Litsea cubeba Essential Oil Yield Harvested from Different Habitat Types on Mt. Papandayan, West Java, Indonesia

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Abstract. The objective of this research was to determine the yield and chemical composition of *Litsea cubeba* essential oil harvested from different habitat types on Mount Papandayan, West Java, Indonesia. The methods used were determination of sample plots at each habitat, followed by laboratory testing. Leaf samples were taken from each plot, the oil was extracted in the laboratory using steam distillation, which was subsequently analyzed by GC-MS. The results showed that the yield of essential oil was high (2.76-9.33%). The three dominant chemical compounds found were eucalyptol (16.97-55.78%), α-terpinenyl acetate (7.27-20.44%), and sabinene (14.45-68.05%). The results confirmed the expectation that *Litsea cubeba* essential oils extracted from *Litsea cubeba* trees growing in various habitats on Mount Papandayan would show a variety in yield and chemical composition.

Keywords: *composition; essential oil; Litsea cubeba; site types; varieties.*

1 Introduction

Litsea cubeba Lour. Persoon is a small to medium-sized tree that belongs to the Lauraceae family. Its Indonesian name is *kemukus* and local names are *ki lemo* or *lemo* (West Java), *krangean* (Central Java), and *attarasa* (North Sumatera). In China, it is known as *may chang* [1,2]. Products from the tree have multiple applications [3,4]. Each part of the tree has high economical value, from its wood, bark, branches, leafs, fruit, and flowers to its roots [4,5-7]. It is well known as a potential source of essential oil for industrial products such as cosmetics (aroma therapy), soap, perfume, skin cleaner, and acne medicine. Essential oil from this tree is also the source of an agent that is believed to be a carcinostatic (anti-cancer). Other applications of *L. cubeba* essential oil are: bio-insecticides and anti-termite agents [8,9], antimicrobe active alkaloid

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isoquinoline is used as a traditional medicine [10], antibacterial agent [11,12], and antioxidant [13]. A research in Thailand showed that essential oil from *L. cubeba* can be used as a repellent for the *Aedes aegypti* mosquito [13].

On Mount Papandayan, *L. cubeba* grows in various habitats. It is assumed that the amount and quality of the essential oil produced by *L. cubeba* varies depending on the substrate on which it grows. To confirm this assumption, it was necessary to conduct research to find out the contents of the essential oils taken from *L. cubeba* trees growing in different habitats.

This study was exciting to conduct because only a limited number of studies have examined the variation of essential oil from *L. cubeba* trees from different natural habitats. Several studies have been carried out in different habitats, including Mount Ciremai West Java (6), North Sumatra (15) and China (16), but these did not specifically address habitat variation and its relationship with the contents of the essential oil.

Litsea cubeba has never been cultured on a large scale. It grows mainly in natural forests, especially in highlands. The tree is threatened by human exploitation. Its culture is urgently needed for conservation of the species and for supporting the essential oil industry.

The objective of this research was to determine the production of essential oil from *L. cubeba* leafs harvested from various habitats on Mount Papandayan, West Java, Indonesia. The results were expected to provide information about the yield and contents of the essential oil taken from the different habitats.

2 Methodology

Two methods were used in this research: field exploration and observation, followed by laboratory testing. The determination of sample plots was conducted by purposive sampling based on: 1. stratum (based on land system map); 2. four types of terrain type; 3. altitude; 4. topography (steep/sloping/ ridge).

Leaf samples of *L. cubeba* were obtained from 15 different habitats, where every habitat was represented by one plot that contained at least one mature tree with a minimum diameter of 20 cm. The leafs were cut from the top of the twigs along 30 cm in all wind directions and canopy positions (top, middle and bottom). 400 g of mixed leaf samples were distilled to obtain essential oil.

Extraction of the essential oil from the leaf samples was conducted by steam distillation for 2 hours or until the essential oil was fully extracted. The leaf samples were dried by air-drying before distillation. Each distillation needed 200 g of air-dried leaf samples and the distillation was carried out in duplo. The following step was to determine the contents and composition of the essential oil by GC-MS analysis (Agilent Technologies GC System (GC 7890 and 5975 C XLEI/CI MSD)) at 250°C. The temperature of the MS detector was 28°C [14]. The results indicate the variability of the essential oil and its composition from the samples taken from the different habitats.

3 Results and Discussions

3.1 Habitat Variation

Based on a field survey, *L. cubeba* trees growing at 15 various habitats with different population sizes were selected (Table 1). All habitats were located between 1000 to 2500 m above sea level, ranging from flat to very steep, and were previously disturbed by illegal logging or forest fires.

Table 3 Habitats of *L. cubeba* on Mount Papandayan.

