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Extraction of Polyphenol Compounds from Herbal Plant Stems of Kalimantan Using Ethanol Solvent

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Abstract

Kalimantan harbors endemic medicinal plant species with untapped therapeutic potential, yet scientific validation of their phytochemical profiles remains limited despite centuries of traditional use by indigenous Dayak communities. This study aimed to characterize the bioactive compounds in stem extracts of six *Kalimantan* herbal plants: *saluang belum* (*Luvunga sarmentosa*), *sintok* (*Cinnamomum sintoc*), *pasak bumi* (*Eurycoma longifolia*), *akar kuning* (*Arcangelisia flava*), *kayu sutra* (*Fragraea racemosa*), and *nonang* (*Xylopia malayana*). A Simple Randomized Design was employed with 70% ethanol maceration extraction, followed by qualitative phytochemical screening (saponins, steroids/triterpenoids, tannins), quantitative analysis (total polyphenols via Folin–Ciocalteu method, total flavonoids via aluminum chloride complexation), and GC–MS compound identification. Results revealed universal presence of tannins across all species, with triterpenoids detected in five species and steroids uniquely in *pasak bumi*. Saponins were identified in *sintok*, *akar kuning*, *kayu sutra*, and *nonang*. Total polyphenol content ranged from 1.78 mg GAE/g (*pasak bumi*) to 8.55 mg GAE/g (*sintok*), while flavonoid content was highest in *pasak bumi* (2.48 mg QE/g). GC–MS analysis identified benzenepropenamide derivatives (41.63%) as dominant compounds in *sintok*, with antimicrobial properties, and n-hexadecanoic acid (38.21%) in *pasak bumi*, associated with cardiovascular benefits. These findings validate traditional medicinal uses through molecular evidence and demonstrate that endemic *Kalimantan* plants harbor diverse bioactive compounds with therapeutic potential spanning antimicrobial, antioxidant, anti-inflammatory, and metabolic applications. The research provides a scientific foundation for developing standardized herbal formulations, supports conservation prioritization of high-value medicinal species, and contributes to Indonesia's pharmaceutical independence through sustainable bioprospecting of indigenous botanical resources.

Keywords: Extract, phytochemical, GC-MS, polyphenols, herbal plants

INTRODUCTION

Kalimantan is known as one of the centers of tropical biodiversity, with a wealth of medicinal plants that remain largely unexplored. Several endemic species, such as *saluang belum* (*Luvunga sarmentosa*), *sintok* (*Cinnamomum sintoc* Blume), *pasak bumi* (*Eurycoma longifolia* Jack), *akar kuning* (*Arcangelisia flava* Merr.), *kayu sutra* (*Fragraea racemosa* Jack ex Wall.), and *nonang* (*Xylopia malayana*), have long been used in traditional medicine by the Dayak community (Qamariah, Mulia, & Fakhrizal, 2020; Patiola, 2023). These plants contain diverse phytochemical compounds such as alkaloids, flavonoids, terpenoids, and phenolics that have potential therapeutic value (Syarpin, Lestari, & Hidayat, 2023). For example, *Eurycoma longifolia* has been reported to exhibit antioxidant, antimalarial, and anticancer activities, mainly due to its quassinoid and eurycomanone constituents (Rahman, Ahmad, & Sulaiman, 2024). Likewise, essential oil from *Cinnamomum sintoc* has been identified to contain major compounds such as linalool, 1,8-cineole, and α-terpineol, which contribute to its antimicrobial and anti-inflammatory properties (Ninggolan, Andona,

Imanuddin, & Hidayatullah, 2023). However, scientific validation of their secondary metabolite contents and biological activities remains limited, particularly regarding standardized testing and pharmacological evaluation (Permatasari, 2024).

The use of natural remedies has also been driven by the growing trend of "back to nature," prompting many people to shift their treatment preferences from conventional medicine to natural-based alternatives. This shift aims to reduce the consumption of pharmaceutical drugs that often contain various synthetic chemicals (Caban & Stepnowski, 2021). People believe that natural or herbal remedies tend to have fewer side effects compared to conventional medicines (Ariwibowo et al., 2021). The increasing public awareness of health has significantly influenced the growing use of herbal medicines, particularly those derived from locally available medicinal plants (Arjona-García et al., 2021).

The urgency of this research is underscored by several critical factors converging at this historical moment. First, the alarming rate of biodiversity loss in Kalimantan—where deforestation has reached approximately 1.5 million hectares annually due to palm oil expansion, mining activities, and urbanization—threatens the extinction of endemic medicinal plant species before their therapeutic potential can be scientifically documented (Burivalova, Şekercioğlu, & Koh, 2020; Santoso, Widiatmaka, & Kartawinata, 2018; Biddle et al., 2024). The traditional knowledge held by indigenous Dayak communities, which has been transmitted orally across generations, is eroding rapidly as younger generations migrate to urban centers (Rinto, Subhadrabandhu, & Kartasih, 2023; Ibrahim, Surya, & Maulana, 2025). This cultural shift, exacerbated by reduced forest dependency and changing livelihoods, has led to a decline in ethnobotanical literacy among the youth (Wijaya & Lestari, 2022; Setiawan, Putri, & Hartono, 2021). Consequently, there is an urgent need to capture and validate this ethnobotanical wisdom through systematic scientific investigation before it disappears entirely (Rahman & Azizah, 2023).

