journal of Essential Oil Research* **22**, 461–466. doi:10.1080/10412905.2010.9700372
- Wu, Y., Wang, Y., Li, Z. H., Wang, C. F., Wei, J. Y., Li, X. L., Wang, P. J., Zhou, Z. F., Du, S. S., Huang, D. Y., and Deng, Z. W. (2014). Composition of the essential oil from *Alpinia galanga* rhizomes and its bioactivity on *Lasioderma serricornis*. *Bulletin of Insectology* **67**, 247–254.
- Xu, J., Lin, R., Wu, Y., Wang, Y., Liu, J., Zhang, Y., Zhang, Y., Xi, C., Wu, Q., and Li, X. (2015). Effect of stimulating acupoint Guanyuan (CV 4) on lower back pain by burning moxa heat for different time lengths: a randomized controlled clinical trial. *Journal of Traditional Chinese Medicine* **35**, 36–40. doi:10.1016/S0254-6272(15)30006-6
- Zheljazkov, V. D., Cantrell, C. L., Evans, W. B., Ebelhar, M. W., and Coker, C. (2008). Yield and composition of *Ocimum basilicum* L. and *Ocimum sanctum* L. grown at four locations. *Hortscienci* **43**, 737–741.
- Zulak, K. G., and Bohlmann, J. (2010). Terpenoid biosynthesis and specialized vascular cells of conifer defense. *Journal of Integrative Plant Biology* **52**, 86–97. doi:10.1111/J.1744-7909.2010.00910.X
- Zumsteg, I. S., and Weckerle, C. S. (2007). *Bakera*, a herbal steam bath for postnatal care in Minahasa (Indonesia): documentation of the plants used and assessment of method. *Journal of Ethnopharmacology* **111**, 641–650. doi:10.1016/J.JEP.2007.01.016

Appendix 1. The essential oils of steam-bathing materials used by Batak people in North Sumatra, Indonesia

Species	Content of the essential oils
<i>Etilingera elatior</i> (Jack.) R.M.Sm	Dodecanal ^{A,B,D,E} , Decanal ^{A,C,D,E} , α -Caryophyllene, 2-Tridecanone, 2-Undecanone, β -Myrcene, β -pinene ^{A,B,C} , Dodecane ^{A,B,D} , 1-dodecanol ^{B,D,E} , 2-Undecanone, Dodecanoic acid ^{C,D,E} , 2-Tridecanone, Acetic acid, Bicyclo[3.1.1]hept-2-ene,2,6,6-trimethyl, Bicyclo[3.1.1]heptan-3-one ^{A,B} , Eicosane ^{B,C} , 1-Tetradecene ^{B,E} , 1-Limonene, 1-Decanol ^{B,D} , α -Pinene ^{C,D} , Hexadecanol, Cyclododecane ^{C,E} , Tetradecanoic acid, Undecane ^{D,E} , <i>trans</i> -(Z)- α -Bisabolene epoxide, 3-Bromo-7-methyl-1-adamantane, Carboxylic acid, 7,11-Dimethyl-3-methylene,1,6,10-Dodecatriene, β -Farnesene, 7-Methylene-9-oxabicyclo[6.1.0]non-2-ene, 2-Pentadecyn-1-ol,(E)-10-Pentadecenol; 1,3-Propanediol, 2-dodecyl, (-)- α -Terpineol (<i>p</i> -menth-1-en-8-ol) ¹ , Bicyclo[3.1.1]heptan-3-ol, Bicyclo[3.1.1]hept-3-ol,Bicyclo[3.1.1]hept-2-ene-2-methanol, Cyclohexane,Cyclohexanol, 2-Cyclohexen-1-one, Cyclohexanone, n-Decanoic acid, Dodecyl ester, 1-Nonanol,Cis-6-Nonenal,phenyl-n-Hexadecanol, 4-Hydroxy-2,6,10-Dodecatrien-1-ol,1,6,10-Dodecatriene, 1,6,10-Dodecatrien-3-ol, 9-Tetradecen-1-ol,1,13-Tetradecadiene, 1,12-Tridecadiene,1-Tetradecanol, 1-Undecene ^B , Borneol, Camphene, Camphor, Caryophyllene, Caryophyllene oxide,(+)- α -Cadinene,Copaene, 1-Cyclohexylnonene, Cyclododecane, Decyl ester, Diacetate, 2,3-dihydroxypropyl octadec-9-enoate (glyceryl palmitoleate), Dihydrocavreol, 1,2-Dimethylcyclooctane, 