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Phytochemical screening and GC-MS analysis of bioactive compounds of *Blumea balsamifera* leaf extracts from South Aceh, Indonesia

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Abstract. *Masyudi, Hanafiah M, Rinidar, Usman S, Marlina. 2022. Phytochemical screening and GC-MS analysis of bioactive compounds of* Blumea balsamifera *leaf extracts from South Aceh, Indonesia. Biodiversitas 23: 1344-1352. Blumea balsamifera* is a traditional herbal medicine that has been used worldwide. It is also known as Capa leaf in Aceh, Indonesia. *B. balsamifera* has been used by the local community for wound healing, anti-bacterial, and anti-inflammation. However, there is no study so far attempting to identify the chemical compounds of *B. balsamifera* leaves from Aceh. The present study thus aimed to analyze the chemical compounds of *B. balsamifera* leaves from Aceh. In this study, the *B. balsamifera* leaves were collected from Gunongpulo village, South Aceh, Indonesia. The extraction process was performed using the maceration method. The active chemical compounds in the *B. balsamifera* leaf extracts with n-hexane, ethyl acetate, and ethanol solvents were analyzed through phytochemical screening, Fourier Transform Infrared (FTIR) Spectroscopy Analysis and GC-MS. The results showed that *B. balsamifera* leaf extracts with ethanol and ethyl acetate solvents contain saponins, flavonoids, phenolics, tannins, and steroids, identified through the phytochemical screening. Meanwhile, the extract of *B. balsamifera* leaves with n-hexane solvent was found to contain steroids, phenolics, and tannins. Twenty-four chemical compounds in the *B. balsamifera* leaf extract with ethanol were identified using GC-MS. Twenty-eight and twenty-seven chemical compounds were also identified in the *B. balsamifera* leaf extracts with ethyl acetate and n-hexane solvents, respectively. The most abundant compounds found in the *B. balsamifera* leaf extracts with ethanol, ethyl acetate, and n-hexane solvents were 2,5-Dimethoxyacetophenone (11.61%), Borneol (14.48%), and Jasmoline (14.32%), respectively. These compounds are members of the flavonoid group which are effective for antibacterial, anti-inflammation, and wound healing applications.

Keywords: *Blumea balsamifera*, chemical compounds, GC-MS, phytochemical screening

INTRODUCTION

Herbal medicines are recognized to be the primary source of traditional drug therapy for human illness in Indonesia (Abu-Rabia 2005; Asmilia et al. 2020). As reported by the WHO, many people have been using traditional herbal medicines for health care (Igoli et al. 2005). The medicinal properties of a plant depend on the physiologically active biochemical compounds called secondary metabolites (Yuan et al. 2016; Hussein et al. 2018; Kavitha and Nadu 2021). In the last two decades, the pharmaceutical industry has made large-scale investments in chemical and pharmacological research to find much more effective medicines (Kumar et al. 2013). Herbal medicines continue to be significant therapeutic agents, both in traditional and modern medicines (De et al. 2013; Thillaivanan and Samraj 2014). The major reason for the continued use of herbal remedies is their usefulness, easy availability, low price, and moderately low or no toxic properties (Welz et al. 2018). It can act on the body with the same effects as pharmaceutical drugs and helps the body start healing itself (Cowan 1999; Valliammai et al. 2020). Some bioactive compounds have been explored and isolated for pharmacological agents (Virganita 2009; Tamasi 2021). The phytochemical components have been utilized as therapeutic agents (Usaizan et al. 2014). Basic compositions of more complex semisynthetic chemical compounds are also derived from phytochemical compounds of plants (Hariharan and Subburaju 2012). Unfortunately, statistics show that the demand for medicinal plants is increasing; thus, exploring new sources is encouraged (Umer et al. 2013; Ekor 2014; Singh et al. 2018).

Blumea balsamifera, known as Capa leaf in Aceh, has been used as traditional medicine for a long time in Indonesia, China, Philippines, Thailand, Malaysia, and Vietnam (Chu et al. 2013; Masyudi et al. 2019). *B. balsamifera* is the most valuable member of the genus *Blumea* and is an original plant of tropical and subtropical countries. The plant is a small tree that emits a strong camphorous odor and can grow up to 3-4 m in the waysides, fields, forest edges, under forests, lowlands, river beds, grasses, valley, and mountainous regions (Pang et al. 2014). Several studies on the chemical constituents of *B.*

balsamifera have reported the presence of some substances from the flavonoid, sesquiterpenoid, and triterpenoid groups in *B. balsamifera* (Shirota et al. 2011; Chu et al. 2013).

Blumea balsamifera leaves have been utilized as raw traditional medicine by many local communities. However, the phytochemical compounds have not yet been identified. The current study thus has several benefits: (i) It can be used as a reference for public and medical practitioners to cure wounds, and (ii) It can be a reference for other researchers to conduct further research in the pharmaceutical field.

This study was conducted to isolate, explore, and identify the bioactive chemical compounds in *B. balsamifera* leaf extracts using three organic solvents and a qualitative phytochemical screening test, FTIR, and GC-MS analysis.

