Chemical Composition and Biological Activities of Essential Oils of the Genus *Litsea* (Lauraceae) – A Review

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Summary

Essential oils are largely consumed as they are beneficial to humans as natural remedies and also for biomedical, cosmetic, food, veterinary, and agriculture applications. *Litsea* which includes around 200 species, is an important genus of the Lauraceae family due to its production of secondary compounds. It comprises several species and can serve as valuable medicinal plants, because of their biological and pharmacological properties. It has been used for a long time in traditional Chinese medicine for the treatment of diarrhea, stomachache, dyspepsia, gastroenteritis, diabetes, edema, cold, arthritis, asthma, pain, and traumatic injury. *Litsea* essential oils have been studied for their chemical compositions and biological activities. The present review is an attempt to collect and document the recent studies on essential oils of the genus *Litsea*. Information on the *Litsea* species was collected via electronic search (using Pubmed, SciFinder, Scopus, Google Scholar and Web of Science) and a library search for articles published in peer-reviewed journals. This review is mainly meant to provide relevant information on the *Litsea* essential oils, which could serve as a guide for the selection of accessions or species with the best chemical profiles. The outcome of these studies will further support the therapeutic potential of the genus *Litsea* and provide convincing evidence to its future clinical applications in modern medicine.

Key words

essential oils, *Litsea*, Lauraceae, pharmacology

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Introduction

The Lauraceae family comprises of approximately 55 genera and over 2,000 species worldwide. It is commonly found in subtropical or tropical regions, especially Southeast Asia and Africa (Lim, 2012). This family is known as *medang* or *tejur* in Malaysia. Most of the species that belong to this family are aromatic evergreen trees or shrubs. These trees are very useful economically as they are a source of timber, nutritious fruits, medicine, perfumes, and essential oils. Most of the plants are being harvested as timbers that are being used for plywood manufacture and decorative purposes (Corner, 1997). The bark of various species has commercial values such as cinnamon (*Cinnamomum verum* and *Cinnamomum cassia*) and *massoy* (*Cryptocarya massoy*). The species that is originally from tropical America known as *avocado* or alligator pear (*Persea americana*), are now widely favored for its fruit as nutritious food (Werff, 1996). *Litsea* is a genus of evergreen or deciduous trees or shrubs. This genus is mostly distributed in tropical and subtropical Asia, but a few species are found in Australia and from North America to subtropical South America (Agrawal et al., 2011). *Litsea* has more than 400 species in Asia, Australasia, and America, while in Peninsula Malaysia, *Litsea* is represented by 54 species (Corner, 1988). The plants in this genus are being used for a long time as a source of traditional medicine, especially in China. *Litsea* genus contains biologically active chemicals that include amides, alkaloids, flavonoids, butanolides, lactones, steroids, monoterpenes, triterpenoids, sesquiterpenes, fatty acids, and lignans (Kong et al., 2015).

Essential oils are composed of secondary metabolites commonly concentrated in the leaves, bark, or fruit of aromatic plants. The essential oils of plant origin have been used since ancient times. The extracts of the aromatic plants is believed to have the power of enhancing beauty and spirit and have medicinal effect (Jiang et al., 2009; Salleh et al., 2016). The essential oils of *Litsea* species have been utilized in folk medicine throughout history. Recently the interest in essential oils had increased as the alternative medicine uses plant essential oils and other aromatic compounds. The most-reported species of *Litsea* is *L. cubeba*. There are several studies of *L. cubeba* essential oils that were released and most of them are from China, which is the biggest *L. cubeba* essential oil exporter in the world (Kamle et al., 2019). Hence, the review regarding *Litsea* essential oils has to be done to simplify and compile the information. However, *L. cubeba* essential oils have been subject to the recent review, which will not be repeated here (Thielmann and Muranyi, 2019).

The available information about *Litsea* essential oils of various species was searched thoroughly via electronic search (Pubmed, SciFinder, Scopus, Google Scholar and Web of Science) and the articles published in peer-reviewed journals were collected via library search. The review aims to compile the information regarding their medicinal uses, chemical composition and bioactivities of the essential oils from the genus *Litsea*.

Botanical Description

Litsea plants have smooth bark, brown in color, and rarely split. The leaves are arranged alternately and singly, rarely sub opposite (Richter, 1981). Depending on the species, the leaves can be either deciduous or evergreen, and aromatic. These plants have flowers that are usually greenish-yellow, greenish to white or yellowish in color. The genus *Litsea* is distinguished from other genera of Lauraceae by a combination of characters, none of which is unique to the tribe: umbellate inflorescences, unisexual and trimerous flowers usually with nine stamens, four-locul anthers, equal or reduced tepals, fruit with small to rather large cupules, and leaves usually alternate or sometimes opposite (Delectis Florae Reipublicae Popularis Sinicae Academiae Sinicae Edita, 1982).