1,1-Dodecanediol, Dodecamethyl, Cyclohexasiloxane, (E)-5-Dodecene, Elaidic acid, β -Elemene, 2-Ethylfenchol, Eucaplytol, (Z)- β -Farnesene, Formic acid, (Z)- β -Farnesene, Glyceryl monooleate, (Z)-3-Hexadecene, (E)-2-Hexenal, 1-Heptadecene, D-Limonene, 1,3,8- <i>p</i> -Menthatriene, <i>Trans</i> nerolidol, Octadec-9-enoic acid, 9-Octadecenal,Oleic acid, Sabinene, α -Terpinene, α -Terpineol, α -Terpinolene, Tetradecyl ester, 1,13-Tetradecadiene, α -Thujene ^C , β -caryophyllene, Decyl acetate, 9-decen-1-ol, α - <i>p</i> -Dimethylstyrene, Dodecyl acetate, Hexadecane, α -humulene, Myrcene, Nerolidol, 2-Nonanol, Linalool, β -Phellandrene, Furfuryl alcohol, Furfural, Para-cymene, (Z)-9-Tetradecen-1-ol, Tetradecyl acetate, Tetradecanol, Terpineol, (Z)-5-Tetradecen-1-ol, Tetra-3-carene, 2-Tridecanone, 10-Undecena, Toluene ^{DP} , Cyclotetradecane, Cycotetracosane, Dodecane-1-2-diol, 3-Dodecyl cyclohexanone, 5-Eicosene, Hexadecanedinitrile, Hexadecanoic acid, 1-Hexadecene, 1-Heneicosyl formate, Icosane, 2-Methyl-1-hexadecanol, 4-Hydrano-5-hydroxymino, Oisopropylidene, Cis-13-octadecenoic acid, 9,12 Octadecadienoic acid, Oxirane, (9E, 12E)-9,12-Octa decadienoicacid, 17-Pentatriacontene, Propanedioic acid, Quinoline, 4,5,6,7-Tetrahydrobenzofuraxane, Cis-9-Tetradecen-1-ol, 9-Tricosane, 2-Tridecanone, Cis vaccenic acid, Tridecane, Cholest-5-en-3-ol, Undecanal, 6-Nitro-2-methylpyrrolo[2,3], 1,2, Benzenedicarboxylic acid ^E .
<i>Alpinia galanga</i> L. (Willd.)	β -Pinene ^{F,G,H,I} , α -Pinene, α -Terpineol ^{F,G,H} , Camphene, Fenchene, α -Phellandrene, γ -Terpinene, Linalool, Fenchol, Borneol, Geraniol, Myrtenol ^{F,G,I} , Camphor ^{F,G,I} , 1,8-Cineole ^{F,I} , β -Farnesene ^{F,I} , Terpinen-4-ol ^{F,H} , β -Terpinen, 2,4(8)- <i>p</i> -Menthadiene, 2-Isopropyltoluene, Eucalyptol, 1-Methyl-3-(1'-methylcyclopropyl) cyclopentene, 2,2-Dimethylheptane, Undecane, Linalool, 2-Methyloctane, Camphene hydrate, 4-Carvomenthenol, (+)-Sabinol, Fenchyl acetate, Citronellyl formate, Benzylacetone, <i>p</i> -Menth-1-en-3-one, 1-Bornyl acetate, Thymyl acetate, Benzalacetone, Nerol acetate, Caryophyllene, α -Caryophyllene, Methyl isoeugenol, Dihydro-cis- α -copaene-8-ol, Aciphyllylene, 2-Methyl-decane, 3,7,11-Trimethyl-3-hydroxy-6,10-dodecadien-1-yl acetate, 1-Methylene-2 β -hydroxymethyl-3,3-dimethyl-4 β -(3-methylbut-2-enyl)-cyclohexane, 2-(1,1-Dimethylethyl)-6-(1-methylethyl)phenol,1-Formyl-2,2-dimethyl-3-trans-(3-methylbut-2-enyl)-6-methylidene-cyclohexane,Methyltrans-2-phenyl-1-cyclopropylcarboxylate, Bicyclo[6.1.0]non-1-ene, 3,5-Dimethyl-4-octanone, 2-Methyl-3-(3-methylbut-2-enyl)-2-(4-methylpent-3-enyl)-oxetane, Bornylane, Scytalone, 3-Ethyl-3-methyl-decane, 9-Oxononanoic acid, 2-(Fench-2-yl)fenchane ^G , Ethyl acetate, (E)-2-Hexenal, (E)-2-Hexenol, Hexanol, Methyl isobutyl ketone, α -Thujene, Tricyclene, 1-Octen-3-ol, Sabinene, Myrcene, δ -3-Carene, α -Terpinene, <i>p</i> -Cymene, Limonene, β -Phellandrene, Benzyl alcohol, (Z)- β -Ocimene, (E)- β -Ocimene, <i>trans</i> -Sabinene hydrate, <i>cis</i> -Linalool