MATERIALS AND METHODS

Study location

Blumea balsamifera leaves as the samples of the study were collected from Gunongpulo Village, South Aceh District, Aceh, Indonesia (Figure 1). The research was carried out from September to December 2020.

Materials

The main materials used for this research were *B. balsamifera* leaves from Gunongpulo Village, South Aceh, ethanol, ethyl acetate, n-hexane solvent, 10% hydrochloric acid, NaCl, FeCl3, aquadest, and the reagent for Phytochemical screening. Other materials and tools used in this research were described in detail in the research procedure.

Sample collection

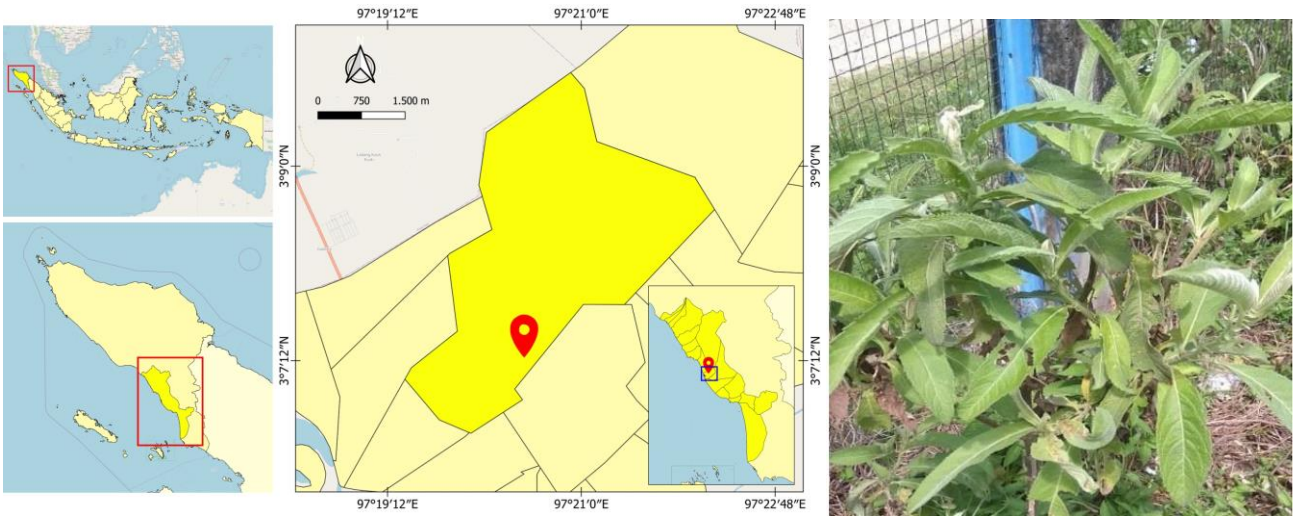
The samples were collected at the coordinate of 03°07'13.7"N and 97°20'28.2"E. The exact sampling location is shown in Figure 1A, while the appearance of *B. balsamifera* plants and leaves is shown in Figure 1B. The plants grow wild in the yards of the residents' houses. They were identified as *B. balsamifera* plants because they have typical *B. balsamifera* characteristics, namely a height of more than 4 m, dark green upright round stems with a diameter of 3-5 cm, a hairy and aromatic top of the stem, a single leaf with a length of 6-30 cm and a width of 1.5-12 cm, an oval shape, sharp edges, a slightly rough surface of the leaf's upper part, and a tight and smooth surface of the underside.

Plant determination

Plant determinations were carried out at the Biology Laboratory, Faculty of Mathematics and Natural Sciences of Syiah Kuala University, Banda Aceh, and the result showed that the plants belong to the genus *Blumea* with the species *Blumea balsamifera* L, as stated in the letter of determination result no. B/647/UN11.18.1/TA/00.01.2020. This determination was essential to ensure the correctness of plants used as research samples.

Preparation of simplicia

Simplicia is a natural material in dry form and has not yet undergone any chemical process. In the current study, the simplicia of *B. balsamifera* was prepared using several steps. First, 20 kg of *B. balsamifera* leaves were collected from Gunongpulo Village, South Aceh. The leaves were then cleaned using running water to remove dirt attached to them. Next, they were air-dried without direct sunlight. Last, the dried leaves were mashed using a blender, resulting in 2.4 kg powder.



A **B**

Figure 1. A. The sampling location in Gunongpulo Village, South Aceh District, Aceh, Indonesia. B. The appearance of *Blumea balsamifera* plant and leaves

Preparation of leaf extracts

Two hundred grams of *B. balsamifera* powder were taken and placed in three separate containers. Then, it was immersed in 1000 mL of ethanol, n-hexane, and ethyl acetate through the maceration process for 24 hours. Then, the extracts were filtered using filter paper to obtain a filtrate. The residues were also re-soaked with the solvents and repeated until the solvents were no longer colored. The viscous semi-solid masses were then dried using a vacuum rotary evaporator at 50°C, resulting in 180 g of extract.

Extract characterization

Determination of the water level

Two grams of the extract were taken and put into a porcelain cup that had already been weighed previously. Then, the extracts were put into an oven, dried at 105ºC for 3 hours, cooled in a desiccator, and weighed. The water content was then calculated thoroughly using the following formula: (% b/b) = x 100%.