Second, the global antimicrobial resistance (AMR) crisis, recognized by the World Health Organization as one of the top ten threats to global health, necessitates the discovery of novel bioactive compounds from natural sources as alternatives to conventional antibiotics that are increasingly losing efficacy (WHO, 2023; Holmes et al., 2023). Kalimantan's unique phytogeographic position and high endemism rate suggest these plants may harbor previously undiscovered secondary metabolites with potent antimicrobial, antioxidant, and anticancer properties (Haruna et al., 2021; Andriyas et al., 2025).

Third, Indonesia's pharmaceutical industry currently imports approximately 95% of the raw materials for drug manufacturing, creating economic vulnerability and dependence on foreign suppliers (Kemenperin, 2023; Yuniarto & Pratama, 2022). This reliance not only increases production costs but also exposes the sector to global supply chain disruptions and foreign exchange fluctuations. Developing indigenous herbal resources into standardized phytopharmaceutical products could significantly reduce this dependency while fostering national health sovereignty and generating economic opportunities for rural communities through sustainable bioprospecting (Utami, Nugroho, & Laksana, 2024).

Herbal medicine refers to medicine obtained from the process of extracting plants. Usually, herbal medicine that has been extracted is available in powder, pill, or liquid form, and its preparation does not involve the use of synthetic chemicals (Hafizh et al., 2021). Herbal

medicines are sourced from various parts of medicinal plants, including roots, rhizomes, tubers, bark, stems, leaves, flowers, fruits, and seeds.

The use of medicinal or herbal plants is often based solely on traditional knowledge passed down through generations, without a clear understanding of the specific compounds contained within these plants. As a result, the public generally lacks accurate information regarding appropriate dosages for the safe and effective use of herbal medicines (Rianti et al., 2019). Therefore, it is essential to conduct scientific research to identify and analyze the bioactive compounds present in these medicinal plants.

The novelty of this research resides in several distinctive aspects that differentiate it from previous phytochemical investigations. First, this study represents the first comprehensive comparative analysis of six endemic Kalimantan medicinal plant species—saluang belum, sintok, pasak bumi, akar kuning, kayu sutra, and nonang—examined simultaneously using standardized extraction protocols and identical analytical methodologies, enabling direct comparison of phytochemical profiles across species. While individual plants such as pasak bumi (*Eurycoma longifolia*) have been extensively studied for their quassinoid content and aphrodisiac properties, and akar kuning (*Arcangelisia flava*) for its berberine alkaloids, the other species—particularly saluang belum, sintok, nonang, and kayu sutra—remain virtually uncharacterized in peer-reviewed scientific literature, representing significant knowledge gaps.

Second, this research focuses specifically on stem tissues rather than the more commonly studied leaves or roots, based on ethnobotanical surveys indicating that Dayak traditional healers preferentially utilize stem preparations for certain therapeutic applications, yet stem phytochemistry has been largely neglected in favor of other plant organs.

Third, the integration of both qualitative phytochemical screening and quantitative GC-MS analysis provides comprehensive chemical fingerprinting that connects traditional use categories with specific bioactive compounds, facilitating evidence-based validation of traditional knowledge.

Fourth, the utilization of 70% ethanol extraction—a food-grade, environmentally benign solvent that mimics traditional water-based decoctions while improving secondary metabolite recovery—addresses the practical need for extraction methods that are scalable, safe, and aligned with traditional preparation techniques, thereby facilitating eventual translation from laboratory findings to community-level herbal medicine production.

Finally, this research contributes to filling the critical gap in Indonesia's national herbal medicine database, supporting the government's initiatives under the *National Action Plan for Medicinal Plants Development 2020–2024*, which prioritizes scientific validation of indigenous botanical resources as a foundation for developing a competitive traditional medicine industry.

This study aims to identify the active compounds present in medicinal plants from Kalimantan, so that we can determine the specific benefits of herbal plants from Kalimantan. The findings are expected to support the use of these plants as natural herbal remedies, offering safer alternatives to synthetic drugs that may cause adverse side effects. Furthermore, this research aims to provide a scientific foundation for the development of standardized herbal formulations derived from Kalimantan endemic species, contribute to the conservation

of traditional botanical knowledge, and inform evidence-based policy recommendations for sustainable bioprospecting and intellectual property protection.