oxide, <i>trans</i> -Linalool oxide, Fenchone, α - <i>p</i> -Dimethylstyrene, Terpinolene, <i>cis</i> -Sabinene hydrate, α -Fenchol, Phenylethyl alcohol, Nonanal, <i>cis</i> - <i>p</i> -Menth-2-en-1-ol, β -Thujone, <i>trans</i> -Pinocarveol, β -Terpineol, Isoborneol, Isopulegol, <i>p</i> -Cymen-8-ol, Myrtenal, Verbenone, <i>trans</i> -Carveol, α -Fenchyl acetate, <i>cis</i> -Carveol, Carvone, Pulegone, Linalyl acetate, Isopulegyl acetate, <i>cis</i> -Sabinyl acetate, 2-Hydroxy-1,8-cineole, Isobornyl acetate, Bornyl acetate, Terpinen-4-yl acetate, pinocarvone, (Z)-Methyl cinnamate, Eugenol, (E)-Methyl cinnamate, α -Cubebene, α -Copaene, β -Patchoulene, β -Bourbonene, β -Elemene, α -Gurjunene, β -Caryophyllene, β -Gurjunene, α -Bergamotene, (E)- β -Farnesene, α -Guaiene, Alloaromadendrene, α -Humulene, Germacrene D, <i>Ar</i> -Curcumene, β -Selinene, Viridiflorene, γ -Murolene, Valencene, α -Murolene, α -Selinene, γ -Elemene, β -Bisabolene, γ -Cadinene, σ -Cadinene, Elemol, (E)-Nerolidol, β -Chamigrene, Carotol, Spathulenol, Caryophyllene oxide, Globulol, Ledol, Viridiflorol, Cubenol, Cuaiol, γ -Eudesmol, Cadinol, Muurolo, α -Cadinol, β -Eudesmol, α -Bisabolol, β -Bisabolol, α -Eudesmol, (Z)- α -Bergamotol, (Z,E)-Farnesol, (E,E)-Farnesol, Nootketone ^F , <i>trans</i> -Caryophyllene, Zingiberene ^I , Methyl Eugenol, Eugenol acetate, Chavicol (4-allylphenol), Chavicol acetate ^K .
<i>Citrus hystrix</i> DC.	α -Pinene ^{L,M,N,O,P,Q} , β -Pinene ^{L,N,O,P,Q,R,S,T,U} , α -Terpineol ^{L,O,P,Q,R,S,T} , Sabinene ^{L,M,N,O,P,T,U} , Terpinene-4-ol ^{N,O,P,R,T} , Linalool ^{M,N,O,P,S,T} , γ -Terpinene ^{L,M,N,O,S} , Citronellol ^{P,R,S,T} , Limonene ^{O,P,Q,R} , <i>cis</i> -Linalool oxide ^{M,O,Q,T} , <i>p</i> -Cymene ^{M,N,O} , Citronellal ^{L,M,P,S} , Geranyl acetate ^{L,M,N,T} , 1-Limonene ^{L,M,N,S} , α -Terpinolene ^{L,M,N,Q} , γ -Cadinene ^{L,M,N,O} , Terpinolene ^{O,P} , 2,6-Dimethyl-5-heptenal ^{N,T,U} , Citronellyl acetate ^{L,N,O} , α -Terpinene ^{M,O} , α -Phellandrene ^{L,M,O} , β -Citronellol ^{L,N,T} , Neryl acetate ^{L,N,O} , Nerolidol, β -myrcen ^{L,N,T} , α -Thujene ^{L,O,P} , Geraniol ^{M,N,T} , Myrcene, Camphene ^{M,O,P} , Bicyclogermacrene, (-)-Isopulegol, Germacrene-D ^{L,M} , <i>trans</i> -Sabinene hydrate ^{L,N} , β -Cubebene ^{L,O} , α -Muurolene ^{M,N} , α -Humulene, α -Copaene ^{L,M} , β -Terpinene ^{F,Q} , 1,8-Cineole ^{O,R} , Isopropyl ^{O,T} , Geraniol, <i>trans,trans</i> - α -Farnesene, α -Guaiene, d-Guaiene, Hexanal, <i>trans</i> -2-Hexenal, <i>trans</i> -Geraniol, 1H-Indole,

(Continued)

Appendix 1. (Continued)

Species	Content of the essential oils