Total ash determination

Two grams of the extract were taken and put into a porcelain cubicle that had already been weighed, ignited, and heated for 3 hours at a temperature of 600ºC until the ash turned white. The ash was then cooled for 30 minutes in a desiccator until the weight became constant. The calculation of the total ash content of the tested materials is expressed in the following formula (% b/b) = x 100%.

Screening of phytochemical compounds

The extracts were examined for steroids, alkaloids, terpenoids, flavonoids, saponins, phenolic compounds, and tannins. The screening of the phytochemical compounds in the extracts was performed based on the standard method (Pang et al. 2017; Muttakin and Zulfajri 2020).

Alkaloid examination

Fifty hundred milligrams of the extracts were mixed with 1 mL of 2N hydrochloric acid and 9 mL of water. It was then heated on a water bath for 2 minutes, cooled and filtered. Next, 3 drops of the extract were put into three test tubes and mixed with 2 drops of Meyer's, Dragendorf's and Bouchardat's reagent. With the Meyer, a white or yellow curdled precipitate will be formed if there is an alkaloid. Meanwhile, with the Dragendorf, an orange or yellow precipitate will be formed, whereas Bouchardat will form a brown to black curdled precipitate.

Flavonoid examination

Fifty hundred milligrams of the extracts were mixed with 2 mL of ethanol. After that, it was shaken, heated, re-shaken, and filtered. Two-milligram samples and 3 drops of concentrated HCl were then added to each filtrate. The formation of red, orange or green ethanol layer indicated the presence of flavonoids.

Steroid and triterpenoid examination

Fifty hundred milligrams of the extract were mixed with 3 drops of concentrated sulfate (Liebermann-Burchart reagent) and 10 drops of anhydrous acetic acid. Discoloration to blue or green indicated the presence of steroids, while discoloration to orange or purple indicated the presence of triterpenoids.

Tannin examination

Fifty hundred milligrams of the extract were mixed with 1 mL of distilled water, boiled for 15 minutes, cooled, and mixed with 1% drop of perchloride. Discoloration to greenish or brown indicates the presence of tannins.

Saponin examination

Fifty hundred milligrams of the extract were mixed with 2 mL of 25% of NaOH and boiled with 20 mL of water in a water bath. The filtrate was shaken and allowed to stand for 15 minutes. The formation of a stable foam means that there are positive saponins (Endriani 2016).

Fourier transform infrared (FTIR) spectroscopy analysis

The FTIR spectrophotometer (Shimadzu Prestige-21) was used to record the spectra analysis. Ten milligrams of each *B. balsamifera* extract were taken and mixed with 180 mg KBr into a pellet with a size of 2 µm and was recorded in the spectra 400-4000 cm^{-1}.

GC-MS analysis

The GC-MS analysis was performed by looking at each component percentage measured from the relative peak area in the chromatogram. The GC-MS analyses of the three types of *B. balsamifera* extracts were performed using the GC-MS equipment (Agilent Technologies 7890A), Gas Chromatograph with AutoSampler 5975A, Mass Selective Detector, and Chemstation data system. A total of 5 µL of the filtered *B. balsamifera* leaf extracts was injected into GC-MS using helium (He) as a carrier gas through a capillary column with constant pressure and a total rate of 1,2 mL/min and a split ratio of 8:1 psi. The injector was at the temperature of 250ºC, the detector temperature at 230ºC, and the operating temperatures at 280ºC and 140ºC. The eluted component was detected using a mass detector. The mass spectrum fragmentation patterns were compared with the spectrometer database from the National Institute of Standards and Mass Spectral Technology (NIST-MS).

Data analysis

The data were presented in pictures and tables. They were accumulated and analyzed descriptively.

RESULTS AND DISCUSSION

Simplicia characterization

The results of the characteristic test of *B. balsamifera* leaf simplicia showed that its water content was 6.44%, which met the water requirement for a simplicia. According to Depkes RI (2000), the appropriate water content of a simplicial is no more than 10%. If the water content is more than 10%, microorganisms and fungi can grow easily. Meanwhile, the appropriate ash content of a *B. balsamifera* leaf simplicia is 5.5%, with the maximum level

of ash content being no more than 11%. The determination of ash content is important to determine the characteristics of the remaining non-organic ash content after the ashing process. The ash content should have a small value because this parameter indicates the presence of heavy metal contamination resistant to high temperatures (Depkes RI 2000).

Table 1. The characteristics of *Blumea balsamifera* leaf simplicia

Simplicia characterization	%
Water content	6,44
Ash content	5,50

Table 2. The characteristics of *Blumea balsamifera* leaf extract

Extracts characterization	Ethanol	N-hexane	Ethyl acetate
Water content	2,1%	2,8 %	3,15%
Ash content	1,35%	1,44%	2,34%

Table 3. Phytochemical compounds of *Blumea balsamifera* leaf extract

Chemical compounds	Ethanol	N-hexane	Ethyl acetate
Alkaloids	-	-	-
Steroids	+	+	+
Terpenoids	-	-	-
Saponins	+	-	+
Flavonoids	+	-	+
Phenolics	+	+	+
Tannins	+	+	+

