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Profiling of Nutrition, Essential Oil, and Antioxidant Capacity (IC_{50}) of Lomo (*Protium Javanicum Burm. F.*)

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Abstract*— Lomo (*Protium javanicum Burm. F.)* is an aromatic leaf traditionally used by the Samawa ethnic group in several local cuisines of Sumbawa, West Nusa Tenggara (NTB), Indonesia. In addition to its culinary applications, lomo has been reported to possess medicinal potential, including antitussive, gastroprotective, anti-inflammatory, antidiarrheal, anticancer, and antibacterial activities. This study aimed to determine the nutritional composition, identify functional groups, characterize the essential oil constituents, and evaluate the antioxidant capacity (IC_{50}) of lomo. Lomo samples were collected from Sumbawa, NTB. Essential oil composition was analyzed using gas chromatography–mass spectrometry (GC–MS). Proximate analysis revealed that lomo contained moisture (10.662%), ash (6.185%), protein (10.662%), fat (0.872%), and carbohydrates (71.619%). Functional group characterization using Fourier transform infrared (FTIR) spectroscopy indicated the presence of O–H, C=C–H, C=O, C–H, C–N, and C–O vibrational bonds. GC–MS analysis showed that the essential oil of lomo is a complex mixture comprising 189 compounds, which can be classified into terpene, sterol, fatty acid, cyclic ester, ether, alkenyne, and phenolic groups. The antioxidant capacity (IC_{50}) of lomo extracts was 9.043 mg/mL in moisture, 1367.053 mg/mL in n-hexane, and 5.800 mg/mL in methanol. The findings of this study provide baseline scientific information on the nutritional profile, functional groups, essential oil composition, and antioxidant activity of lomo. This information may support the development and diversification of herbal food and beverage products incorporating lomo, as well as contribute to the promotion of traditional Sumbawa culinary products such as sepat samawa and singang samawa.

***Keywords*— lomo samawa, proximate, FTIR, GC-MS, antioxidant capacity**

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I. INTRODUCTION

Protium javanicum has long been used both as a culinary ingredient and as a traditional medicinal plant. In Sumbawa, the local community commonly consumes lomo as an ingredient in sepat Field [1] and singang, traditional Sumbawan dishes. The leaves are valued for their distinctive aroma and fresh taste and are also eaten alongside fresh vegetables. In Bali, lomo is similarly used as a vegetable and in traditional medicine to treat coughs, stomachaches, inflammation, and diarrhea. It has also been reported to exhibit anticancer and antibacterial potential [2–5]. Protium javanicum is known by various vernacular names across Indonesia, including kayu bawang (Sundanese), trenggulun or tenggulun (Javanese and Balinese), katimus (Sasak), and kayu pahit (Bengkulu) Field [6]. Among the Samawa people of Sumbawa, P. javanicum has specific local terminology: the tree is referred to as puin katimis, the young leaf tips are called den lomo **(Figure 1)**, and the fruit is known as bua loam. Puin katimis is widely distributed in Sumbawa and commonly grows in home gardens and agricultural fields. Taxonomically, Protium javanicum belongs to the genus Protium within the family *Burseraceae* [5].

The maturity stage of *Protium javanicum Burm. f.* leaves significantly influence their physicochemical properties, particularly moisture content, ash content, and crude fiber content. Observations conducted on leaves at different developmental stages: very young, young, moderately mature, and mature, revealed moisture contents ranging from 7.35% to 9.15%, ash contents from 6.45% to 13.44%, and crude fiber contents from 6.24% to 18.43%. Information on sensory

characteristics is essential prior to the development of lomo-based products, particularly for applications such as herbal tea [7]. Previous studies have investigated herbal tea formulations combining lomo from Sumbawa with ginger. Lomo tea is characterized by a slightly sour aroma and a greenish-yellow coloration. The incorporation of ginger was found to significantly influence flavor attributes and enhance the antioxidant activity of lomo tea [8].

The medicinal potential of *Protium javanicum Burm. f.* is largely attributed to its diverse phytochemical composition, which includes essential oils, triterpenoids, steroids, phenolic compounds, and quinones. Additional bioactive constituents such as alkaloids, flavonoids, terpenoids, tannins, polyphenols, and saponins have also been identified [9,10]. Quantitative analyses have reported phenolic contents ranging from 9.27% to 13.36%, flavonoid contents from 1.94% to 2.39%, and tannin contents from 9.89% to 14.17% [7].