	Neral, <i>cis</i> - β -Ocimene, <i>trans</i> - β -Ocimene, 1-Penten-3-ol, 4-Pentenal, <i>cis</i> -2-Pentenol, Octanol, Neois(iso)pulegol, α -Terpinen-4-ol, δ -3-Carene, (+)-Aromadendrene, Diethyl phthalate, Decanal, (+)-Cycloisositivene, <i>trans</i> -4,8-Dimethyl-1,3,7-nonatriene, d-Cadinene, Epi-bicyclosesquiphellandrene, 2-(2-Hydroxy-2-propyl)-5-m-cyclohexanol, <i>trans</i> - β -Farnesene, <i>trans</i> - β -Caryophyllene ^L , <i>cis</i> - β -Terpineol, T-Murolol, <i>trans</i> - β -Terpineol, α -Terpineol, Isoborneol, Ledene, Linalool oxide, 2- β -Pinene, γ -Selinene, β -Selinene, Terpinenol, 1,4,6-Trien-3-ol, α -Ylangene, Octyl phenyl acetate, δ -Cadinene, Cadina-1,4-diene, Elemol, 1-Citronellol, α -Eudesmol, γ -Eudesmol (Selinenol), α -Fenchene, Citronellyl acetate, Benzoic acid, Cyclofenchene, Cyclohexene; D-Fenchyl alcohol, Caryophyllene ^M , Epoxy-linalool oxide, <i>trans</i> -Linalool oxide, Guaiol, Nerol, <i>l</i> - α -Terpineol, <i>cis</i> -Ocimene, <i>p</i> -Menth-3,8-diol, 4- <i>p</i> -Menthene, <i>iso</i> -Pulegol, <i>trans</i> -Caryophyllene, Caryophyllene oxide, α -Bergamotene, Δ -3-Carene, β -Bisabolene, <i>l</i> -Citronellal, Eugenol, <i>d</i> -Citronellal, β -Elemene, 2,6-Dimethyl-5-heptenol ^N , (Z)-Caryophyllene, Borneol, Germacrene, <i>neo</i> -Isopulegol, <i>iso</i> -Isopulegol, <i>exo</i> -Fenchol, α -Cubebene, β -Citronellol ^O , δ -2-Carene ^P , α -Caryophyllene ^Q , Cyclohexanol, Cyclohexanol ^S , 5,9-Dimethyl-1-decanol, <i>Cis</i> -2,6-Dimethyl-2,6-octadiene, 8-Dimethyl-1,7-nonadien-4-ol, (E)-2,5-Dimethyl-1,6-octadiene, 2-(2-Hydroxy-2-propyl)-5-methyl-cyclohexanol, Methyl citronellate, 2-Methyl-7-oxabicyclo-heptane, 4-Methyl-6-hepten-3-ol, 3-Hexen-1-ol, Isopulegol, 1,8-Terpene, (E)-Furanoid, Linalool oxide, Tetrahydro-4-methyl-2-(2-methyl-1-propenyl)-2H-pyran, 3-Undecanol ^T , Citronellic acid, (-)-Citronellal ^U .
<i>Cymbopogon citratus</i> (DC.) Stapf.	Geraniol ^{V,W,X,Y,Z} , Neral ^{V,W,Y,Z} , α -Gurjene, β -Eudesmol, Citronellal, δ -Cadinene ^{V,X,Z} , Geranic-acid ^{V,W,Y} , Linalool ^{V,X,Y} , Citronellol ^{V,Y,Z} , Myrcenol, α -Bergamotene ^{V,W} , β -Myrcene, Nerol ^{V,X} , Citral ^{V,Y} , Germacrene-D, β -Farnesene, α -terpineol ^{V,Z} , Geraniol, Elemol ^{X,Z} , Myrcene ^{V,Z} , Methyl-n-nonyl-ketone, 1-Octyn-3-ol <i>trans</i> -Chrysanthamal, α -Pinene oxide, Borneol, α -Amorphene, 3-Undecyne, 3-Carvomenthenone, Valencene, β -O-Cimene, Allo- <i>o</i> -cimene, Viridiflorol, <i>t</i> -Cadinol, <i>trans</i> -(-)-Carveol, Dextro-carvone, α -Elemol, α -Gurjunene, Humulene, <i>t</i> -Murolol, Levo- β -elemene, γ -Murolene, α -Murolene, β -Sesquiphellandrene, α -Selinene ^V , α -Phellandren-8-ol, α -Pinene, β -Pinene, τ -Gurjunene, β -Caryophyllene, β -Caryophyllene oxide, α -Terpinolene, <i>trans</i> -3(10)-Caren-2-ol, β -Citronellol, <i>p</i> -Cymene, <i>cis</i> -Verbenol, 2-Undecanone, β -Bourbonene, <i>cis</i> -Geraniol, Geranyl acetate, β -Linalool, β -Citronellal, <i>p</i> -Mentha-1(7),8(10)-dien-9-ol; <i>cis</i> - <i>p</i> -mentha-2,8-dienol, Eudesm-7(11)-en-4-ol, Nopol, Neric acid, (Z)- β -Ocimene, (E)- β -Ocimene ^W , 6-Methyl-5-hepten-2-one, Naphthalene, <i>cis</i> - β -Farnesene, α -Murolene, σ -Murolol, β -Citral, E-Eitral, β -Bisabolene, Caryophyllene oxide, β -Chamigrene, <i>cis</i> -Ocimene, β -Z-Ocimene, Germacrene B, β -Panasinene ^X , Citronellyl tiglate, Bicyclogermacrene, Limonene, Methyl-5-epiten-2-one, γ -Eudesmol, Sabinene hydrate, β -Elemene ^Z .