Note: (+) active compounds, (-) non-active compound

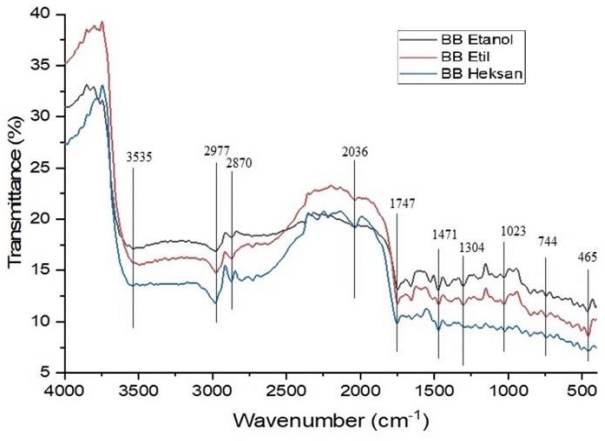


Figure 2. FTIR spectrum of *Blumea balsamifera* leaves extracts from Aceh - Indonesia

Extract characterization

The results of the characteristic test of *B. balsamifera* leaf extract showed that the water content in the ethanol extract, n-hexane extract, and ethyl acetate extract was 2.1%, 2.8%, and 3.15%, respectively. Similar to the water content of simplicia, the water content of the extracts should also be no more than 10% to prevent fungi and microorganisms from growing. The total ash content of the ethanol extract, n-hexane extract, and ethyl acetate extract was 1.35%, 1.44% and 2.34%. The total ash content found in *B. balsamifera* leaf was in accordance with the standard amount of ash required in a *B. balsamifera* leaf.

Phytochemical analysis

The results of the phytochemical screening of *B. balsamifera* leaf extracts were distinguished by the types of solvents used during the extraction process. The solvents used in this study were ethanol, n-hexane, and ethyl acetate. The phytochemical compounds of each solvent were presented in Table 3. The findings showed that the phytochemical compounds of *B. balsamifera* leaf extract with ethanol were not different from the compounds of *B. balsamifera* leaf extract using ethyl acetate. They both contained saponins, flavonoids, phenolics, tannins, and steroids. Meanwhile, the active compounds of *B. balsamifera* extract using n-hexane were steroids, phenolics, and tannins. These *B. balsamifera* leaves can be an alternative for wound healing because they contain active compounds, such as alkaloids, saponins, flavonoids, and tannins (Dachriyanus 2004; Pang et al. 2014).

Table 3 shows that the n-hexane extract of *B. balsamifera* contains steroids, phenolics and tannin, which are different from the ethanol and ethyl extracts of *B. balsamifera* that contain a large number of bioactive compounds. Huang et al. (2010) identified the phytochemical contents of *B. balsamifera* from China, namely flavonoid, alkaloid, streroid, tannin, and glycoside. Isnawati et al. (2006) reported that the phytochemical contents of *B. balsamifera* plants from Malang, Tawangmangu, and Bogor are tannin and flavonoid. In a study conducted by Pang et al. (2017), it was revealed that the phytochemical contents of *B. balsamifera* from china are essential oil, flavonoid, alcohol, dihydroflavonol, sterol, organic acid, monoterpene, sesquiterpene, triterpenoid.

FTIR analysis

The FTIR analysis of the *B. balsamifera* extracts using ethanol, n-hexane and ethyl acetate showed strong absorption at a wavenumber of 2927 and 2870 cm^{-1}. It was strengthened by the absorption of wavenumbers of 1471 and 1474 cm^{-1}, indicating the C-H functional group. This wavenumber was assumed to originate from steroid and saponin compounds.

Uptake at wave number 1747cm^{-1} indicates C=O, which was assumed to derive from tannins. The absorption band at a wavenumber of 1023, 1029 and 1304 cm^{-1} represent C-O ether group presence, whereas the absorption at a wavenumber of 1471 cm^{-1} with low intensity indicates the O-H groups presence, assumed to come from the flavonoid compounds.

The O-H functional groups, C-H alkane, C=C cycloalkane, and C-O indicate the presence of flavonoid compounds. The existence of vibrations in the wavenumber of 1023 cm^{-1} was the absorption of C-N. This was strengthened by the absorption period at a wavenumber of 1747 cm^{-1} with C=O carboxylic group and wavenumber of 1023 cm^{-1} with a stretching vibration of C-O alcohol. This showed the existence of alkaloids. The data showed that the alkaloid compounds contain O-H, C-H, C-N, C=O, C-O alcohols, and C=O carboxylate group.

The FTIR analysis showed that the FTIR spectra of *B. balsamifera* ethanol, ethyl acetate, and n-hexane had no significant difference because they were from the same plant. There was only a slight change in the wavenumber between the three FTIR spectra, but they were insignificant and did not affect the change in the composition of the compound functional groups in the sample. Based on the results of the FTIR test, plants of the same type growing in two different places tend to have insignificant differences (Seriana et al. 2021).