Medicinal Uses of *Litsea*

Litsea plants have been known for their medicinal benefits for ages. People have been using the parts of the plants to extracts essential oils for various reasons. The fruits, roots, leaves, and barks of these plant species are adopted for the therapy of diseases in the different approaches including (i) pharmaceutics (e.g. decoction, pill, powder, etc.) of signal medicine, or compound preparations with other traditional Chinese medicines; (ii) drunk as tea; (iii) eaten. The essential oils obtained are traditionally consumed as daily remedies to treat discomfort and to maintain health both physically and mentally (Editorial Committee of Zhonghua Bencao National Traditional Chinese Herb Administration, 1999). Table 1 shows several medicinal uses of *Litsea* species.

Chemical Compositions of *Litsea* Essential Oils

Analysis of chemical components identified in the *Litsea* essential oils shows that the oil consists of several groups of components, which are monoterpene hydrocarbons, oxygenated monoterpenes, sesquiterpene hydrocarbons, and oxygenated sesquiterpenes. Besides, oxygenated diterpenes, aldehydes, alcohols, ketones, and alkanes were also identified. Table 2 shows the major components identified in *Litsea* essential oils from various origins.

The major components of *Litsea* essential oils mainly consist of monoterpene hydrocarbons. Limonene was identified as the major component of four *Litsea* species, which are: *L. akoensis* (Taiwan) (Ho et al., 2011), *L. helferi* (Vietnam) (Son et al., 2014), *L. neesiana* (Mexico), and *L. parvifolia* (Mexico) (Jiménez-Pérez et al., 2011). The oils of those species are extracted from the leaf part of the plants. Ocimene was found in two different *Litsea* species, which are: *L. glutinosa* leaf oil from Vietnam (Son et al., 2014), *L. glutinosa* fruit oil from India (Choudhury et al., 1996), and *L. konstermanin* stem oil from Taiwan (Cheng and Cheng, 1983). The other monoterpene hydrocarbons were α-phellandrene, sabinene, and α-pinene. In the leaf oil of *L. acutivena* (Vietnam) α-phellandrene was found (Dai et al., 2019), while β-phellandrene was identified in the twig oil of *L. akoensis* (Taiwan) (Ho et al., 2011). Sabinene was discovered in leaf oil of *L. ferruginea* (Vietnam) (Son et al., 2014), while α-pinene was from leaf oil of the *L. konstermanin* (Taiwan) (Cheng and Cheng, 1983). Oxygenated monoterpenes were also reported in *Litsea* essential oils: 1,8-cineole, linalool, bulnesol, and citral. 1,8-Cineole was extracted from five species of *Litsea* leaf oils, which are *L. pringlei, L. schaffheri, L. glaucescens, L. muelleri* (Jiménez-Pérez et al., 2011), and *L. guatemalensis* (Vallverdú et al., 2005). All of those species were from Mexico except for *L. guatemalensis* which was from Guatemala. Linalool was found as the major component of the leaf oils of *L. guatemalensis* (Mexico)

Table 1. Medicinal uses of several *Litsea* species

Species	Part	Medicinal uses
L. cubeba	Leaf	To treat headaches, chills, fever or depression, as well as a common cold, stomach aches, diarrhea, and cholera (Choudhury et al., 1998)
	Fruit	Used in the treatment of stomachache, cold, hiccough, gastric cavity crymodynia, cold hernia, celialgia, and stagnancy of cold-damp (Wang and Liu, 2010)
L. ariculata	Bark	Treating stomach distension (Xie and Yu, 1996)
L. coreana	Bark	Effective in heatstroke prevention, diarrhea, and as an aid to digestion (Huang et al., 2010)
	Leaf	Treating stomach distension, lowering blood fat and sunstroke (Huang et al., 2010)
L. elliptica	Leaf	To treat stomach ulcers, fever and headache (Grosvenor et al., 1995)
L. euosma	Fruit	Tonifying spleen, treating dyspepsia and sore (Xie and Yu, 1996)
L. glaucescens	Leaf	To relieve illness related to the central nervous system, such as epilepsy, fright, and sadness (Jimenez-Perez et al., 2011)
L. glutinosa	Bark	Treating furuncle, traumatic injury, reducing swelling, and treating sore (Xie and Yu, 1996)
L. guatemalensis	Leaf	Used orally to treat respiratory and gastrointestinal disorders, and dermatomucosal diseases (Vallverdú et al., 2005)
L. hupehana	Leaf	Treating diarrhea (Xie and Yu, 1996)
L. ichangensis	Fruit	Treating dyspepsia and diarrhea (Xie and Yu, 1996)
L. mollis	Fruit	Treating chronic eczema (Xie and Yu, 1996)
	Root	Treating traumatic injury (Xie and Yu, 1996)
L. monopetala	Leaf	Treating fracture and dislocation (Xie and Yu, 1996)
	Bark	Used to cure gonorrhea, skin disease, boil, diarrhea, and dislocation (Baul et al., 2011)
L. polyantha	Bark	Used to treat pains, bruises, fractures, and diarrhea (Ghosh and Sinha, 2010)
L. populifolia	Root	Treating dyspepsia, relieving pain, nausea, and emesia (Xie and Yu, 1996)
L. rotundifolia	Root	Relieving pain, treating rheumatic arthritis, traumatic injury, dysmenorrhea, stomachache, and diarrhea (Xie and Yu, 1996)
L. rubescens	Fruit	Treating enterogastritis, stomachache, and dyspepsia (Xie and Yu, 1996)
L. salicifolia	Fruit	To treat the bone fracture and stomach disorder (Kala, 2005)
L. pungens	Fruit	Strengthening spleen, treating dyspepsia, diarrhea, and sunstroke, as well as externally used for sore (Xie and Yu, 1996)
L. verticillata	Root	Promoting blood circulation, relieving pain and treating traumatic injury (Xie and Yu, 1996)