Fig 1. Lomo (*Protium Javanicum Burn F.*) (Personal source)

Fourier Transform Infrared (FTIR) spectroscopy is widely recognized as an effective analytical technique for elucidating chemical composition and its correlation with biological activity. Compared with chromatographic methods, FTIR offers several advantages, including simplicity, non-destructive analysis, rapid data acquisition, cost-effectiveness, and satisfactory accuracy. The integration of FTIR with multivariate statistical tools, such as Principal Component Analysis (PCA), further enhances its capability to discriminate variations in sample composition arising from the use of different extraction solvents. FTIR spectral profiles have been reported to correlate with total phenolic content, antioxidant capacity, and α-amylase inhibitory activity. In particular, five characteristic wavenumber regions have been identified as indicative of phenolic functional groups [11]. The presence of flavonoid glycosides and phenolic acids is strongly associated with antioxidant activity, whereas catechol groups and compounds lacking polyphenolic structures show limited or no significant correlation with antioxidant capacity [12]. Extraction solvent polarity plays a critical role in determining antioxidant activity [10], [13]. Previous studies on *Protium javanicum Burm. f.* leaf extracts from Banyuwangi reported IC_{50} values of 9,799 ppm for methanol and 118,683 ppm for ethyl acetate extracts [13]. Furthermore, IC_{50} values obtained using ethanol, distilled moisture, methanol, and acetone as solvents were 19.98 ppm, 262.20 ppm, 13.52 ppm, and 82.24 ppm, respectively.

Based on existing studies, lomo (*Protium javanicum Burm. f.*) contains various secondary metabolites and exhibits antioxidant potential. However, despite its distinctive aroma and widespread use in traditional Samawa cuisine, comprehensive information regarding its nutritional profile, essential oil composition, and antioxidant capacity (IC_{50}) remains limited. This knowledge gap presents a challenge and an opportunity for further scientific investigation. Therefore, this study aimed to conduct a proximate analysis and evaluate the essential oil composition and antioxidant capacity (IC_{50}) of lomo collected from Sumbawa. The chemical characteristics of lomo were analyzed using Fourier Transform Infrared (FTIR) spectroscopy to identify functional groups, while gas chromatography–mass spectrometry (GC–MS) was employed to identify and quantify secondary metabolite constituents in the essential oil. Overall, the findings of this study are expected to provide fundamental information on the chemical composition and bioactive properties of lomo, thereby supporting its optimal utilization not only as a flavoring agent in traditional Sumbawa cuisine but also as a potential ingredient in functional food and herbal-based products.

II. Material and Methods

A. Material

Fresh lomo (*Protium javanicum Burm. f.*) was collected from Lamenta Village, Sumbawa Regency, West Nusa Tenggara (NTB), Indonesia. The chemicals and reagents used in this study included n-hexane, distilled moisture, methanol, sodium sulfate (Na_2SO_4), copper sulfate ($CuSO_4$), sulfuric acid (H_2SO_4), sodium hydroxide (NaOH), boric acid, methyl red, bromocresol green, hydrochloric acid (HCl), and 2,2-diphenyl-1-picrylhydrazyl (DPPH). All chemicals were of analytical grade.

B. Methods

1. Proximate analysis of lomo [14]

Moisture content was determined using the oven-drying method. Approximately 2.0 g of sample (W_1) was accurately weighed into a porcelain crucible of known mass. The sample was dried in a hot-air oven at 100–105 °C for 3 h, then cooled to room temperature in a desiccator and reweighed. The drying process was continued for additional 1 h intervals, with cooling in a desiccator between each step, until a constant weight (W_2) was obtained. A constant weight was defined as a difference of less than 0.02 mg between successive weighings.

Ash content was determined by dry ashing. An empty crucible was preheated in a muffle furnace, cooled in a desiccator, and weighed. Approximately 3.0 g of sample was placed in the crucible, weighed, and initially charred over a gas flame until visible smoke ceased. The crucible was then transferred to a muffle furnace and heated at 400 °C, followed by further ashing

at 550 °C. After each heating step, the crucible was cooled in a desiccator and weighed. The ashing process was repeated until a constant ash weight was achieved.