GC-MS analysis of the ethanol extracts of *B. balsamifera* leaves

The chemical compounds of ethanol extract of *B. balsamifera* were identified using GC-MS, as shown in Figure 3. Mass spectrometry can be used to analyze the molecular structure and the molecule mass of an organic compound (Dachriyanus 2004). The chemical compounds of the *B. balsamifera* leaf with ethanol solvent were identified using GC-MS, as shown in Table 4. There were 24 chemical compounds identified, with the most abundant compound being ethanone,1-(2,5-dimethoxyphenyl)- (11.61%). Another name of this compound is dimethyl ether ($C_{10}H_{12}O_3$), and this compound is a member of the flavonoid group. It was detected at 30.74 min with a molecular weight of 180.2005 g/mol.

Another compound detected was L-borneol with a similarity index of 97% at 5.52 min. It has a chemical formula of $C_{10}H_{18}O$ and a mass of 154.25 g/mol. L-borneol is a compound of *B. balsamifera* leaf that belongs to the flavonoid group that has the ability to heal wounds. The second most dominant compound was 2-aminoethanoiol hydrogen sulfate (ester) with a similarity index of 93%, detected at 29.14 min. The amount of it was 7.4%. Another name for this compound is $C_{13}H_{29}NO_3S_2$ with a mass of 311.5 g/mol and is a part of the flavonoid group.

A previous study by Bhuiyan et al. (2009) and Huang et al. (2010) found that *B. balsamifera* plants from Chittagong Bangladesh contain L-borneol (32%) and Camphor (0.11%). These compounds were also found in the *B. balsamifera* plants from South Aceh through GC-MS. However, some differences exist, which were mainly caused by the plants' geographical locations and the nutrients available in the soil where they grow. All of the chemical compounds can be seen in Table 4.

GC-MS analysis of the ethyl acetate extract of *B. balsamifera* leaves

The chemical compounds of *B. balsamifera* leaf extract with ethyl acetate were identified using GC-MS, as shown in Figure 4. The chemical compounds of the *B. balsamifera* leaf extract with ethyl acetate solvent are shown in Table 5. There were 28 chemical compounds identified, with the most abundant compound being (1S)-Endo-(-) Borneol (14.48%). This compound has a similarity index of 97%. This compound ($C_{10}H_{16}O$) also has a molecular weight of 152.233 g/mol and is a member of the flavonoid group detected at 5.55 min. A compound with the highest similarity index (99%) was Caryophyllene and a molecular formula of $C_{15}H_{24}$. Caryophyllene is also known as L-Caryophyllene and beta-caryophyllene, was detected at 12.30 and 18.30 min. The amount of it was 9.12% and 2.27% of the total compounds. L-caryophyllene is also a member of the flavonoid group (Pang et al. 2014).

Camphor was another compound found in *B. balsamifera* extract. It has a similarity index of 98%, detected at 4.91 min. This compound has a molecular formula of $C_{10}H_{16}O$ with a molecular weight of 152.23 g/mol. It also belongs to the flavonoid group (Wang et al. 2017). All of the chemical compounds in the *B. balsamifera* leaf extract using ethyl acetate were detected using GC-MS (Table 5).

GC-MS analysis of the n-hexane extract of *B. balsamifera* leaves

The chemical compounds of *B. balsamifera* leaf extracts with n-hexane were found using GC-MS (Figure 5). There were 27 chemical compounds identified here with the most abundant compound being Jasmoline (14.32%). Jasmoline ($C_{21}H_{30}O_3$) was detected at 30.78 min with a molecular weight of 330.5 g/mol. The second and third largest compounds were Borneol (13.22%) and Caryophyllene (10.03%), respectively. They are also parts of the flavonoid groups (Huang et al. 2010). The chemical compounds of the *B. balsamifera* leaf extract using n-hexane are presented in Table 6.

Three types of *B. balsamifera* leaf extracts identified using GC-MS showed the presence of different chemical compounds in each. However, they also share some similarities, in which camphor, jasmoline, caryophyllene, and borneol compounds are present in them. These compounds have been proven to have anti-bacterial, anti-inflammatory, and wound healing properties (Sakee et al. 2011; Asmilia et al. 2020).

There were 24 compounds, 28 compounds, and 27 compounds of the *B. balsamifera* leaf extracts identified using ethanol, ethyl acetate, and n-hexane solvents, respectively. The findings showed that the samples of the same material tested with different solvents during the extraction process will produce different chemical compounds.