(Jiménez-Pérez et al., 2011) and *L. verticillata* (Vietnam) (Son et al., 2014). Bulnesol was found in *L. resinosa* (Malaysia) (Ahmad et al., 2005) and citral was found *L. coreana* (China) (Qin et al., 2018).

Another group of components that was found in *Litsea* essential oils is sesquiterpene hydrocarbons. In the leaf oil in high quantity were found: γ-cadinene - *L. cylindropica* (Malaysia) (Mehat, 2008), β-caryophyllene - *L. deccanensi* (India), and β-elemene - *L. quinqueflora* (India) (Irulandi et al., 2016); and *trans*-α-bergamotene in the fruit oil of *L. laevigata* (India) (Arif et al., 2008). Ledene was identified in the leaf oil of *L. gracilipes* and *L. paludosa* from Malaysia (Ahmad et al., 2005), while germacrene D in seed and mesocarp oil of *L. japonica* (Hiromichi et al., 1978). Oxygenated sesquiterpenes were also identified in *Litsea* essential oil. Globulol was found to be rich in Malaysian *L. ferestrata* leaf oil and *L. gracilipes* stem oil (Khong, 2006). *Litsea megacarpa* leaf oil from Malaysia contained caryophyllene oxide (Khong, 2006), while *L. monopetala* from India has α-caryophyllene alcohol in its flower oil (Choudhury et al., 1997). Phytol, an oxygenated diterpene, was detected in the leaf oil of *L. glutinosa* (Bangladesh) (Chowdhury et al., 2008). Alkane was discovered as tricosane in the leaf oil of *L. rigidularis* (Malaysia) (Mehat, 2008). Three ketones were the ketones found in oils: ethylfuranone in *L. garciae* (Malaysia), acetovanillone in *L. nidularis* (Malaysia) (Mehat, 2008), and 2-undecanone in *L. petiolate* (Thailand) (Thongthip et al., 2017). Aldehydes were identified as decanal and tetradecanal. Decanal was found in the leaf oil of *L. gerciae* (Taiwan) (Cheng and Cheng, 1983) and fruit oil of *L. monopetala* (India), while tetradecanal was found in bark oil of *L. monopetala* (India) (Choudhury et al., 1997). Cyclohexanemethanol and 2-naphthalenemethanol are the alcohol group identified in *Litsea* essential oil. Cyclohexanemethanol was discovered in the stem oil of *L. machilifolia*, while 2-naphthalenemethanol in the leaf and stem oil of *L. resinosa* from Malaysia (Khong, 2006).