The practical implications extend to multiple stakeholder groups: for local communities, the research validates traditional practices while potentially creating economic opportunities through cultivation and sustainable harvesting of high-value medicinal plants; for the pharmaceutical and nutraceutical industries, it provides preliminary phytochemical data to guide drug discovery programs targeting specific bioactive compounds; for conservation agencies, it generates a scientific rationale for prioritizing the protection of medicinal plant habitats; and for policymakers, it offers evidence to support regulatory frameworks for quality control, safety assessment, and market authorization of indigenous herbal medicines.

RESEARCH METHOD

Raw materials

The materials used for the maceration extraction process included labels, tissue papper, and powdered stems of herbal plants. The materials used for analysis included 70% ethanol, herbal stem extract, distilled water (aquades), gallic acid, 20% Folin-Denis reagent, saturated Na_2CO_3, quercetin, 5% $AlCl_3$, 2 N HCl, chloroform, acetic anhydride, sulfuric acid, 1% ferric chloride, and supernatant.

Maceration extraction

The maceration extraction process began with size reduction of the stems from medicinal plants originating from Kalimantan. The stems were ground using a blender until herbal plant powder was obtained. This step is essential to increase the surface area of the material, allowing the solvent to penetrate plant tissues more effectively and accelerating the dissolution of active compounds into the solvent. Each dried sample (5 grams) was weighed and placed into an Erlenmeyer flask containing 70% ethanol (ethanol in water, v/v) at a ratio of 1:10 (w/v). The mixture was then macerated for 3 hours at room temperature, with stirring using a magnetic stirrer at 100 rpm every 30 minutes. After 3 hours of maceration, the mixture was filtered to separate the filtrate and residue. The filtrate was collected in a receiving tube, while the residue was re-extracted using fresh 70% ethanol under the same conditions as the initial extraction. A total of five extraction time were performed. The combined filtrates were then evaporated using a rotary vacuum evaporator at 78–80°C and a rotation speed of 40 rpm. The resulting concentrated filtrate was further dried in an oven at 100°C until the ethanol was completely evaporated. The final product, an ethanol extract of the plant stems, was then subjected to analysis for total polyphenol, total flavonoid, saponin, tannin, and steroid/triterpenoid content.

Qualitative phytochemical content analysis

Saponin

The saponin identification test was conducted by observing the presence of stable foam in the sample extract. A 0.05 gram sample extract was placed into a beaker, then 10 mL of hot water was added and shaken for approximately 10 seconds. The test is considered positive for saponins if stable foam forms and remains even after the addition of 1 mL of 2 N HCl.

Terpenoid (steroid/triterpenoid)

For the identification test, 0.05 grams of the sample were dissolved in 2 mL of chloroform, followed by the addition of 10 drops of acetic anhydride and 3 drops of concentrated sulfuric acid (H_2SO_4) carefully added along the inner wall of the test tube. The resulting color changes were then observed. The presence of triterpenoids is indicated by the formation of a brownish or violet color, whereas the presence of steroids is indicated by the formation of a bluish-green color.

Tanin

A total of 0.5 grams of the herbal plant ethanol extract was placed into a beaker, then 20 mL of aquadest was added and the mixture was filtered. Afterwards, 1 mL of 1% $FeCl_3$ solution was added to the filtrate, and the resulting color change was observed. A positive result is indicated by the formation of a greenish-black color.

Total polyphenol analysis

The determination of total phenolic content in the ethanol extract of the herbal plant stem was carried out using a modified procedure based on (Nursan *et al*., 2023). A gallic acid solution was prepared by dissolving 0.01 grams of gallic acid in 100 mL of aquadest, resulting in a 100× dilution. Subsequently, a 0-1 mL gallic acid dilution is made with the code S_0-S_{10}. The sample solution was prepared by diluting 0.8 grams of the sample in 5 mL of aquadest to achieve a 5× dilution. Then, 1 mL of the sample solution was transferred into a test tube, followed by the addition of 0.5 mL of Folin-Denis reagent (Folin-Ciocalteu reagent diluted with distilled water in a 1:1 ratio). The mixture was left to stand for 1 minute. After that, saturated Na_2CO_3 was added to the sample mixture, then left for 10 minutes and vortexed. Aquadest was added to a volume of 7,5 mL and then incubated for 30 minutes at room temperature. The absorbance was measured at λ 750 nm and total polyphenols were calculated using the formula :

Total polyphenol content (mg GAE/g) = $\frac{c\ x\ V\ x\ Fp}{m}$

Description:

c = total flavonoid concentration from the quercetin standard curve (mg/L)

V = extract volume (L)

Fp = sample solution dilution factor

m = sample weight (g)

Total flavonoid analysis

The stages for determining total flavonoid levels refer to (Agustina *et al*., 2020) which has been modified. First, 0.02 grams of quercetin was weighed and diluted 100 times by adding 100 mL of ethanol. A 0-1 mL dilution of quercetin was made with the code S_0-S_{10}. Next, 0.8 grams of the sample was weighed and diluted 5 times by adding 5 mL of aquadest. Subsequently, 1 mL of the sample solution was transferred into a test tube, followed by the addition of 2 mL of 5% $AlCl_3$ solution and 7 mL of ethanol. The mixture was vortexed and allowed to stand for approximately 10 minutes. The absorbance was measured using a UV/Vis spectrophotometer at a wavelength of 415 nm. A calibration curve was then constructed to relate absorbance to concentrnd the total flavonoid content was calculated using the formula:

Total flavonoid content (mg QE/g) = $\frac{c \; x \; V \; x \; Fp}{m}$

Description:
c = total flavonoid concentration from the quercetin standard curve (mg/L)
V = extract volume (L)

Fp = sample solution dilution factor

m = sample weight (g)

GC-MS analysis

The GC-MS analysis procedure was based on a modified method from (Simanjuntak *et al*., 2021). The analysis began with the preparation of ethanol extract from the herbal plant using the maceration method, where the herbal plant ethanol extract was placed into a microtube. The analysis was conducted with an injection time set for 36 minutes at an injector temperature of 250°C. Helium gas was used as the carrier gas at a constant flow rate of 1 mL/min. Identification using GC-MS provided a list of phytochemical compounds based on their retention times and molecular weights, which were presented in the form of a chromatogram.

RESULT AND DISCUSSION

Yield

Table 1. Duncan's Multiple Range Test Results for Yield (%) of Stem Extract

	Mean Yield (%)
A (Saluang Belum Stem)	46,8±1,2^{ab}
B (Sintok Stem)	55,2±4,8^{d}
C (Ginseng Kalimantan Stem)	51,9±2,3^{cd}
D (Akar Kuning Stem)	46,2±0,9^{a}
E (Kayu Sutra Stem)	50,0±0,6^{ab}
F (Nonang Stem)	51,1±1,4^{bc}

Note: Means followed by different letters indicate significant differences based on Duncan's Multiple Range Test at the 5% level.

Source: Research data (2024)

The results of Duncan's test showed that there were significant differences among the treatments. The highest average yield was obtained from the ethanol extract of sintok stem at 55.2%, while the lowest average yield was found in the ethanol extract of akar kuning stem at 46.2%. Based on the results of Duncan's Multiple Range Test, it can be concluded that the ethanol extract of sintok stem was the most effective treatment in increasing stem extract yield, whereas the ethanol extract of akar kuning stem produced the lowest yield. The treatment group consisting of ethanol extracts from Kalimantan ginseng, nonang, kayu sutra, and saluang belum showed varying yield values but did not differ significantly from each other statistically.The higher yield observed in this study indicates that the extraction conditions used were more optimal extracting active compounds from the plant stems. This suggests the potential of this method for producing extracts with greater efficiency.

Qualitative phytochemical content analysis

Table 2. Phytochemical Analysis of Stem Extracts from Kalimantan Herbal Plants

Treatment	Saponin	Terpenoid Steroid/Triterpenoid	Tanin
A (Saluang Belum Stem)			
	(-)	(+) triterpenoid (-) steroid	(+)
B (Sintok Stem)			
	(+)	(+) triterpenoid (-) steroid	(+)
C (Ginseng Kalimantan Stem)			
	(-)	(+) steroid (-) triterpenoid	(+)
D (Akar Kuning Stem)			
	(+)	(+) triterpenoid (-) steroid	(+)
E (Kayu Sutra Stem)			
	(+)	(+) triterpenoid (-) steroid	(+)

Treatment	Saponin	Terpenoid Steroid/Triterpenoid	Tanin
F (Nonang Stem)			
	(+)	(+) triterpenoid (-) steroid	(+)

Note : (+) = present
(-) = absent

Source: Research data (2024)

The ethanol extract of saluang belum (*Luvunga sarmentosa*) and Kalimantan ginseng (*Eurycoma longifolia* Jack) showed negative (–) results, indicating the absence of saponin compounds in the stem extracts of these plants. In contrast, the ethanol extracts of sintok (*Cinnamomum sintoc* Blume), akar kuning (*Arcangelisia flava* Merr.), nonang (*Xylopia malayana*), and kayu sutra (*Fragraea racemosa* Jack ex Wall.) showed positive (+) results for saponins, as indicated by the formation of stable foam on the surface of the sample solution. The presence of triterpenoid/steroid compounds was indicated by the appearance of a brownish or bluish-green color, which signifies a positive reaction for triterpenoid or steroid content in the tested sample. The ethanol extracts of saluang belum (*Luvunga sarmentosa*), sintok (*Cinnamomum sintoc* Blume), akar kuning (*Arcangelisia flava* Merr.), kayu sutra (*Fragraea racemosa* Jack ex Wall.), and nonang (*Xylopia malayana*) showed positive (+) results for the presence of triterpenoids. Meanwhile, the ethanol extract of Kalimantan ginseng (*Eurycoma longifolia* Jack) showed a positive (+) result for the presence of steroids.