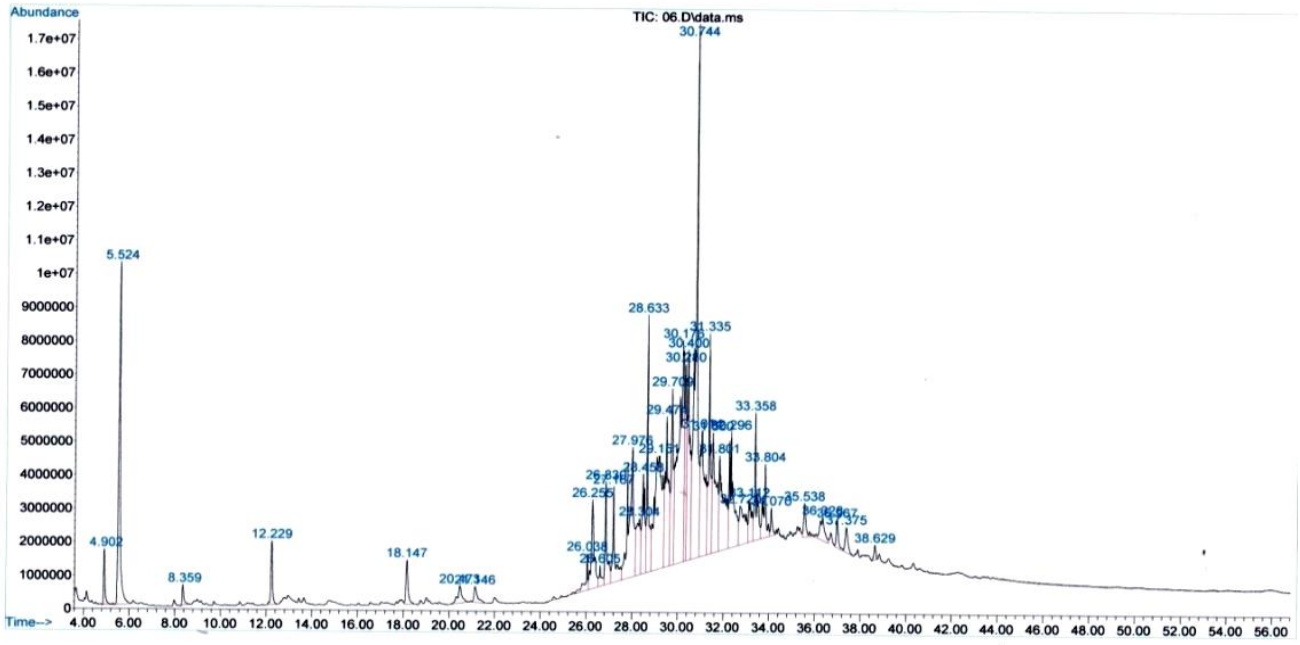


Figure 3. The GC-MS chromatogram of the ethanol extract of *Blumea balsamifera*

Table 4. All chemical compounds of the ethanol extract of *Blumea balsamifera*

Retention time	Compound	Similarity index	%
5.524	((1S)- Endo)) – (-) - Borneol	97	5.13
26.259	1H-Indene, 1-Ethylideneoctahydro 7a-methyl-cis-	43	2.08
26.831	1h-Inden-1-One, 3-Ethyl-6-Hydroxy-2-Phenyl-	83	1.60
27.169	Hexadecanoic Acid, Methyl Ester	96	1.68
27.975	Hexadecanoic Acid	99	4.82
28.306	Tridecanoic Acid	62	2.00
28.458	13-Tetradece-11-yn-1-o1	96	2.28
28.631	Phytol	91	2.97
29.148	2-Aminoethanethiol Hydrogen Sulfate (Ester)	93	7.47
29.472	(-)- Alpha-Amorphene	51	3.99
29.706	2,6,10trimethylundecan-(5z)-2,5,9-Trien-4one	42	3.15
30.175	Pregn-4-Ene-3,20-dione, 11- hydroxyl-,(11.alpha)-	41	9.70
30.278	Geranylgeraniol	49	3.06
30.403	Borinic acid, diethyl-, 1-Cyclododecen-1-y1 ester	49	4.46
30.740	Ethanone, 1-(2,5- dimethoxypheny1)-	35	11.61
31.016	2,3-Epoxy-2-Erhyl-6,6-Dimethylcibcyclo [3,1,111] Heptane	70	4.72
31.333	Iso-Bornyl Propanoate	78	3.25
31.499	Hopenpne B	86	3.87
31.802	Pridine-3-carboxamide, oxime, N-(2-Trifluoromethylpheny1)-	92	3.86
32.299	3-Octyne, 2,2,7- Trimethyk-	64	3.68
32.719	Ursodeoxycholic acid	64	1.96
33.112	5-Choro-6-nitrocholestan	91	1.07
33.361	Sigmastery1 acetate	93	2.24
33.802	Stigmastan-3,5-diene	83	1.56