Table 2. Major components identified from *Litsea* essential oils

Species	Locality	Part	Total components	Major components
L. acutivena	Vietnam	Leaf	22; 97.1%	α-Phellandrene (30.4%), α-pinene (14.2%), β-pinene (7.3%), guaia-1(10),11-diene (5.7%) (Dai et al., 2019)
L. akoensis	Taiwan	Leaf	71; 99.9%	Limonene (18.5%), thymol (10.1%), *p*-cymene (9.6%), β-caryophyllene (8.9%), and carvacrol (8.2%) (Ho et al., 2011)
		Twig	40; 99.9%	β-Phellandrene (43.7%), *trans*-β-ocimene (10.4%) (Ho et al., 2011)
L. cylindrocarpa	Malaysia	Leaf	NI	γ-Cadinene (55.3%), β-guaiene (46.8%) (Mehat, 2008)
L. coreana	China	Leaf	50; 99.6%	Citral (21.1%), caryophyllene (15.7%), dodecanal (15.3%), α-humulene (13.5%), decanal (13.1%) (Qin et al., 2018)
L. deccanensis	India	Leaf	40; 98.8%	β-Caryophyllene (51.8%), germacra-3,9,11-triene (11.6%), caryophyllene epoxide (8.5%), bicyclogermacrene (6.6%), α-humulene (5.2%) (Irulandi et al., 2016)
L. ferestrata	Malaysia	Leaf	NI	Globulol (28.9%), 1*H*-cycloprop(e)azulen-7-ol (18.6%), viridiflorol (17.3%), 3-cyclohexen-1-carboxaldehyde (8.7%), ledol (7.8%), epiglobulol (5.7%) (Khong, 2006)
L. ferruginea	Vietnam	Leaf	43; 99.2%	Sabinene (34.5%), α-pinene (10.1%), γ -ternene (7.8%), limonene (6.9%), terpinen-4-ol (6.6%) (Son et al., 2014)
L. fulva	Malaysia	Leaf	NI	*cis*-(Z)-α-Bisabolene epoxide (9.5%), *trans*-(Z)-α-bisabolene epoxide (8.3%), 1b,5,5,6a-tetramethyl-octahydro-1-oxa-cyclopropa[a]inden-6-one (7.3%), longipinocarvone (5.6%) (Khong et al., 2013)
L. garciae	Malaysia	Leaf	NI	Ethylfuranone (34.7%), lauric acid (22.0%) (Mehat, 2008)
L. gerciae	Taiwan	Leaf	32; 99.3%	Decanal (53.5%), 1,8-cineole (11.0%) (Cheng and Cheng, 1983)
L. glaucescens	Mexico	Leaf	45; 95.2%	Eucalyptol (26.0%), *o*-cymene (25.8%), limonene (8.66%), terpinen-4-ol (5.0%) (Guzman-Gutierrez et al., 2012)
		Leaf	25; 94.2%	1,8-Cineole (36.2%), terpinen-4-ol (10.5%), α-pinene (9.5%), β-pinene (7.3%), linalool (5.0%) (Jimenez-Perez et al., 2011)
L. glutinosa	Bangladesh	Leaf	83; 99.8%	Phytol (22.4%), caryophyllene (21.4%), thujopsene (12.1%) (Chowdhury et al., 2008)
		Fruit	33; 99.0%	Lauric acid (44.8%), 3-octen-5-yne-2,7-dimethyl (28.7%), α-cubebene (6.4%), caryophyllene (5.0%) (Chowdhury et al., 2008)
	India	Leaf	37; 84.6%	9,12-Octadecadienoic acid (62.5%), hexadecanoic acid (12.6%), stigmast-5-en-3-ol (6.8%) (Arunodaya et al., 2016)
		Fruit	28; 90%	(*E*)-β-Ocimene (70.8%), caryophyllene oxide (5.0%) (Choudhury et al., 1996)
	Vietnam	Leaf	37; 92.5%	(*E*)-β-Ocimene (57.4%), α-pinene (7.8%), β-pinene (7.3%) (Son et al., 2014)
L. gracilipes	Malaysia	Leaf	39; 82.8%	Ledene (9.0%), aromadendrene (8.3%), α-copaene (6.8%), calamenene (6.7%), δ-cadinene (6.5%), globulol (6.0%) (Ahmad et al., 2005)
		Stem	NI	Globulol (35.2%), hexan-3-one (25.7%), viridiflorol (11.1%), ledol (6.9%), epiglobulol (5.9%) (Khong, 2006)
L. guatemalensis	Guatemala	Leaf	74; 97.3%	1,8-Cineole (26.8%), α-terpineol (14.5%), linalool (10.8%), terpinen-4-ol (6.8%) (Vallverdu et al., 2005)
	Mexico	Leaf	26; 90.2%	Linalool (21.9%), limonene (16.4%), α-pinene (10.7%), isobornyl acetate (5.7%) (Jimenez-Perez et al., 2011)
L. helferi	Vietnam	Leaf	40; 99.3%	Limonene (17.5%), β-caryophyllene (14.2%), bicyclogermacrene (13.1%), bicycloelemene (12.4%), α-phellandrene (8.0%) (Son et al., 2014)
L. japonica	Japan	Seed	20; 99.9%	Germacrene D (64.5%), caryophyllene (17.6%) (Hiromichi et al., 1978)
		Meso-carp	25; 99.9%	Germacrene D (28.8%), caryophyllene (22.9%), (Z)-β-ocimene (13.6%) (Hiromichi et al., 1978)
L. kostermanin	Taiwan	Leaf	38; 99.6%	α-Pinene (40.0%), camphene (11.6%), β-pinene (11.0%), limonene (8.4%), 1,8-cineole (5.8%) (Cheng and Cheng, 1983)
		Stem	33; 90.5%	(*E*)-β-Ocimene (33.4%), 1,8-cineole (11.8%), α-pinene (10.1%), γ-cardene (8.9%) (Cheng and Cheng, 1983)