Quantitative analysis

Total polyphenol content

Table 3. Duncan's Multiple Range Test Results for Total Polyphenol Content (mg GAE/g)

Ethanol Extract Treatment	Mean Total Polyphenol Content (mg GAE/g)
A (Saluang Belum Stem)	$3{,}39 \pm 1{,}6^{ab}$
B (Sintok Stem)	$8{,}55 \pm 1{,}3^{c}$
C (Ginseng Kalimantan Stem)	$1{,}78 \pm 0{,}2^{a}$
D (Akar Kuning Stem)	$2{,}02 \pm 0{,}6^{a}$
E (Kayu Sutra Stem)	$3{,}65 \pm 0{,}9^{ab}$
F (Nonang Stem)	$4{,}94 \pm 0{,}6^{b}$

Note: Means followed by different letters indicate significant differences based on Duncan's Multiple Range Test at the 5% level.

Source: Research data (2024)

Based on the analysis of total polyphenol content shown in Table 3, there were significant differences among treatments according to Duncan's Multiple Range Test (DMRT) at the 5% significance level. The ethanol extract of sintok stem exhibited the highest mean total polyphenol content at 8.55 mg GAE/g, while the ethanol extract of Kalimantan ginseng stem

showed the lowest content at 1.78 mg GAE/g. These results indicate that sintok (*Cinnamomum sintoc* Blume) contains a higher level of phenolic compounds compared to the other treatments. The higher the phenolic compound content, the greater its antioxidant activity.

Total flavonoid content

Table 4. Duncan's Multiple Range Test Results for Total Flavonoid Content (mg QE/g)

Ethanol Extract Treatment	Mean Total Flavonoid Content (mg QE/g)
A (Saluang Belum Stem)	1,51 ± 0,4[b]
B (Sintok Stem)	,80 ± 0,1[a]
C (Ginseng Kalimantan Stem)	2,48 ± 0,1[c]
D (Akar Kuning Stem)	1,28 ± 0,2[ab]
E (Kayu Sutra Stem)	,90 ± 0,1[a]
F (Nonang Stem)	1,28 ± 0,4[ab]

Note: Means followed by different letters indicate significant differences based on Duncan's Multiple Range Test at the 5% level.

Based on the results of Duncan's Multiple Range Test for total flavonoid content (mg QE/g) presented in Table 4, it is evident that the treatment factor had a significant effect on the total flavonoid levels obtained. The mean total flavonoid contents were as follows: saluang belum stem = 1.51, sintok stem = 0.80, Kalimantan ginseng stem = 2.48, akar kuning stem = 1.28, kayu sutra stem = 0.90, and nonang stem = 1.28 mg QE/g. The ethanol extract of Kalimantan ginseng stem exhibited the highest flavonoid content at 2.48 mg QE/g, while sintok stem had the lowest at 0.80 mg QE/g. Therefore, the high flavonoid content in Kalimantan ginseng (*Eurycoma longifolia* Jack) supports its potential as a natural antioxidant source for the development of herbal products.

GC-MS (Gas Chromatography-Mass Spectrometry)

Stem extract of sintok

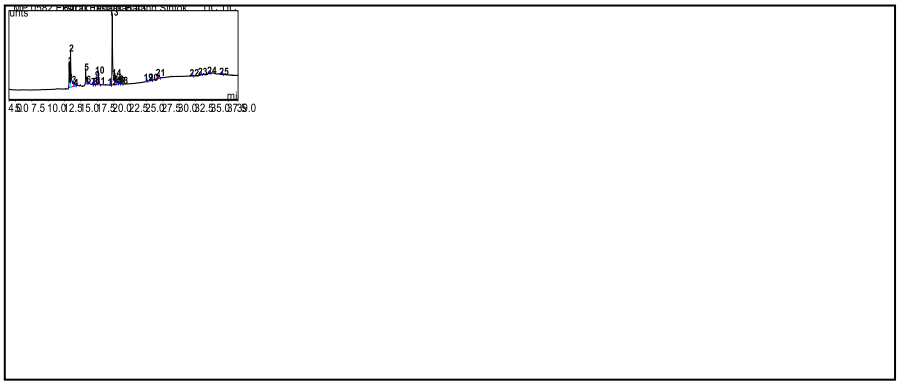

Figure 1. GC-MS Analysis Results of Ethanol Extract of Sintok Stem

Source: Research data (2024)