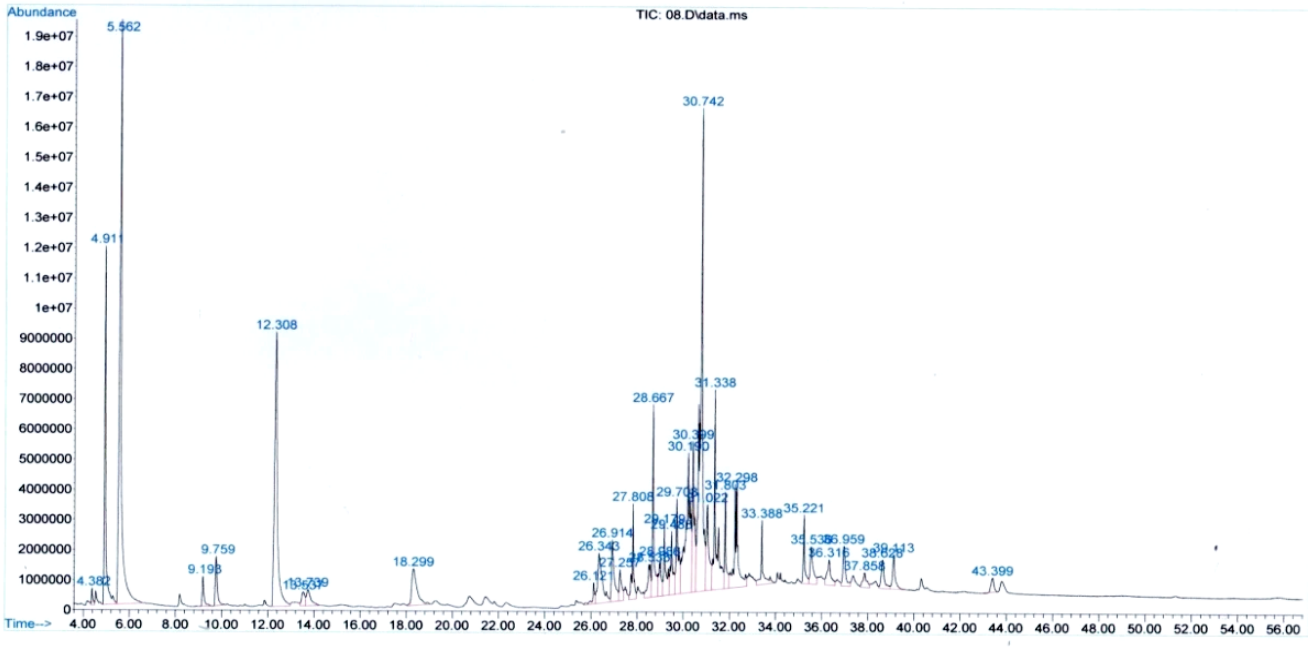


Figure 4. The GC-MS chromatogram of the *Blumea balsamifera* extract using ethyl acetate

Table 5. Overall of the chemical compounds in the ethyl acetate

Retention time	Compound	Similarity index	%
4.911	(+ -) – Camphor	98	5.72
5.559	((1S) – Endo) – (-)-Borneol	97	14.48
9.758	13,14,15,16,17-Patanorlabda-7,9 (11) Diene	91	1.15
12.309	Caryophyllene	99	9.12
18.301	(-) – Beta –Caryophyline Epoxide	99	2.27
26.341	(2s, 4as,5s,8ar) –Perhydro-5, 8a-Dimethylnaphthalen-2-Ol	72	2.64
26.914	3-Oxo-4,7,11, .Alpha. H,5,8. Beta. H-Eudesman-8,2-Olide	80	2,06
27.810	Bicy1o [2.2.1] heptane, 2-[9-borabicylo [3.3.1] non-9-yloxy1-, 1,7,7-trimethy1-	53	1.61
28.534	4-Tetradecyne	72	1.07
28.665	Phytol	90	3.36
28.3989	1-Docosene	95	1.09
29.175	1,11-Tridecadiene	56	1.67
29.486	5-Isopropylidene-4,6- dimethylnone-3,6,8-trien-2-ol	46	1.65
29.706	Phenol, (1,1-Dimethylethyl)-4-Methoxy-	38	2.32
30.189	Cyclopentanone, 2-acetyl-3,3-Dimethyl-2-(3-oxo-1-buteny1)-	50	6.86
30.403	3-Methyl-2-butenoic acid, 2-methyl oct-5yn-4yl ester	42	3.52
30.741	6- Methoxy-1,3-Benzothiazol-2-Ylamine	30	13.60
31.023	2-T-Butyl-1-Cyclohexylaziridine-2-Carbonitrile	60	2.79
31.340	Cyclodecene, 3-bromo-	90	4.61
31.802	Squalene	99	1.41
32.299	4-Hydroxy-N-(4-Methylpheyl)Benze Necarbothioamide Thiobenzamide, 4-Hydroxy-N- (4-Methylphenyl	46	4.03
33.388	Octacosane	96	1.41
35.223	Icosane	97	1.21
33.540	Stigmasterol	99	1.32
36.319	4,4,6a,6d,8a,11,11,14b-Octamethyl-1,4,4a,5,6,6a,6b,7,8,8a,9,10,11,12,12a 14,14a,14b- Octadecahydro-2H-Picen-3-One	94	1.10
36.960	3-Keto-Urs-12-Ene	95	1.17
38.629	Urs-12-En-24-Oic Acid, 3oxo-, Methyl Ester, (+)	99	1.01
39.112	Nophytadiene	90	1.08