Protein content was determined using the Kjeldahl method. Approximately 0.5 g of sample was accurately weighed and transferred into a Kjeldahl digestion flask. A catalyst mixture consisting of sodium sulfate (Na_2SO_4) and copper sulfate ($CuSO_4$) in a 20:1 (w/w) ratio, with a total mass of 1.0 g, was added to the flask. Subsequently, 6 mL of concentrated sulfuric acid (H_2SO_4) was added, and the mixture was subjected to digestion at 350 °C for 2–3 h until the solution became clear, indicating complete digestion. The digest was then allowed to cool to room temperature. After digestion, 200 mL of distilled moisture was added to the flask, and the mixture was thoroughly homogenized. Alkalization was achieved by adding 25–30 mL of 40% sodium hydroxide (NaOH) solution. The resulting mixture was distilled, and approximately 150 mL of distillate was collected into an Erlenmeyer flask containing 10 mL of 2% boric acid solution and 4–5 drops of a mixed indicator (methyl red and bromocresol green). The collected distillate was subsequently titrated with 0.1 N hydrochloric acid (HCl) until the endpoint was reached, as indicated by a color change from green to pink. The volume of HCl consumed was recorded and used to calculate the protein content.

$$N\ (\%) = \frac{\text{V sample (mL)} - V\ blank(mL)}{\text{sample (mg)}}\ x\ 0.1\ x\ 14.008\ x\ 100$$

$$Protein\ (\%) = \text{N}(\%)\ x\ Factor\ converse$$

Oil content was determined using the Soxhlet extraction method. Approximately 10.0 g of the prepared sample was placed into a cellulose extraction thimble. The thimble was inserted into a Soxhlet apparatus connected to a round-bottom flask containing 200 mL of n-hexane as the extraction solvent. A condenser was attached, and cooling moisture was circulated continuously throughout the extraction process. The extraction was carried out for 2 h under reflux conditions. Following extraction, the solvent was removed by evaporation, and the resulting oil extract was quantitatively transferred into a pre-weighed container. The increase in mass of the container after solvent removal was recorded as the oil content of the sample.

2. FTIR Analysis of Lomo [14], [15]

The Fourier Transform Infrared (FTIR) spectrometer was powered on, and the corresponding software was initiated. Prior to analysis, the scan function was verified to be active. The diamond crystal and sample holder were thoroughly cleaned with ethanol to avoid cross-contamination. A background spectrum was recorded by selecting the background acquisition mode and allowing the scan to reach completion (100%). For solid or gel samples, a small amount of sample was placed directly onto the diamond crystal (ATR sample holder). The pressure arm was carefully positioned and engaged to ensure adequate contact between the sample and the crystal. The sample table was selected in the software interface, and the scan was initiated. Pressure was gradually applied until a value of approximately 60 (as displayed by the instrument) was achieved. The scan was continued until the acquisition reached 100% and the infrared spectrum was generated. Upon completion of the measurement, the sample was removed, and the diamond crystal was cleaned with ethanol. For liquid samples, analysis was performed using a metal sampling tube equipped with a filter, and pressure was not applied via the diamond lever. The scan was initiated directly through the software interface.

3. Phytochemical screening of lomo using GC-MS [16], [17]

The sample extract was dissolved in n-hexane, vortexed at 9500 rpm for 5 min, and subsequently centrifuged to separate the particulate matter. The resulting supernatant was carefully transferred into a GC–MS vial for analysis. The GC–MS system was operated using ultra-high-purity (UHP) helium as the carrier gas. Instrument parameters were set as follows: injector temperature, 230 °C; split flow rate, 10 mL/min; split ratio, 10:1; front inlet flow rate, 1.00 mL/min; MS transfer line temperature, 250 °C; ion source temperature, 200 °C; mass scan range, 40–500 amu; purge flow rate, 3 mL/min; gas saver flow rate, 5 mL/min; and gas saver activation time, 5 min. The prepared sample was injected, and the resulting chromatograms and mass spectra were used for identification and quantification of the volatile compounds.