<i>Andropogon nardus</i> L.	Geranyl acetate ^{W,Z,AA,AB,AC,AE} , Limonene ^{W,Z,AA,AB,AD,AE} , Nerol ^{W,AA,AB,AD,AE} , Geraniol ^{W,Z,AB,AC,AD} , Geraniol ^{Z,AB,AC,AD,AE} , Citronellyl acetate ^{AA,AC,AD,AE} , Germacrene-D, β -Elemene ^{W,Z,AA,AB} , Eugenol ^{W,AA,AB,AC} , Neral ^{W,Z,AB,AC} , Citronellol ^{Z,AB,AC,AE} , Citronellal ^{AA,AB,AC,AD,AE} , Elemol ^{Z,AA,AB} , α -Cadinol, δ -Cadinene ^{W,AA,AB} , Linalool ^{AA,AB,AD} , Myrcene ^{Z,AB,AE} , β -Eudesmol ^{Z,AA} , Isopulegol, α -Eudesmol ^{AA,AB} , β -Myrcene, α -Murolene, τ -Cadinol ^{W,AA} , Citral ^{AA,AE} , Bicyclogermacrene, α -Farnesene ^{Z,AB} , α -Terpineol ^{Z,AE} , <i>trans</i> - β -Caryophyllene ^{AB,AC} , 4-Nonanone ^{AC,AD} , Isoeugenol ^{W,AE} , 7-Acetil-2-hidroksi-2-metil, 5-Nitrobenzofuran-2-carboksil acid, Bisiklo(4,4,0) dec-1-en, 2 isopropyl, Endo-1-bourbonanol, Siklobutene, 1,2,3,4-Tetrametil, Z-Citral, Geraniol, Geraniol formate, 2,6-Dimetil-5-heptenal, α -Copaena, (-)-Isopulegol, Patchouli alcohol, β -Patchoulene, δ Guaiena, T-Murolol ^{AA} , γ -Eudesmol, Citronellyl tiglate, <i>Cis</i> Citronella ^Z , Citronellyle acetate, β -Cadinol, D-Germacrene-4-ol ^{AB} , γ -Cadinene, 1-Ethyl-2-methylcyclopentene ^{AC} , τ -Eudesmol, β -Caryophyllene, β -Citronellal, β -Citronellool, Cubenol, β -Cubebene, τ -Gurjunene, α -Humulene, β -Linalool, Ledol, Melonal, (Z,E)-Farnesol, Seychellene, τ -Murolene ^W , 6-Metil-5-hepten-2-ona, (Z)- β -Ocimene, (E)- β -Ocimene, Caryofilenol ^{AD} , <i>cis</i> -Citral, <i>trans</i> -Citral, α -Pinene, β -Pinene, Menthone ^{AE} .
<i>Ocimum basilicum</i> L.	Linalool ^{AF,AG,AH,AJ,AK,AL,AM,AN,AO,AP,AQ} , Camphor ^{AG,AH,AJ,AL,AM,AN,AO,AP,AQ,AR} , Eugenol ^{AG,AH,AJ,AL,AM,AN,AO,AP,AQ} , Methyl eugenol ^{AF,AH,AK,AL,AN,AO,AP,AQ} , Methyl chavicol ^{AG,AJ,AK,AL,AM,AN,AO,AP} , α -Pinene ^{AF,AJ,AL,AM,AN,AO,AP,AQ} , 1,8-Cineole ^{AG,AH,AJ,AK,AM,AN,AP,AQ} , β -Pinene ^{AF,AH,AJ,AL,AM,AN,AO,AP,AQ} , Myrcene ^{AF,AL,AM,AN,AO,AP,AQ,AR} , α -umulene ^{AF,AG,AH,AJ,AN,AQ} , <i>trans</i> - α -Bergamotene ^{AF,AG,AL,AM,AN,AQ,AR} , Sabinene ^{AF,AM,AN,AO,AP,AQ} , Terpinene-4-ol ^{AG,AH,AM,AN,AP,AR} , Bornyl acetate ^{AF,AH,AL,AN,AR,AS} , Bicyclogermacrene, Camphene ^{AJ,AM,AN,AO,AP,AQ} , Germacrene-D ^{AF,AG,AH,AM,AN,AO,AP,AQ} , γ -adinene ^{AG,AH,AM,AN,AP,AQ,AR} , β -Elemene ^{AF,AH,AM,AN,AP,AR} , γ -Terpinene ^{AF,AJ,AM,AN,AP,AQ} , β - α -Terpinene ^{AF,AL,AM,AO,AP,AQ} , α -Terpineol ^{AF,AH,AL,AN,AP,AR} , Spathulenol ^{AG,AM,AN,AP,AQ,AR} , Limonene ^{AF,AH,AM,AP,AQ} , Borneol ^{AM,AN,AP,AQ,AR} , Geraniol ^{AF,AM,AN,AO,AP,AR} , β -Cubebene ^{AF,AH,AM,AN,AP} , α -Cubebene, α -Copaene ^{AF,AM,AN,AP,AS} , Eudesmol ^{AG,AM,AP,AQ,AS} , Fenchone ^{AG,AM,AN,AP,AQ} , Cadinol ^{AH,AM,AN,AQ,AR} , α -Bulnesene ^{AM,AN,AP,AQ,AR} , α -Guaiene ^{AF,AM,AN,AP} , Caryophyllene oxide ^{AG,AM,AP,AQ} , 1,8-Cineol ^{AL,AO,AR} , Neral, Geraniol ^{AF,AG,AQ} , Linalyl acetate ^{AF,AL,AO} , β -Caryophyllene ^{AF,AJ,AK} , <i>cis</i> -Sabinene hydrate, <i>cis</i> -Linalool oxide (furanoid), <i>cis</i> -Murola-4(11),5-diene ^{AF,AN,AQ} , β -Bourbonene ^{AF,AM,AP} , Geranyl acetate ^{AF,AN,AR} , α -Thujene, Nerol ^{AF,AO,AQ} , <i>p</i> -cymene ^{AF,AP,AQ} , 1,10-di- <i>epi</i> -Cubenol ^{AG,AN,AQ} , Terpinolene, (E)- β -Ocimene, (E)-Caryophyllene, (E)- β -Farnesene, α -Cadinene ^{AM,AN,AP} , α -Bisabolol ^{AM,AP,AQ} , Phytol ^{AM,AP,AR} , Ocimene ^{AO,AS} , Carvacrol ^{AF,AH} , Eucalyptol ^{AF,AI} , Cadina-3,9-dien ^{AF,AJ} , Endo-fenchyl acetate ^{AF,AN} , <i>trans</i> - β -Ocimene, <i>trans</i> -Myroxide, Terpinen-4-ol, Chavicol, Exo-2-hydroxycineole acetate ^{AF,AQ} , Germacrene-A, <i>epi</i> - α -Cadinol ^{AG,AN} , Methyl cinnamate ^{AH,AJ} , <i>trans</i> - α -Bisabolene ^{AG,AQ} .

(Continued)

Appendix 1. (Continued)

Species	Content of the essential oils
	Caryophyllene ^{AH,AO} , α -(Z)-Bergamotene, α -Amorphene, Δ -Cadinene ^{AH,AP} , Estragole ^{AH,AO} , 3-Carene ^{AJ,AS} , Farnesol ^{AL,AO} , (Z)- β -Ocimene, (Z)-Sabinene hydrate, Aromadendrene, α -Zingiberene, (Z)-Nerolidol, (Z)-Calamene, Alloaromadendrene ^{AM,AP} , <i>trans</i> -Calamene ^{AN,AO} , Benzaldehyde, <i>cis</i> -hex-3-Enyl acetate, <i>cis</i> - β -Ocimene, <i>trans</i> -Linalool oxide, Neo-allo-ocimene, Menth-2-en-1-ol, Pinocavone, 3,7-Dimethyloct-1,5-dien-3,7-diol, <i>n</i> -Octyl acetate, Bicycloelemene, 3,7-Dimethyloct-1,7-dien-3,6-diol, α -ylangene, β -Copaene, δ -Murolene, β -Acoradiene, α -Acoradiene, Bicyclogermacrene, Benzaldehyde, Octen-3-ol, <i>cis</i> -3-Hexenyl acetate, β -Phellandrene, <i>n</i> -Octanol, Octan-3-yl acetate, Cyclopentanal-1,2-dimethyl-3(1-methylethenyl), <i>cis</i> -Menth-2-en-1-ol, Pinol, Methyl calicylate, <i>n</i> -Octyl acetate, <i>cis</i> -3-Hexenyl valerate, Myrtenyl formate, β -Cycloelemene, Exo-2-hydroxycyclooleone acetate ^{AF} , Octen-3-ol, 6-Methyl-5-hepten-2-one, <i>trans</i> -Caryophyllene, Humulene epoxide II ^{AO} , Alloaromadendrene, Carvone, β -Burbone, Calamene, β -Farnesene, α -Bisabolene, (Z)-(E)-Spatulenol, Torreyol, Chavicol ^{AH} , <i>trans</i> -Caryophyllene, Cadinol ^{AI} , 1-4-Hexen-1-ol, 2-Hexenal, β -Myrcene, α -Phellandrene, D-Limonene, Terpinen-4-acetat, Bergamotene, β -Murolene ^{AJ} , β -Terpinene, β -Terpineol, Iso eugenol ^{AL} , β -Selinene, σ -Cadinene ^{AM} , Exo-fenchyl acetate, Guaiene, <i>cis</i> - β -Guaiene, Viridiflorene, δ -Amorphene, 10-Epi-cubebol ^{AN} , 1,4-Terpineol, Methyl chavicol, Geraniol, Cadinene, <i>cis</i> -Bisabolene, Nerolidole, Seline, t-Cadinol ^{AO} , β -Phellandrene, α -Longipinene, α -Cedrene, (E)- α -Farnesene, β -Sinsal ^{AP} , Ethyl 2-methyl butyrate, Ethyl isovalerate, Octen-3-yl acetate, 4-Acetyl-1-Methylcyclohexene, σ -Terpineol, Octanol acetate, Fenchyl