Code	Name of location	Altitude (m above sea level)	Topography	Landscape	Land cover
H1	Sorok Teko/Tgl Puspa	1919-1956	Sloping-slightly steep	Cliff	Forest fire debris
H2	Gn Walirang	1617-2058	Flat-very steep	Cliff-Ridge	Bush
H3	Puntang/S. Cibeureum	2040	Very steep	Cliff river/ravine	Forest fire debris
H4	Bungbrun	2169	Flat-sloping	Plateau at the top of the hill	Forest fire debris
H5	Pada Awas/Lutung-Pondok Serok	2044	Steep-very steep	Cliff/ravine	Forest fire debris
H6	Pada Awas/Tibet-Lutung	2100	Steep-very steep	Cliff/ravine	Forest fire debris
H7	Tegal Bungbrun	2300	Sloping	Ridge	Young secondary forest
H8	Lembah Cibeureum	2161-2160	Sloping	Plateau	Young secondary forest
H9	Lutung	2040	Steep	Cliff	Young secondary forest
H10	Tibet	2100	Sloping	Plateau	Gap/hiatus
H11	Lereng Curug Angklong	2100	Sloping	Plateau	Bush
H12	Batu Kasang	1882	Slightly steep	Ridge	Young secondary forest
H13	Batu Kasang 2	2030	Very steep	Cliff/ravine	Gap/hiatus
H14	Lembah Puntang/Supa beureum	2157	Flat	Valley	Young secondary forest
H15	Tgl Panjang	2041	Slightly steep	Cliff	Gap/hiatus

Litsea cubeba generally grows within a temperature range of 16-26.3°C (with an average temperature of 19.24°C), a humidity range of 60-95%, and light intensity range of 300-85600 lux. The habitats on Mount Papandayan are colder and more humid compared to those in North Sumatra, another natural distribution area of *Litsea cubeba* in Indonesia apart from West and Central Java [15].

These observations show that *L. cubeba* can grow in open spaces with various disturbed habitats and has great potential for use as a pioneer tree [15].

3.2 Yield of Essential Oil

The results of the distillation process showed variation in the essential oil content of the *L. cubeba* leafs harvested from the 15 different habitats (Table 2). The resulting essential oils were either yellowish or colorless and had a pungent smell like citrus mixed with eucalyptus oil (Figure 1).

Table 4 Distillation results of essential oil of *L. cubeba* harvested from 15 habitats.

Sample code	Water content (%)	Weight of essential oil	Yield (%)
H4	25	18.65	9.33
H13	71	18.50	9.25
H3	31	17.85	8.93
H8	36	16.33	8.16
H2	25	16.13	8.06
H5	40	15.55	7.77
H7	21	15.04	7.52
H1	9	14.30	7.15
H6	43	13.88	6.94
H9	27	13.82	6.91
H12	72	13.62	6.81
H11	56	11.08	5.54
H15	57	10.24	5.12
H10	60	9.84	4.92
H14	56	4.27	4.27

Table 2 shows that the yield of essential oil ranged from 2.76 to 9.33%. The maximum yield in this research was higher than the extraction result of similar leafs originating from Mount Ciremai (5.4%) [6] and China (4.56%) [16].

Among all the locations, the leafs collected from locations H4 and H13 had the highest yield, followed by locations H3, H2, and H8. Further analysis showed that the essential oil yield was not affected by altitude, topography, or landscape factors but only by land cover conditions.

The resuls showed that burnt bush and forest fire debris land cover types tended to have a higher yield compared to other land cover types. This is probably due to the different level of environmental stress received by *L. cubeba*. Habitat stress, such as limited nutrition in the soil, can increase the production of flavanoid as secondary metabolite [17]. This implies an increase of the chemical compounds in the plant. Further research on soil characteristics is needed to explain this phenomenon.

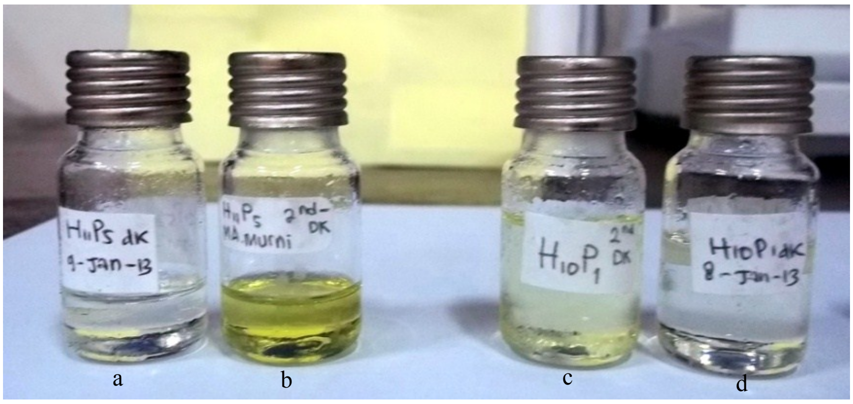

Figure 1 Color variations of *L. cubeba* essential oils originating from Mt. Papandayan–(a) and (d): examples of colorless essential oil; (b) and (c): examples with a yellowish color.

3.3 Chemical Composition of Essential Oil

GC-MS analysis showed that the chemical composition of the essential oil extracted from *L. cubeba* leafs from different habitats was similar, but was different in abundance of each chemical compound (Table 3).