4. Antioxidant Capacity Analysis (IC50) of lomo [18]

Sample extracts were prepared at a series of concentrations (10, 25, 50, 100, and 200 ppm) by serial dilution. A 50 mg/L solution of 2,2-diphenyl-1-picrylhydrazyl (DPPH) was also prepared as the radical source. For the assay, 1 mL of each sample extract was mixed with 2 mL of the DPPH solution. A blank containing only the solvent was included for baseline correction. All reaction mixtures, including the blank, were incubated in the dark at room temperature for 30 min to allow the reaction to reach completion. Following incubation, the absorbance of each mixture was measured at 517 nm using a UV–Vis spectrophotometer. The percentage of DPPH radical inhibition was calculated for each concentration. A regression curve of percentage inhibition versus sample concentration was constructed, and the resulting regression equation was used to determine the concentration required to achieve 50% inhibition (IC_{50}). The IC_{50} value corresponds to the concentration at which the regression curve intersects 50% inhibition.

III. Result and Discussion

C. Proximate analysis of lomo

Leaf nutrient analysis was conducted to quantify key nutritional components, including total carbohydrates, total protein, total oil, total ash, and moisture content. Such information is essential for optimizing the utilization of leaves, particularly for health-related and food applications. As shown in **Figure 2** and **Table 1**, lomo exhibits the highest content of total carbohydrates (71.619%) compared to other nutrients. This carbohydrate level is comparable to that reported for trenggulun leaf from Bali, which contains 72.53% total carbohydrates. Balinese trenggulun tea powder has been reported to contain 42.73% dietary fiber, of which 40.19% is moisture-insoluble fiber and 2.53% is moisture-soluble fiber [1]. According to SNI guidelines, crude fiber content in tea leaf should not exceed

16.5% [19]. Carbohydrates in leaf serve multiple physiological functions, acting as reactants in photosynthesis, providing energy, and contributing to structural components of leaf tissue. During photosynthesis, carbohydrates such as starch are synthesized, which are generally insoluble in moisture and stored within the leaf tissue.

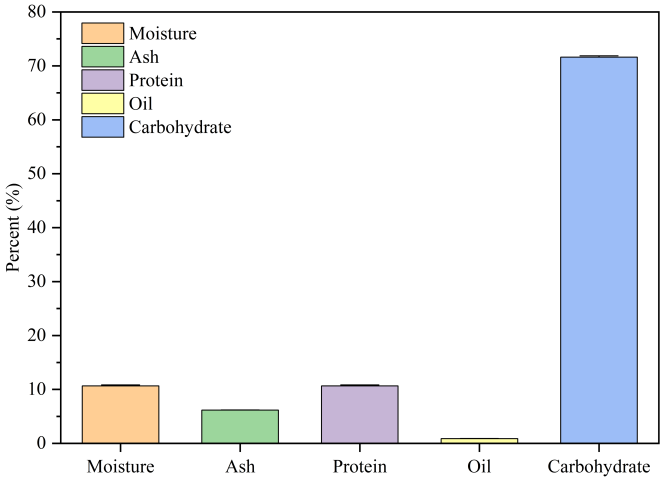

Fig. 2 Nutritional comparison of lomo

TABLE 1
RESULTS OF PROXIMATE ANALYSIS OF LOMO

Proximate	n	Mean (%)	SD	Min. (%)	Med. (%)	Maks. (%)
Moisture	3	10.662	0.159	10.522	10.628	10.835
Ash	3	6.185	0.009	6.179	6.180	6.195
Protein	3	10.662	0.159	10.522	10.628	10.835
Oil	3	0.872	0.038	0.838	0.865	0.913
Carbohydrate	3	71.619	0.292	71.296	71.699	71.863

A 5-hour drying period was sufficient to reduce the leaf's moisture content to a stable level, while maintaining a moderate temperature of 40 °C helped prevent protein denaturation and significant nutrient loss. Dabbour et al. (2022) reported that drying at moderate temperatures, such as 40 °C, may influence the physical properties of protein isolates but does not substantially affect total protein content, as many proteins remain stable and resistant to denaturation at this temperature [20]. Similarly, Asrate and Ali (2025) observed that moderate drying conditions minimize protein degradation while achieving the target moisture level [21]. Yin et al. (2025) further noted that within the temperature range of 40–60 °C, both moisture and bioactive compounds are progressively lost through evaporation, with higher temperatures accelerating this process due to increased diffusion rates. These findings underscore the importance of selecting an optimal combination of drying temperature and duration to preserve nutritional and bioactive components [22].