Species	Locality	Part	Total components	Major components
L. laevigata	India	Fruit	27; 99.2%	*trans*-α-Bergamotene (26.7%), α-pinene (25.0%), β-pinene (8.2%) (Arif et al., 2008)
L. machilifolia	Malaysia	Stem/root	NI	Cyclohexanemethanol (42.8%), globulol (27.4%), 1*H*-cycloprop(e)azulene (8.6%), 1*H*-cycloprop(e)azulen-7-ol (6.8%), epiglobulol (6.2%), ledol (6.0%) (Khong, 2006)
L. megacarpa	Malaysia	Leaf	NI	Caryophyllene oxide (56.8%), 1*H*-cycloprop(e)azulen-7-ol (29.4%) (Khong, 2006)
L. monopetala	India	Fruit	39; 91.6%	Decanal (26.7%), nonanol (l6.8%) and capric acid (15.5%) (Choudhury et al., 1997)
		Flower	35; 99.6%	α-Caryophyllene alcohol (13.9%), pentacosane (11.4%), caryophyllene oxide (9.5%), humulene oxide (9.5%), tricosane (8.1%) (Choudhury et al., 1997)
		Bark	33; 99.6%	Tetradecanal (30.2%), tridecanol (l1.3%), myristic acid (10.5%), tridecanal (9.4%) (Choudhury et al., 1997)
L. muelleri	Mexico	Leaf	28; 94.9%	1,8-Cineole (19.4%), α-pinene (12.5%), β-pinene (8.5%), α-terpinyl acetate (6.8%), *m*-cymene (5.9%), terpinen-4-ol (5.4%) (Jimenez-Perez et al., 2011)
L. neesiana	Mexico	Leaf	27; 93.3%	Limonene (14.7%), linalool (14.5%), borneol (11.2%), α-pinene (10.1%), camphene (6.3%), nerolidol (5.4%), cis-linalool oxide (5.2%) (Jimenez-Perez et al., 2011)
L. nidularis	Malaysia	Leaf	NI	Acetovanillone (49.6%), methyl vanillate (33.4%) (Mehat, 2008)
L. paludosa	Malaysia	Leaf	36; 92.5%	Ledene (17.8%), aromadendrene (10.3%), elemol (7.7%), globulol (6.4%) (Ahmad et al., 2005)
L. parvifolia	Mexico	Leaf	26; 87.0%	Limonene (16.7%), nerolidol (15.6%), β-eudesmol (11.6%), linalool (8.8%), 1,7-octadien-3-ol acetate (5.6%) (Jimenez-Perez et al., 2011)
L. petiolate	Thailand	Leaf	74; 96.9%	2-Undecanone (79.5%), 12-tridecen-2-one (6.2%) (Thongthip et al., 2017)
L. pringlei	Mexico	Leaf	24; 85.0%	1,8-Cineole (21.1%), linalool (14.3%), caryophyllene oxide (9.9%) (Jimenez-Perez et al., 2011)
L. quinqueflora	India	Leaf	56; 97.3%	β-Elemene (16.0%), β-caryophyllene (13.3%), decanal (6.5%) (Irulandi et al., 2016)
L. resinosa	Malaysia	Leaf	36; 95.5%	Bulnesol (14.9%), β-caryophyllene (10.2%), β-elemene (10.2%), caryophyllene oxide (7.8%), α-copaene (6.0%), γ-muurolene (5.2%) (Ahmad et al., 2005)
		Leaf	NI	2-Naphthalenemethanol (30.1%), 2*H*-benzocyclohepten-2-one (26.6%), globulol (19.3%), 1-naphthalenemethanol (9.3%), viridiflorol (9.2%), 1*H*-benzocyclohepten-7-ol (5.2%) (Khong, 2006)
		Stem, root	NI	2-Naphthalenemethanol (54.2%), 2*H*-benzocyclohepten-2-one (19.5%), 1-naphthalenemethanol (16.3%), agarospirol (6.8%) (Khong, 2006)
L. rigidularis	Malaysia	Leaf	NI	Tricosane (53.9%), methyl vanillate (32.2%), phytol (31.8%) (Mehat, 2008)
L. schaffneri	Mexico	Leaf	22; 95.8%	1,8-Cineole (23.7%), α-pinene (11.9%), linalool (11.4%), borneol (8.2%), *m*-cymene (7.2%), terpinen-4-ol (6.8%), α-terpineol (6.4%), β-pinene (6.0%) (Jimenez-Perez et al., 2011)
L. sessilis	Malaysia	Leaf	NI	Pentadecanal (23.8%), bicyclo-(4,4)-dec-1-ene (19.6%), tetradecanal (18.78%), tridecanal (8.2%), 2-nonadecanone (5.9%) (Khong, 2006)
L. verticillata	Vietnam	Leaf	48; 95.0%	Linalool (23.4%), α-pinene (26.1%), β-pinene (11.7%) (Son et al., 2014)

*NI - no information

Biological Activities

Antimicrobial activity

Cruz et al. (2014) reported activity of three *Litsea* species from Guatemala: *L. glaucescens, L. guatemalensis* and *L. neesiana*. All tree oils showed significant activity against *Mycobacterium smegmatis* and *Bacillus subtilis* with MIC values of 0.16 mg/mL. Qin et al. (2018) reported that the leaves oil of *L. coreana* from China exhibited the best activity against *Escherichia coli* (156.25 μg/mL), *Staphylococcus aureus* (156.25 μg/mL), *Salmonella typhimurium* (156.25 μg/mL), *Shigella flexneri* (156.25 μg/mL), *Micrococcus tetragenus* (312.50 μg/mL), and *Bacillus subtilis* (625 μg/mL). Ho et al. (2011) reported that the leaves oils of *L. akoensis* from Taiwan had excellent antimicrobial activities against *Candida albicans, Bacillus cereus, Staphylococcus aureus* and *Staphylococcus epidermidis*, with MIC values of 31.25 μg/mL, each. The essential oil of the fruits of Indian *L. laevigata* showed the best activity against *Streptococcus albus* with inhibition zone diameter of 60 mm (Arif et al., 2008). The Indian *L. glutinosa* stem bark oil showed significant activity against *Vibrio cholera* and *Salmonella typhi* with MIC values of $0.15\pm0.15\times10^{-2}$ and $1.30\pm0.20\times10^{-2}$ mg/mL, respectively (Arunodaya et al., 2016). The essential oil of *L.*