Table 5. List of Compounds Identified by GC-MS Analysis in Sintok Stem Extract

Peak	RT	Compound Name Hit 1	*Chemical Formula*	*Retention Area (%)*	Compound Class
1	13,20	*Palmitoleic acid*	$C_{16}H_{30}O_2$	11,36	Fatty acid
2	13,41	*l-(+)-Ascorbic acid 2,6-dihexadecanoate*	$C_{38}H_{68}O_8$	22,68	Polyphenol
3	13,81	*9-Hexadecenoic acid*	$C_{16}H_{30}O_2$	0,57	Fatty acid
4	14,12	*cis-11-Eicosenoic acid*	$C_{20}H_{38}O_2$	0,55	Fatty acid
5	15,71	*cis-13-Octadecenoic acid*	$C_{18}H_{34}O_2$	6,77	Fatty acid
6	16,04	*trans-13-Octadecenoic acid*	$C_{18}H_{34}O_2$	0,44	Fatty acid
7	16,76	*9-Hexadecenoic acid*	$C_{16}H_{30}O_2$	0,23	Fatty acid
8	17,04	*9-Hexadecenoic acid*	$C_{16}H_{30}O_2$	0,40	Fatty acid
9	17,38	*cis-13-Eicosenoic acid*	$C_{20}H_{38}O_2$	1,79	Fatty acid
10	17,65	*Glycidyl palmitate*	$C_{19}H_{36}O_3$	3,62	Fatty acid esters
11	17,82	*Glycidyl oleate*	$C_{21}H_{38}O_3$	0,21	Ester epoxide
12	19,56	*9-Octadecenoic acid (Z)-, tetradecyl ester*	$C_{32}H_{62}O_2$	0,23	Fatty acid
13	19,78	*Benzenepropenamide, N-(phenylmethyl)-*	$C_{16}H_{15}NO$	41,63	Aromatic
14	20,21	*9-Octadecenoic acid (Z)-, 2-hydroxy-1-(hydroxymethyl)ethyl ester*	$C_{21}H_{40}O_4$	1,88	Fatty acid
15	20,36	*Ethyl iso-allocholate*	$C_{26}H_{44}O_5$	1,14	Steroid
16	20,57	*Glycidyl oleate*	$C_{21}H_{38}O_3$	0,86	Ester epoxide
17	20,89	*9-Hexadecenoic acid*	$C_{16}H_{30}O_2$	0,25	Fatty acid
18	21,24	*Ethyl iso-allocholate*	$C_{26}H_{44}O_5$	0,52	Steroid
19	25,07	*Ethyl iso-allocholate*	$C_{26}H_{44}O_5$	0,84	Steroid
20	25,85	*Oleic acid, eicosyl ester*	$C_{38}H_{74}O_2$	0,23	Fatty acid esters
21	26,92	*Ethyl iso-allocholate*	$C_{26}H_{44}O_5$	2,12	Steroid
22	32,08	*Ethyl iso-allocholate*	$C_{26}H_{44}O_5$	0,32	Steroid
23	33,37	*7,8-Epoxylanostan-11-ol, 3-acetoxy-*	$C_{32}H_{54}O_4$	0,73	Triterpenoid/ Steroid
24	34,77	*Ethyl iso-allocholate*	$C_{26}H_{44}O_5$	0,36	Steroid
25	36,62	*Ethyl iso-allocholate*	$C_{26}H_{44}O_5$	0,28	Steroid

Source: Research data (2024)

The GC-MS (Gas Chromatography-Mass Spectrometry) analysis of *Cinnamomum sintoc* Blume stem extract identified 25 major compounds with varying retention area percentages, indicating the diversity of bioactive compounds present in the extract. The chromatogram shown in Figure 1 displays five prominent peaks—specifically peaks number 13, 2, 1, 5, and 10. The significant height of these peaks indicates a higher concentration of these compounds compared to the others detected in the extract.

Peak 13 has a retention time of 19.78 minutes with an area percentage of 41.63%. The compound identified at this peak is *Benzenepropenamide, N-(phenylmethyl)-*, which belongs to the aromatic/amide group. Amide compounds serve various functions, including as antimicrobial agents and surfactants (Nande *et al*., 2020).

Peak 2 has a retention time of 13.41 minutes and accounts for 22.68% of the total area. The predominant compound detected at this peak is *L-(+)-Ascorbic acid 2,6-dihexadecanoate*, a derivative of vitamin C that belongs to the polyphenol group. This compound has been reported to exhibit multiple pharmacological activities, including anticoagulant, antioxidant, anti-inflammatory, antitumor, anticonvulsant, antidiabetic, and antidiarrheal effects. The

presence of this compound in the plant extract indicates its strong potential as a multifunctional herbal medicine, particularly in the treatment of diseases related to free radicals, infections, cancer, and digestive disorders.

Peak 1 has a retention time of 13.20 minutes with a retention area of 11.36%. The compound identified at this peak is *Palmitoleic acid*, which belongs to the fatty acid group. *Palmitoleic acid* has been reported to exhibit numerous beneficial biological functions, particularly its ability to enhance insulin sensitivity and reduce the risk of diabetes (Hu *et al*., 2019).

Peak 5 has a retention time of 15.71 minutes with a retention area of 6.77%. The compound found at this peak is *cis-13-Octadecenoic acid*, a type of fatty acid. This compound, also known as elaidic acid, is known for its antibacterial and antifertility activities. Due to its diverse pharmacological properties, cis-13-Octadecenoic acid can be developed as an active ingredient in pharmaceuticals, health supplements, and herbal medicinal products for the treatment and prevention of various diseases.