Drying at 40°C for 5 hours resulted in the same moisture and protein content, namely 10.662%. The protein and moisture content in Balinese terengulun tea powder were 12.2% and 7.66%, respectively [1]. Different processing methods also produce different moisture content in trenggulun tea, ranging from 8.03% to 10.141% [23]. The moisture content of tea leaf, according to SNI, ranges from 5% to 8% [19]. The ash and oil content of lomo were 6.185% and 0.872%, respectively. Referring to the Indonesian National Standard (SNI) for dry tea, the permitted ash content ranges from 4% to 8%, while instant tea has a higher ash content, a maximum of 20% [19]. The ash content produced by each withering method is 6.127%, direct drying, 6.093%, and leaf steaming, 6.167% [23]. Balinese Trenggulun tea powder has an oil content of 0.53% [1]. Based on the one-sample test variance, the moisture content, protein content, and carbohydrate content have insignificant differences in each replication. Meanwhile, the ash content and oil content have significant differences.

D. FTIR Analysis of Lomo

FTIR enables rapid detection of functional groups without complicated sample preparation or sample damage. These functional groups facilitate the interpretation of complex spectral data from heterogeneous biological matrices. When combined with chemometric analysis, FTIR can differentiate samples based on subtle spectral variations that reflect chemical composition. The characterization of functional groups in organic compounds from natural products has been widely conducted using FTIR. Vibrations corresponding to O–H, C=O, aromatic, and aliphatic C–H groups can be readily detected in sample matrices [24].

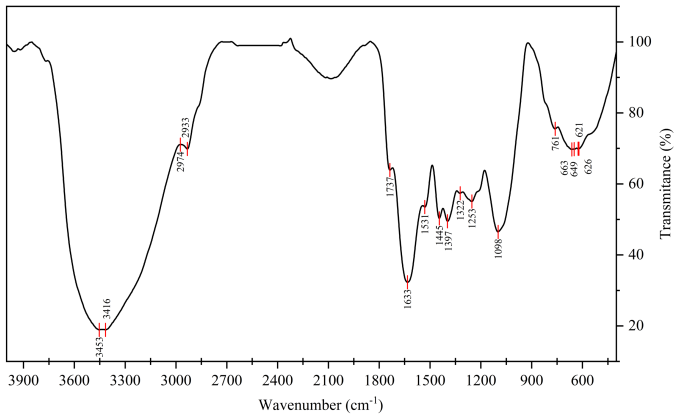

Fig. 3 FTIR Spektra of lomo

For instance, C–H, C=O, and NH functional groups, along with several fingerprint features in plant tissues, have been identified in amaranth extract samples through chemometric analysis of ATR-FTIR data [25]. Similarly, FTIR combined with chemometrics has been employed for fingerprint analysis of *Strobilanthes phyllostachya* leaf to differentiate natural product extracts based on functional group profiles [26]. Fingerprint functional groups, typically located at wavenumbers below 1500 cm^{-1}, provide detailed information about molecular structure [25]. Additionally, patterns of moisture, protein, and fat in various seeds and nuts can also be monitored using ATR-FTIR and NIR data [14]. FTIR analysis can be used to determine the chemical composition of leaf, roots, and plant cell

walls. The FTIR results in **Figure. 3** and **Table 2** show that Lomo contains several functional group bond vibrations, including: O—H; C=O—H; C=O; C—N; C—O. FTIR supports the nutritional data in lomo. In the 800–1800 cm^{-1} region, FTIR spectra of lomo exhibited bond vibrations corresponding to polysaccharides, amides, and esters. Alkyl ester groups are components of leaf lipids and pectin layers. Characteristic wavenumbers at 1650, 1550, 1436, and 1244 cm^{-1} are associated with amide groups and C—N bond vibrations in proteins, whereas the CH_3 bending vibration at 1384 cm^{-1}, along with vibrations in the 1100–1000 cm^{-1} range, indicates the presence of cellulose [15].