Overall, 16 chemical substances were identified in the leaf extracts, with 8 chemical substance compounds found in all leaf samples, i.e. α-pinene, (-)-sabinene, 2-β-pinene, β-myrcene, D-limonene, eucalyptol and α-terpinenyl acetate. There were specific chemical compounds that were found only in a specific habitat, i.e. linalool found only in the leaf samples from locations H1 and H15, and α terpineol found only in the leaf sample from location H12.

Table 3 Chemical composition of essential oil of *L. cubeba* growing in different habitats.

Name of chemical compound	Abundance (Peak Area (%))														
	H1	H2	H3	H4	H5	H6	H7	H8	H9	H10	H11	H12	H13	H14	H15
-phellandrene	0.48	0.51	0.48	0.23	0.51	0.46	0.56	0.54	0.44	-	-	-	0.50	0.50	0.48
-pinene, (-)-	4.58	4.46	4.63	2.28	4.53	4.48	5.03	4.78	4.40	4.39	4.21	4.14	4.84	4.63	4.41
Sabinene	15.78	15.99	15.56	68.05	15.74	16.05	16.33	16.07	14.81	15.51	14.45	15.22	16.54	15.28	15.14
2- -pinene	4.00	3.89	4.02	1.70	4.00	3.97	4.31	4.02	4.04	3.83	3.75	3.81	4.05	3.81	3.69
-myrcene	1.10	1.24	1.00	0.55	1.07	1.07	0.99	1.24	1.13	0.99	0.89	1.00	1.21	1.09	1.19
D-limonene	4.64	4.00	3.78	1.74	2.09	4.25	2.82	3.99	4.93	3.90	4.94	3.10	4.59	4.26	3.58
Eucalyptol	52.00	46.91	51.46	16.97	52.60	52.79	51.64	49.01	51.79	54.29	54.80	55.78	51.23	48.03	47.12
1,4-cyclohexadiene, 1-methyl-4-(1-methylethyl)-		0.29		0.12				0.42	0.35	-	-	-	-	-	0.37
Cis-sabinene hydrate	0.53	0.60		0.23	0.63	0.64		0.53	0.58	0.74		0.77	0.82	0.66	0.62
Linalol	1.51								-	-	-	-	-	-	0.52
4-terpineol		0.41		0.16				0.50	0.47	-	-	-	-	-	-
terpineol									-	-	-	2.71	-	-	-
Ocimenyl acetate	0.95			0.54	1.12	0.97	1.00	1.22	1.10	0.88	0.93	0.74	1.02	1.31	1.45
Terpinyl acetate (CAS)		1.41	1.10						-	-	-	-	-	-	-
-terpinenyl acetate	14.43	19.81	17.95	7.27	17.21	15.31	17.34	17.08	15.97	14.94	16.03	12.13	15.21	20.44	20.96
Caryophyllene		0.51		0.17	0.52			0.58	-	0.53	-	0.60	-	-	0.46

This research found three dominant chemicals in the extracted oil, i.e. eucalyptol (16.97-55.78%), α-terpinenyl acetate (7.27-20.44%), and sabinene (14.45-68.05%).

These dominant chemical compounds are different from those found through research conducted in other areas. For example, the abundance of dominant chemical compounds of the *L. cubeba* essential oil from: (i) Cikole West Java – sineol (56.61%) and citronellol (12.26%) [4]; (ii) Mount Ciremai West Java – sineol (56.61%), β-pinen (14.54%), and citronellol (12.28%) [7]; (iii) Thailand – sabinene (42.69%), 1.8 cineole (18.32%), and β-pinene (6.15%) [18]; (iv) China – monoterpenes (94.4-98.4%), represented mainly by neral and geranial (78.7–87.4%) [16]; (v) Zhao [19] showed that the dominant chemical compounds were citral, eucalyptol, citronellol, 6-octenal, 3,7-dimethyl-2,6 octadien-1-ol (geraniol alcohol), and so on. Wang & Liu [12] discovered that the dominant chemical compounds were citral B (neral), β-phellandrene, and β-terpinene.

This research showed that the variety in chemical composition of the investigated samples of essential oil of *L. cubeba* was quite high. This condition is presumed to be affected by factors in the different habitats. Therefore, further research is needed to understand the ecological preference and its relation to the chemical composition of *L. cubeba*, which in turn may support the culture of *L. cubeba*.

4 Conclusions

Litsea cubeba has a tendency to grow well in open spaces with various land covers that have been disturbed. The yield variation of the essential oil produced by *L. cubeba* in different habitats tends to be high. The highest yield of essential oil was obtained from locations H4 (a burnt area): 9.33% and H13 (an ex-encroachment area): 9.25%, while the lowest yield was found in a dead forest: 4.27%.

In general, it can be concluded that there is a tendency that burnt areas and ex-encroachment areas produce the highest yield of essential oil. Higher environmental stress results in a higher yield of essential oil. The three dominant chemical compounds found were, i.e. eucalyptol (16.97-55.7%), terpinenyl acetate (7.2- 20.44%), and sabine (14.45-68.05%).

Further research is needed to learn more about the ecological preference and its relation to the chemical compounds of essential oil from *L. Cubeba*.

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