acetate, <i>cis</i> -Methyl cinnamate, Neryl acetate, <i>trans</i> -Methyl cinnamate, β -Elemene, Sesquithujene, β -Caryophyllene, α -Quaie, <i>trans</i> - β -Farnesene, 10- <i>epi</i> - β -Acoradiene, <i>trans</i> -Murola-4(11),5-diene, β -bisabolene, β -Sesquiphellandrene, Salviadienol, <i>trans</i> -Nerolidol, Maaliol, Guaia-6,10(11)-diene-4- β -ol, α -Murolol, Aromadendran-12-ol, Aromadendran-11-ol, <i>cis</i> -Lanceol, <i>trans</i> -Phytol, <i>trans</i> -Phytol acetate ^{AO} , β -(Z)-Ocimene, Cubenol ^{AR} , 1,2,3,4,5 Pentamethyl-1,3-cyclopentadiene, P-Menth-2-en-1-ol, 6-methyl-5-(1-methylethylidene)-6,8-nonadien-2-one, 3,6-Dimethyl-4,5,6,7-tetrahydrobenzofuran, 1-Ethenyl-1-methyl-2-(1-methylethenyl)-4-(1-methylethylidene) cyclohexane, 1,7,7-Trimethylbicyclo [2.2.1] heptan-2-ol, 4-methyl-1-(1-methylethyl) cyclohexene, γ -Elemene, 1-Ethenyl-1-methyl-2-(1-methyl) cyclohexane, Eugenyl acetate, Copaene, 1,4-Dimethyl-7-(prop-1-en-2-yl)-1,2,3,4,5,6,7,8-octahydroazulene, 2,4,5,6,7,8-Hexahydro-1,4,9,9-tetramethyl-3H-3a,7-Methanoazulene, 2,2,4,8 Tetramethyltricyclo [5.3.1.0(4,11)]undecan-7-ol, γ -Himalchalone, 9- β -Acetoxy-3 α -hydroxy-3,5,8-trimethyltricyclo [6.3.1.0(1,5)]dodecane, Isoeugenyl acetate, Uncinol, Rosifoliol, 6,10,11-trimethyl-2-pentadecanone, Tricyclo[6.3.0.0(3,7)]undec-1(8)-en-3-ol, Famesylacetone, Isophytol, Thunbergol, 1,5,6,7-Tetramethylbicyclo [3.2.0] hept-6-en-3-one ^{AS} .
<i>Zingiber officinale</i> Roscoe	Zingiberene ^{AT,AU,AV,AW,AX,AY,AZ,BA} , 1,8-Cineole ^{AT,AV,AW,AX,AZ,BB} , β -Sesquiphellandrene ^{AT,AW,AX,AY,AZ,BB} , Neral ^{AT,AW,AX,AZ,BB} , Geranial ^{AT,AW,AZ,BA,BB} , Camphene ^{AU,AX,AZ,BA,BB} , γ -Terpinene ^{AV,AW,AX,AZ,BB} , α -Pinene ^{AV,AW,AX,AY,AZ,BB} , β -Bisabolene ^{AT,AW,AX,AZ} , Copaene ^{AX,AY,BA,BB} , Terpinen-4-ol, α -Terpineol, Geraniol ^{AW,AX,AZ,BB} , β -Pinene ^{AV,AY,AZ,BB} , Nerol ^{AW,AX,AZ} , Limonene ^{AW,AZ,BB} , δ -(E,E) Farnesene, Ar-curcumene, Linalool ^{AW,AX,BB} , Sabinene, 6-Methyl-5-hepten-2-one, 2-Heptanol, Myrcene, δ -Cadinene, Germacrene-D, Geranyl acetate, 2-Undecanone, Bomyl acetate, Camphor, Bomeol ^{AX,AZ,BB} , β -Phellandrene, α -Zingiberene, Neryl acetate ^{AW,BB} , γ -Eudesmol, β -Caryophyllene, β -Eudesmol, β -Elemene, α -Murolene, (E)- β -Ocimene ^{AZ,BB} , (E, Z)-Farnesol, (Z)-Lanceol, (Z, Z) Farnesol, Eudesma-3,7(11) diene, Zingerone, α - β -Bergamotol, β -Bisabolol, Sesquisabinene hydrate, Epi- α -cedrenol, β -Guiacol, Cubenol, Elemol, (E)-Nerolidol, (Z)-Nerolidol, δ -Elemene, Undecanal, <i>trans</i> -Linalool oxide ^{AX,AZ} , σ -3-Carene, p-Cymene, Linalyl acetate, Citronellal, Tricyclene ^{AX,BB} , e-Citral, z-Citral, Ocimene ^{AU} , α -Phallandrene, Citral ^{AV} , Octanol, <i>trans</i> -Carveol, <i>Cis</i> -caryophyllene, α -Caryophyllene, E-Ethyl cinnamate, G-Epi-caryophyllene, γ -Curcumene, Apo farnesal-2-dihydro, α -(Z) Bisabolene ^{AW} , Octenal, β -Myrcene, α -Phellandrene, α -Terpinene, d-Limonene, 2-Nonanol, Undecanone, Citronellol, Sabinol, Iso borneol, Myrtenol, Carveol, Gerania, Neric acid, Neryl acetate, Geranic acid, σ -Elemene, β -Elemene, γ -Elemene, α -Bergamotene, (E)- β -Farnesene, Thujopsene, α -Guaie, Germacrene-d, α -Murolene, Cedre-8-en-13-ol, α -Murolol, Eudesma-7(11)-en-4-ol, <i>trans</i> - α -Bisabolene epoxide, Farnesene epoxide, Curcumenyl acetate, Cinnamyl cinnamate ^{AX} , Santolina triene, α -Curcumene, β -Sesquiphellandrene ^{AY} , Hexanal, Hexanol, o-Xylene, Amyl acetate, Undecane, Menthone, Menthol, Decanal, <i>trans</i> -Carvone oxide, β -Cubebene, α -Copaene, α -Bergamotene, β -Farnesene, γ -Murolene, Zingiberenol, α -Murolool, α -Eudesmol, (E, E)-Farnesol ^{AZ} , 2-Heptyl acetate, <i>trans</i> - β -Ocimene, Terpinolene, 2-Nonanone, <i>trans</i> -Sabinene hydrate, Camphene hydrate, Isoborneol, Terpinen-4-ol, Myrtenal, Linalyl formate, β -Citronellol, <i>trans</i> -2-Decenal, Myrtenyl acetate, Isocaryophyllene, α -Humulene, Allo-aromadendrene, α -Selinene, α -Elemol, <i>trans</i> -Nerolidol, Caryophyllene oxide, Caryophyllenedienol, α -Bisabolol, <i>cis</i> , <i>cis</i> -Farnesol, <i>trans</i> , <i>trans</i> -Farnesol, <i>trans</i> , <i>trans</i> -Farnesal, Phytol ^{BB} .

^AAbdelwahab *et al.* 2010; ^BAbdelmageed *et al.* 2011; ^CJaafar *et al.* 2007; ^DWong *et al.* 1993; ^EMaimulyanti and Pribadi 2015; ^FJirovetz *et al.* 2003; ^GWu *et al.* 2014; ^HRaina *et al.* 2014; ^IRaina *et al.* 2002; ^JPhanthong *et al.* 2013; ^Kde Pooter *et al.* 1985; ^LTinjan and Jirapakkul 2007; ^MSrisukh *et al.* 2012; ^NNor 1999; ^OHongratanaworakit and Buchbauer 2007; ^PKasuan *et al.* 2013; ^QKerdchoechuen *et al.* 2010; ^RWaikedre *et al.* 2010; ^SSuri *et al.* 2002; ^TLoh *et al.* 2011; ^USato *et al.* 1990; ^VEkpenyong *et al.* 2014; ^WKpoviessi *et al.* 2014; ^XSubramanian *et al.* 2015; ^YRanitha M *et al.* 2014; ^ZKoba *et al.* 2009; ^{AA}Setiawati *et al.* 2011; ^{AB}Abena *et al.* 2007; ^{AC}Hazwat *et al.* 2014; ^{AD}Fuselli *et al.* 2010; ^{AE}Nakahara *et al.* 2013; ^{AF}Ozcan and Chalchat 2002; ^{AG}Sajjadi 2006; ^{AH}Politeo *et al.* 2007; ^{AI}Zheljazkov *et al.* 2008; ^{AJ}Klimánkova *et al.* 2008; ^{AK}Werker *et al.* 1993; ^{AL}Kandil *et al.* 2009; ^{AM}Hassanpouraghdam *et al.* 2010; ^{AN}Dzida 2010; ^{AO}Said-Al Ahl and Mahmoud 2010; ^{AP}Hassanpouraghdam *et al.* 2011; ^{AQ}Beatovic *et al.* 2015; ^{AR}Carvalho Filho *et al.* 2006; ^{AS}Unnithan *et al.* 2013; ^{AT}Ekundayo *et al.* 1988; ^{AU}Raina *et al.* 2005; ^{AV}Sultan *et al.* 2005; ^{AW}El-Baroty *et al.* 2010; ^{AX}Nampoothiri *et al.* 2012; ^{AY}Wang *et al.* 2012; ^{AZ}Barman and Kumar 2013; ^{BA}Kumari *et al.* 2014; ^{BB}Sivasothy *et al.* 2011.

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