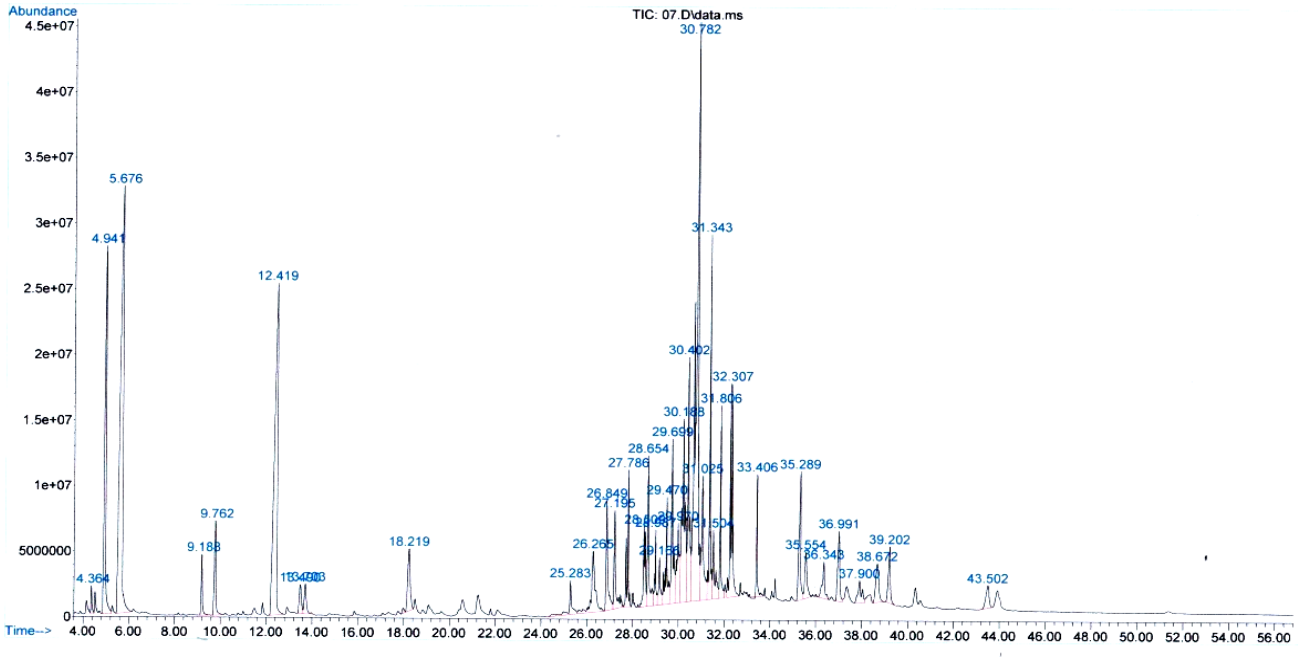


Figure 5. GC-MS chromatogram of the *Blumea balsamifera* leaf extract using n-hexane

Table 6. The chemical compounds of *Blumea balsamifera* leaf extracts with n-hexane

Retention time	Compound	Similarity index	%
4.938	(+ -) – Camphor	98	5.76
5.676	Borneol	96	13.22
12.420	Caryophyllene	99	10.03
18.219	Caryophyllene, Epoxide	99	1.58
26.265	(2S, 4AS,5S,8AR) –Perhydro-5, 8A-Dimethylnaphthalen-2-Ol	42	2.30
26.852	3-Oxo-4,7,11,. Alpha. H,5,8.Beta. H-Eudesman-8,2-Olide	86	2.02
27.196	Hexadecanoic acid, methy1 ester	99	1.66
27.789	1-Isopropenyl-4-Methlcyclonexanem Ethanol	59	1.46
28.506	9,12-Octadecadienoic Acid, Methl Ester	99	1.39
28.651	Phytol	87	2.26
29.472	Tetracyclo [6.1.0.0 (2,4). 0 (5,7) – (1.alpha. ,2,alpha, .4.alpha. 5.beta., 7.beta., 8,alpha	42	1.69
29.669	3-tert-Butyl1-4-hydroxyanisole	42	2.49
29.968	Z-12-Pentacosene	96	1.95
30.189	4a,9a-Methano-9H-fluorene	30	4.64
30.403	Z-12-Pentacosene	38	3.71
30.782	Jasmoline	25	14.32
31.023	1-Cyelohexene-1-propanal, 2,6,6-trimethy1-	38	2.73
31.340	1,7,7-Trimethylbicyclo [2.2.1] Hept-2-YL Acetate	60	2.96
31.506	4a,9a-Methano-9h-Fluorene	41	1.34
31.809	Squalene	98	1.48
32.306	Phosphan Bornyldichloro	50	3.91
33.409	Tetracosane	97	1.23
35.291	Hexadecande	96	2.14
33.553	Stigmasterol	99	1.09
36.995	3-Keto-Urs-12-Ene	93	1.41
38.670	Methyl 3-Oxours-12-En-23-Oate	99	1.16
39.201	Neophytadiene	94	1.18

In conclusion, the extracts of *B. balsamifera* leaves from Aceh were identified using three different solvents, namely ethanol, n-hexane, and ethyl acetate. The results of the phytochemical screening of *B. balsamifera* extracts using ethanol and ethyl acetate confirmed the presence of saponins, flavonoids, phenolics, tannins, and steroids. Meanwhile, the *B. balsamifera* extracts with n-hexane solvent revealed the presence of steroids, phenolics, and tannins. The FTIR analysis showed that the FTIR spectra of *B. balsamifera* ethanol, ethyl acetate, and n-hexane did not

differ significantly because they came from the same plant. The GC-MS analyses showed that the most abundant compounds of the *B. balsamifera* extracts were Borneol, Caryophyllene, Camphor, and Jasmoline, which are the members of the flavonoid groups. These compounds are effective as antibacterial, anti-inflammatory, and wound healing treatments. In the future, it is necessary to conduct further research on the use of various phytochemical compounds in the Pharmaceutical field.

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