petiolata leaves from Thailand showed good antibacterial activity against tested human pathogenic bacteria including *Escherichia coli* (MIC 31.25 µg/mL), *Salmonella typhimurium* (MIC 125 µg/mL), and *Vibrio parahaemolyticus* (MIC 125 µg/mL) (Thongthip et al., 2017).

Antioxidant activity

The Indian *L. glutinosa* stem bark oil showed significant *in vitro* antioxidant property in DPPH radical scavenging (IC_{50} value 4.5 ± 0.06 µg/mL), ABTS (IC_{50} value 256.0±0.06 µg/mL), and β-carotene bleaching assay (I%: 78.5 ± 0.42%) (Arunodaya et al., 2016). Qin et al. (2018) reported the antioxidant activity of the leaves oil of *L. coreana* from China. Using the DPPH assay, the radical scavenging activity of the oil collected from Pingshan gave IC_{50} value of 0.71 mg/mL, which was stronger than BHT (IC_{50} 0.76 mg/mL) (Qin et al., 2018), while potent radical scavenging activity using ABTS assay was 78.67 mg TEs/g. The oil collected from Ningguo showed the strong reducing power of 26.06 mg Fe^{2+}/g using the FRAP assay. The leaf and twig oils of *L. akoensis* from Taiwan were tested for their DPPH free radical scavenging capability. The IC_{50} of the DPPH free radical scavenging capability of the leaf and twig essential oils was 68.5 > 2000 µg/mL, respectively. The results demonstrated clearly that leaf oil had antioxidant activities superior to those of twig oil (Ho et al., 2011).

Toxicity activity

The acute and subacute toxicities of *L. elliptica* leaves oil from Malaysia were administrated orally by gavage to female Sprague-Dawley rats. In the acute toxicity study, *L. elliptica* essential oil caused dose-dependent adverse behaviors and mortality. The median lethal dose value was 3 488.86 mg/kg and the acute non-observed-adverse-effect level value was found to be 500 mg/kg. The subacute toxicity study of *L. elliptica* essential oil did not reveal alterations in body weight, and food and water consumption (Budin et al., 2012). The toxic effects of *L. elliptica* essential oil from Thailand, against Sprague-Dawley rat's red blood cells (RBCs) were reported by Taib et al. (2009). The essential oil was given by oral gavage five times per week for three treated groups in the doses of 125, 250, and 500 mg/kg of body weight. Although *L. elliptica* essential oil administration had significantly different effects on hemoglobin (Hb), mean cell hemoglobin concentration (MCHC), mean cell volume (MCV), and mean cell hemoglobin (MCH) in the experimental groups as compared to the control group, the values were still within the normal range. *L. elliptica* induced morphological changes of RBC into the form of echinocyte. However, the RBC membrane osmotic fragility and total proteins of RBC membrane findings did not differ significantly between control and treated groups. Contact toxicity of essential oils of *L. pungens* from China was assessed against third-instar *Trichoplusia ni* larvae via topical application. The oil showed moderate activity with LD_{50} values of 87.1 µg/larva (Jiang et al., 2009).

α-Glucosidase activity

The α-glucosidase inhibitory effects of the leaves oil of *L. coreana*, collected from Ningguo, Mingshan, and Wuxi, China has the potential as a natural hypoglycemic agent with IC_{50} values of 1.71, 2.64, and 3.88 mg/mL, respectively (Qin et al., 2018).

Cytotoxicity activity

The cytotoxicity activity of the leaves oil of *L. coreana*, collected from Ningguo, China showed the best activity to all the three cell lines, HCT116, HepG2, and MCF7, with IC_{50} values of 77.03, 71.60, and 66.03 µg/mL, respectively (Qin et al., 2018).

Conclusion

In the present article, we reviewed the relevant literature to congregate the medicinal uses, chemical composition, and bioactivities information on the *Litsea* essential oils. The diversity of quantitative and qualitative components observed could be due to the genetic differences or to the environmental conditions of the plant material, based on different geographic locations. To unravel the full therapeutic potential of *Litsea* species, more pharmacological investigations into other pharmacological activities should be performed. Furthermore, preclinical analyses, as well as clinical trials, as conducted for essential oils from other species, are required to evaluate the potential of essential oils from *Litsea* species for drug development.