TABLE 2
INTERPRETATION OF FTIR SPECTRA OF LOMO

Functional Group	Wavenumber (cm^{-1})	
	Refference	lomo
O—H; N—H stretch	3009–3347	3453; 3416
CH_2 and CH_3 stretching	2853–2928	2974; 2933
N—H bending, C=O bending C=O stretching peptide* C=C	1634–1744 1650 1640	1633; 1737
Aromaticity N—H bending, C—N stretching amide*	1540–1550 1550	1531
CH_3 lipids/proteins and COO amino acids C—N stretching in peptide*	1399–1457 1438	1445; 1397
Primary or secondary O—H bending (in-plane), and phenol or tertiary alcohol (O—H bend) C—O stretching ester* CH_3 stretching cellulose*	1377–1407 1375 1384	1322; 1397
C=O stretching peptide; N—H deformation amide*	1244 ;1103	1253
C—O stretching vibrations C—C ; C—O streching; C—H bending carbohydrate*	1048–1160 1076; 1035	1098; 1070;
C—H bending vibrations	721–997	761;663; 649;626;621

[11], [15]

FTIR analysis also provides information on essential oil constituents. Vibrations observed at 2900 cm^{-1}, 1700 cm^{-1}, 3400 cm^{-1}, and 1100 cm^{-1} correspond to C—H stretching, C=O stretching, O—H stretching, and C=O stretching of terpenes, respectively. Monoterpene signals are observed at 886 cm^{-1}, 1436 cm^{-1}, and 1644 cm^{-1}, while O—C—O vibrations of primary alcohols appear at 1100 cm^{-1} and 1020 cm^{-1}. The $=CH_2$ stretching of methylene groups is detected at 890 cm^{-1} [27]. In lomo, bond vibrations were observed at 2933, 1737, 3416, 1098, 1445, 1633, and 1253 cm^{-1}, indicating the presence of phenolic and essential oil groups (**Figure. 4**). The band at 1531 cm^{-1} corresponds to aromatic compounds, overlapping with protein signals. Bands at 1322 and 1397 cm^{-1} are attributed to phenolic compounds, with overlap from proteins, carbohydrates, and lipids. Such overlapping vibrations arise from the similarity in vibrational energy ranges. It is important to note that detecting compounds present at concentrations below 1%, such as certain essential oil constituents, is challenging using FTIR [27]. Detailed interpretation of the FTIR spectra of lomo is presented in **Table 2**.

E. Phytochemical Screening of Lomo Using GC-MS

Lomo tea is characterized by its distinctive, slightly sour aroma. Rosiana (2024) reported that lomo tea has a sour odor and taste, whereas adding ginger modifies the sensory profile, imparting a spicy, ginger-flavored note [8]. The characteristic aroma of lomo tea reflects the presence of volatile compounds. Essential oils are volatile, nonpolar substances with weak van der Waals interactions. Volatile compounds with high boiling points are often difficult to separate by conventional distillation; however, separation can be achieved through hydrodistillation or by increasing their vapor pressure. In the hydrodistillation process, vapors of volatile compounds are carried by steam toward the condenser, where their vapor pressure is reduced. This change in vapor pressure can induce condensation, causing the volatile compounds to return to the aqueous phase [28]. Volatile compounds serve as communication signals in plants and have significant applications in the pharmaceutical industry, particularly in aromatherapy and perfumery [29]. Additionally, they play important roles in the food industry as natural flavor and aroma enhancers and are utilized in cosmetic formulations for skincare applications.

Compound identification using GC–MS relies on both the gas chromatogram (GC) and the mass spectrum (MS) data. The experimental mass spectrum is compared to reference spectra in a spectral library—in this case, Chromeleon Mainlib (c) Dionex Version 7.2.10.24543, maintained by the Integrated Research and Testing Laboratory, Gadjah Mada University. The software evaluates the unknown spectrum against all candidate spectra in the library and generates a “match list” of potential compound identities, ranked according to how closely each reference spectrum matches the experimental spectrum.