Peak 10 has a retention time of 17.65 minutes with a retention area of 3.65%. The compound identified at this peak is *Glycidyl palmitate*, which belongs to the fatty acid ester group. This compound has demonstrated significant antidiabetic effects by inhibiting key enzymes involved in carbohydrate metabolism, namely α-amylase and α-glucosidase. The potential of *glycidyl palmitate* in diabetes and cancer management is attributed to its antioxidant properties and its ability to modulate key signaling pathways involved in glucose and lipid metabolism, insulin secretion, and cancer progression (Puspa *et al*., 2025).

Stem extract of ginseng Kalimantan

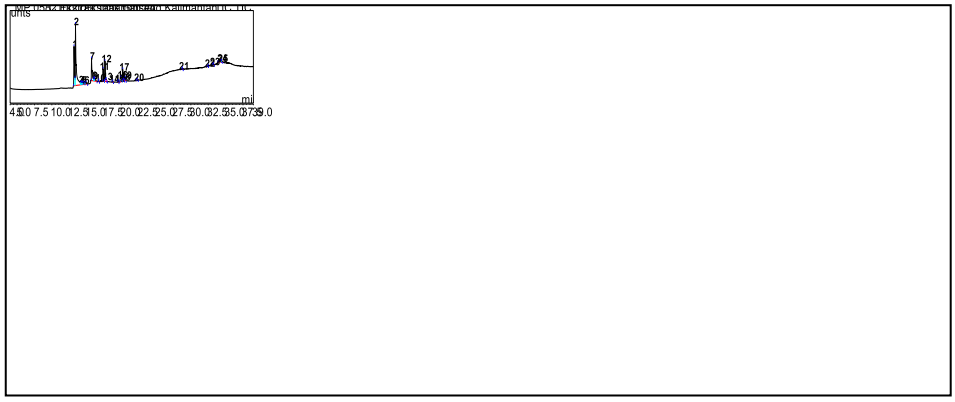

Figure 2. GC-MS Analysis Results of the Ethanol Extract of Ginseng Stem

Source: Research data (2024)

Table 6. List of Compounds Identified by GC-MS Analysis of the Ginseng Stem Extract

Peak	**RT**	**Compound Name Hit 1**	***Chemical Formula***	***Retent ion Area (%)***	**Compound Class**
1	13,19	*Palmitoleic acid*	$C_{16}H_{30}O_2$	18,16	Fatty acid
2	13,40	*n-Hexadecanoic acid*	$C_{16}H_{32}O_2$	38,21	Fatty acid
3	14,12	*9-Hexadecenoic acid*	$C_{16}H_{30}O_2$	1,54	Fatty acid
4	14,32	*9-Hexadecenoic acid*	$C_{16}H_{30}O_2$	1,41	Fatty acid
5	14,50	*9-Hexadecenoic acid*	$C_{16}H_{30}O_2$	1,95	Fatty acid
6	14,92	*cis-13-Octadecenoic acid*	$C_{18}H_{34}O_2$	1,23	Fatty acid
7	15,71	*trans-13-Octadecenoic acid*	$C_{18}H_{34}O_2$	10,50	Fatty acid
8	16,05	*trans-13-Octadecenoic acid*	$C_{18}H_{34}O_2$	1,45	Fatty acid
9	16,17	*trans-13-Octadecenoic acid*	$C_{18}H_{34}O_2$	1,57	Fatty acid
10	16,76	*trans-13-Octadecenoic acid*	$C_{18}H_{34}O_2$	0,31	Fatty acid
11	17,37	*Glycidyl oleate*	$C_{21}H_{38}O_3$	3,70	Ester epoxide
12	17,65	*Glycidyl palmitate*	$C_{19}H_{36}O_3$	6,45	Fatty acid esters
13	17,81	*l-(+)-Ascorbic acid 2,6-dihexadecanoate*	$C_{38}H_{68}O_8$	0,34	Polyphenol
14	18,77	*9-Hexadecenoic acid*	$C_{16}H_{30}O_2$	0,30	Fatty acid
15	19,56	*9-Octadecenoic acid (Z)-, 2-hydroxy-1-(hydroxymethyl)ethyl ester*	$C_{21}H_{40}O_4$	0,32	Fatty acid esters
16	19,95	*2-Oleoylglycerol, 2TMS derivative*	$C_{27}H_{56}O_4Si_2$	3,85	Gylcerol ester
17	20,21	*Glycidyl oleate*	$C_{21}H_{38}O_3$	3,89	Ester epoxide
18	20,37	*Glycidyl oleate*	$C_{21}H_{38}O_3$	0,11	Ester epoxide
19	20,56	*Glycidyl oleate*	$C_{21}H_{38}O_3$	0,77	Ester epoxide
20	22,34	*Glycidyl oleate*	$C_{21}H_{38}O_3$	0,39	Ester epoxide
21	28,80	*Ethyl iso-allocholate*	$C_{26}H_{44}O_5$	0,36	Steroid
22	32,52	*Ethyl iso-allocholate*	$C_{26}H_{44}O_5$	0,29	Steroid
23	33,25	*3,5,9-Trioxa-5-phosphaheptacos-18-en-1-aminium, 4-hydroxy-N,N,N-trimethyl-10-oxo-7-[(1-oxo-9-octadecenyl)oxy]-, hydroxide, inner salt, 4-oxide, (R)-*	$C_{44}H_{84}NO_8P$	0,37	Fosfolipid / amino fosfat
24	34,30	*Hexadecanoic acid, 1-[[[(2-aminoethoxy)hydroxyphosphinyl]oxy] methyl]-1,2-ethanediyl ester*	$C_{37}H_{74}NO_8P$	1,93	Fosfolipid / Ester fosfat
25	34,40	*Hexadecanoic acid, 1-[[[(2-aminoethoxy)hydroxyphosphinyl]oxy] methyl]-1,2-ethanediyl ester*	$C_{37}H_{74}NO_8P$	0,60	Fosfolipid / Ester fosfat