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References

Agrawal N., Choudhary A.S., Sharma M.C., Dobhal M.P. (2011). Chemical constituents of plants from the genus *Litsea*. Chem Biodivers 8(2): 223-243.

Ahmad F., Jantan I., Bakar B.A., Ahmad A.S. (2005). A comparative study of the composition of the leaf oils of three *Litsea* species from Borneo. J Essent Oil Res 17(3): 323-326.

Arif M.M., Raj S.M., Jirovetz L., Shafi M.P. (2008). Composition and antimicrobial analysis of the essential oil of *Litsea laevigata* Nees. (Lauraceae). Nat Prod Commun 3(7): 1069-1072.

Arunodaya H.S., Krishna V., Shashikumar R., Girish Kumar K. (2016). Antibacterial and antioxidant activities of stem bark essential oil constituents of *Litsea glutinosa* C.B.Rob. Int J Pharm Pharm Sci 8(12): 258-264.

Baul T.K., Hossain M.M., Mezbahuddin M., Mohiuddin M. (2011). Vegetative propagation of *Litsea monopetala,* a wild tropical medicinal plant: Effects of indole-3-butyric acid (IBA) on stem cuttings. J For Res 22(3): 409-416.

Budin S.B., Ain S.M.S.N., Omar B., Taib I.S., Hidayatulfathi O. (2012). Acute and subacute oral toxicity of *Litsea elliptica* Blume essential oil in rats. J Zhejiang Univ-Sci B 13(10): 783-790.

Cheng M., Cheng Y. (1983). Compositions of the essential oils of *Litsea kostermanin* Chang, *Litsea gerciae* Vidal and *Litsea cubeba* (Lour.) Persoon. J Chinese Chem Soc 30(1): 59-62.

Choudhury S.N., Singh R.S., Ghosh A.C., Leclercq P.A. (1996). *Litsea glutinosa* (Lour.) C.B. Rob. A new source of essential oil from Northeast India. J Essent Oi1 Res 8(5): 553-556.

Choudhury S.N., Ghosh A.C., Choudhury M., Leclercq P.A. (1997). Essential oils of *Litsea monopetala* (Roxb.) Pers. A new report from India. J Essent Oil Res 9(6): 635-639.

Choudhury S., Ahmed R., Barthel A., Leclercq P.A. (1998). Composition of the stem, flower and fruit oils of *Litsea cubeba* Pers. from two locations of Assam, India. J Essent Oil Res 10(4): 381-386.

Chowdhury J.U., Bhuiyan M.N.I, Nandi N.C. (2008). Aromatic plants from Bangladesh: Essential oils of leaves and fruits of *Litsea glutinosa* (Lour.) C.B. Robinson. Bangl J Bot 37(1): 81-83.

Corner E.J.H. (1988). Wayside Trees of Malaya. 3rd ed. United Selangor Press. Kuala Lumpur: Malaysia.

Corner E.J.H. (1997). Wayside Trees of Malaya. 4th Edition, United Selangor Press, Kuala Lumpur: Malaysia.

Cruz S.M., Marroquin M.N., Gaitan I.C., Caceres A. (2014). Antimicrobial activity of essential oils and ethanolic extracts of three species of Laurel (*Litsea* spp.) from Guatemala. Acta Hortic 1030(1): 23-29.

Dai D.N., Lam N.T.T., Dung N.A., Huong L.T., Chau D.T.M., Ogunwande I.A. (2019). Composition of essential oils from *Litsea acutivena* Hayata. Amer J Pl Sci 10(4): 615-621.

Delectis Florae Reipublicae Popularis Sinicae Academiae Sinicae Edita (1982). Flora Reipublicae Popularis Sinicae, Tomus 32. Science Press, Beijing, China.

Editorial Committee of Zhonghua Bencao National Traditional Chinese Herb Administration (1999). Zhonghua Bencao. Shanghai Scientific and Technical Publishing House, Shanghai.

Ghosh M., Sinha B. (2010). GC-MS studies on the bark extracts of *Litsea polyantha* Juss. Middle East J Sci Res 5(6): 441-444.

Grosvenor P.W., Gothard P.K., McWilliam N.C., Supriono A., Gray D.O. (1995). Medicinal plants from Riau Province, Sumatra, Indonesia. Part 1: Uses. J Ethnopharmacol 45(2): 75-95.

Guzman-Gutierrez S.L., Gomez-Cansino R., Garcia-Zebadua J.C., Jimenez-Perez N.C., Reyes-Chilpa R. (2012). Antidepressant activity of *Litsea glaucescens* essential oil: Identification of β-pinene and linalool as active principles. J Ethnopharmacol 143(2): 673-679.

Hiromichi N., Iwakiri M., Kubota T. (1978). The constituents of the essential oil from *Litsea japonica* (Thunb.) Juss. fruit. Agric Biol Chem 42(8): 1601-1603.

Ho C.L., Lin C.Y, Wang E.I., Su Y.C. (2011). Composition, antioxidant and antimicrobial activities of leaf and twig essential oils of *Litsea akoensis* from Taiwan.. Nat Prod Commun 6(6): 901-904.

Huang C., Ma T., Meng X., Lv X., Zhang L., Wang J., Li J. (2010). Potential protective effects of a traditional Chinese herb, *Litsea coreana* levl. on liver fibrosis in rats. J Pharm Pharmacol 62(2): 223-230.

Irulandi K., Kumar S.J., Arun K.D., Rameshprabu N., Swamy P.S. (2016). Leaf essential oil composition of two endemic *Litsea* species from South India. Chem Nat Comp 52(1): 1-3.

Jiang Z., Akhtar Y., Bradbury R., Zhang X., Isman M.B. (2009). Comparative toxicity of essential oils of *Litsea pungens* and *Litsea cubeba* and blends of their major constituents against the cabbage looper, *Trichoplusia ni*. J Agric Food Chem 57(11): 4833-4837.

Jimenez-Perez N.C., Lorea-Hernandez F.G., Jankowski C.K., Reyes-Chilpa R. (2011). Essential oils in Mexican Bays (*Litsea* spp., Lauraceae): Taxonomic assortment and ethnobotanical implications. Economic Bot 65(2): 178-189.

Kala C.P. (2005). Ethnomedicinal botany of the Apatani in the Eastern Himalayan region of India. J Ethnobiol Ethnomed 1(11): 1-11.

Kamle M., Mahato D.K., Lee K.E., Bajpai V.K., Gajurel P.R., Gu K.S., Kumar P. (2019). Ethnopharmacological properties and medicinal uses of *Litsea cubeba*. Plants 8(6): E150.

Khong H.Y. (2006). The essential oils of some *Litsea* species. CSSR.

Khong H.Y., Din L., Zakaria Z., Ismail N.H., Ismail N., Yarm M.A. (2013). A qualitative analysis of *Litsea fulva* essential oils using comprehensive two-dimensional gas chromatography coupled with time-of-flight mass spectrometry. Sains Malays 42: 943-948.

Kong D.G., Zhao Y., Li G.H., Chen B.J., Wang X.N., Zhou H.L., Lou H.X., Rn D.M., Shen T. (2015). The genus *Litsea* in traditional Chinese medicine: An ethnomedical, phytochemical and pharmacological review. J Ethnopharmacol 164: 256-264.

Lim T.K. (2012). Edible Medicinal and Non Medicinal Plants, Vol. 3, Fruits. Springer Science, Netherlands.

Mehat S.I. (2008). Chemical compositions of essential oil from six *Litsea* species. Thesis: Bachelor of Science. Faculty of Resource Science and Technology, Universiti Malaysia Sarawak, Malaysia.

Qin Z., Feng K., Wang W., Wang W., Wang Y., Lu J., Li E., Niu S., Jiao Y. (2018). Comparative study on the essential oils of six Hawk tea (*Litsea coreana* Levl. var. *lanuginosa*) from China: Yields, chemical compositions and biological activities. Ind Crops Prod 124: 126-135.

Richter H. (1981). Anatomie des sekundaeren Xylemsund der Rinde der Lauraceae. Sonderb Naturwiss Vereins Hamburg, Germany.

Salleh W.M.N.H.W., Ahmad F., Khong H.Y., Zulkifli R.M. (2016). Essential oil compositions of Malaysian Lauraceae: A mini review. Pharm Sci 22(1): 60-67.

Son L.C., Dai D.N., Thang T.D., Huyen D. (2014). Analysis of the essential oils from five Vietnamese *Litsea* species (Lauraceae). J Essent Oil Bear Pl 17(5): 960-971.

Taib I.S., Budin S.B., Siti Nor Ain S.M., Mohamed J., Louis S.R., Das S., Sallehudin S., Rajab N.F., Hidayatulfathi O. (2009). Toxic effects of *Litsea elliptica* Blume essential oil on red blood cells of Sprague-Dawley rats. J Zhejiang Univ Sci B 10(11): 813-819.

Thielmann J., Muranyi P. (2019). Review on the chemical composition of *Litsea cubeba* essential oils and the bioactivity of its major constituent's citral and limonene. J Essent Oil Res 31(5): 361-378.

Thongthip P., Atiphasaworn P., Monggoot S., Pansanit A., Pripdeevech P. (2017). *In vitro* antibacterial activity and essential oil composition of *Litsea petiolata* Hook.f. leaves. J Appl Pharm Sci 7(9): 94-98.

Vallverdú C., Vila R., Cruz S.M., Caceres A., Canigueral S. (2005). Composition of the essential oil from leaves of *Litsea guatemalensis*. Flav Fragr J 20(4): 415-418.

Wang H., Liu Y. (2010). Chemical composition and antibacterial activity of essential oils from different parts of *Litsea cubeba*. Chem Biodivers 7(1): 229-235.

Werff H. (1996). Toward an improved classification of Lauraceae. Ann Missouri Bot Gard 83(3): 409-418.

Xie Z., Yu Y. (1996). The Guide of National Chinese Herbal Medicine (I); People's Medical Publishing House, Beijing, China.

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