Source: Research data (2024)

The GC-MS (Gas Chromatography–Mass Spectrometry) analysis of the ethanol extract from the stem of Kalimantan ginseng (*Eurycoma longifolia* Jack) identified 25 major compounds, indicating the diversity of bioactive constituents present in the extract. The chromatogram in Figure 2 shows five prominent peaks, specifically peaks 2, 1, 7, 12, and 17. The significant height of these peaks indicates that the corresponding compounds are present in higher concentrations compared to others.

Peaks 2 and 1 share similar compound identities with those found in the ethanol extract of *Cinnamomum sintoc* stem. Peak 2 has a retention time of 13.40 minutes and an area percentage of 38.21%, and it was identified as *containing n-Hexadecanoic acid*. Meanwhile, Peak 1, with a retention time of 13.19 minutes and an area percentage of 18.16%, was identified as *Palmitoleic acid*. Both compounds are classified as primary metabolite fatty acids. These compounds are known for their antioxidant, antimicrobial, anti-inflammatory, and potential anticancer activities (Sogandi *et al*., 2019).

Peak 7 has a retention time of 15.71 minutes and an area percentage of 10.50%. The compound identified at this peak is *trans-13-Octadecenoic acid*, which belongs to the fatty acid group. This compound is known to possess anti-inflammatory, antiandrogenic, anaemiagenic, insecticidal, and flavor-enhancing properties (Awonyemi *et al*., 2020). Herbal plants with anti-inflammatory properties can be utilized to treat inflammation-related conditions (Yuda *et al*., 2022). Furthermore, the antiandrogenic activity of this compound is beneficial in managing conditions associated with excessive androgen hormones, such as acne, benign prostatic hyperplasia (BPH), androgenic alopecia (male pattern baldness), and polycystic ovary syndrome (PCOS).

Peak 12 has a retention time of 17.65 minutes and an area percentage of 6.45%. The compound identified at this peak is *Glycidyl palmitate*, which is also classified as a fatty acid. According to a study by (Puspa *et al*., 2025), *Glycidyl palmitate* exhibits promising anticancer properties. Therefore, this compound has the potential to be further developed as an effective and safe candidate for the treatment of diabetes and cancer in the future.

Peak 17 has a retention time of 20.21 minutes and an area percentage of 3.89%. The compound identified at this peak is *Glycidyl oleate*, a chemical classified as an epoxide ester. In the chemical industry, this compound can serve as a raw material or intermediate in the synthesis of other chemical substances, particularly those derived from fatty acids. However, specific pharmacological benefits and detailed information regarding the active components of *Glycidyl oleate* are not widely documented in the available literature.

CONCLUSION

This study highlights the rich medicinal potential of six endemic Kalimantan herbal plant species—saluang belum, sintok, pasak bumi, akar kuning, kayu sutra, and nonang—revealing diverse phytochemical compositions with promising pharmacological properties. Tannins were universally present, while triterpenoids dominated most species except pasak bumi, which uniquely contained steroids, indicating varied biosynthetic pathways. Sintok

exhibited the highest total polyphenol content and strong antioxidant capacity, whereas pasak bumi showed the highest flavonoid concentration, underscoring metabolic diversity. GC-MS profiling identified benzenepropenamide derivatives in sintok and fatty acids in pasak bumi as major bioactive constituents, validating traditional uses for antimicrobial, anti-inflammatory, and metabolic ailments. The detection of glycidyl palmitate in both species further suggests potential for antidiabetic applications. Future research should focus on comprehensive in vitro and in vivo bioactivity testing, toxicity evaluations, and clinical validation to support the formulation of standardized, evidence-based herbal medicines that promote pharmaceutical independence and sustainable economic growth in Indonesia.

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