This ranking reflects the degree of correspondence between the experimental and reference spectra, typically quantified using a match score or match factor. These scores are often calculated using cosine similarity or modified cosine functions, which measure the similarity of fragment ion distributions (m/z values and intensities) between the unknown and reference spectra. The highest score, the best candidate, representing the highest spectral similarity or identification score, is assigned to Hit 1, followed by progressively lower scores for Hits 2 (the second-best match, considered a reasonable alternative to Hit 1) and Hit 3 (the third-best match, another potential candidate ranked by similarity) [30]. Retention times from the chromatogram are also commonly used to increase confidence in the identification. In this study, the rank order of hits (Hit 1, Hit 2, Hit 3) provides a tentative identification of a secondary metabolite for an unknown peak based on spectral similarity. It is important to note that this constitutes a tentative, not definitive, identification, and should be interpreted alongside retention data. A higher-ranked hit indicates a more probable identity when corroborated by retention time and other chromatographic evidence.

Based on HPLC and GC–MS data, the composition of essential oils can generally be classified into the following major groups: monoterpene hydrocarbons, oxygenated monoterpenoids, sesquiterpene hydrocarbons, oxygenated sesquiterpenoids, and phenylpropanoids. Essential oils are complex mixtures of volatile organic compounds, and GC–MS analysis provides a reliable method for their categorization [31].

Monoterpenes (C_{10}) are composed of two isoprene units; these include monoterpene hydrocarbons (e.g., α-pinene, β-pinene) and oxygenated monoterpenes (e.g., 1,8-cineole, linalool). Oxygenated monoterpenoids often dominate the volatile profile of many leaf and herb essential oils and frequently exhibit bioactive properties, such as antioxidant and antimicrobial effects. Monoterpene hydrocarbons contribute mainly to aroma and volatility. Sesquiterpenes (C_{15}) are composed of three isoprene units; this class includes sesquiterpene hydrocarbons (e.g., germacrene D, β-caryophyllene) and oxygenated sesquiterpenes (e.g., caryophyllene oxide). These compounds often contribute bitter or spicy aromas and can act as insect deterrents. Phenylpropanoid-like aromatic compounds are derived from phenylalanine (e.g., eugenol, methyl chavicol). Although generally less abundant than terpenes, they often exhibit significant biological activity. Other volatile constituents include alcohols, aldehydes, ketones, esters, fatty acids, and other minor volatile compounds. These constituents can also possess antioxidant or antimicrobial properties, depending on the species and extraction method [31]. Benabderrahmane et al. (2024) conducted GC–MS analysis of *Hertia cheirifolia L.* essential oils and classified the phytochemical composition into monoterpenoids and sesquiterpenoids, illustrating the typical chemical grouping observed in essential oil analysis [32]

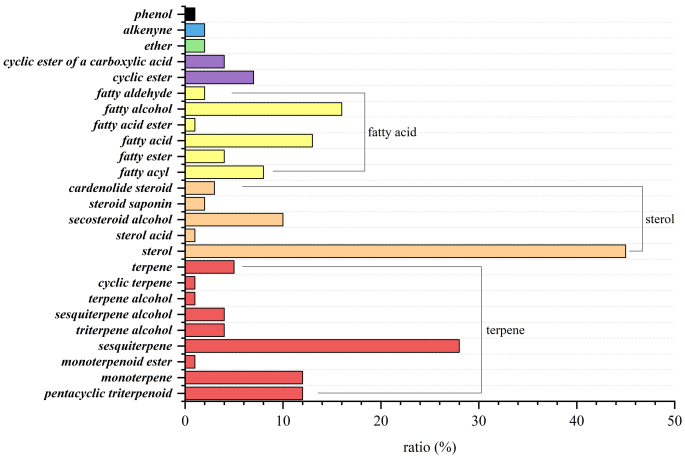

Fig. 4 Classification of nonpolar compounds in lomo

The essential oil composition of lomo (*Protium javanicum Burm. f.*) was analyzed using n-hexane as the extraction solvent. As a nonpolar solvent, n-hexane is effective in dissolving lipophilic compounds, including polyketides, lipids, waxes, phenolics (such as flavonoids), saponins, cyclitols, sterpenoids, and various aromatic-ring compounds [33]. The resulting chromatograms of lomo are presented in **Figure. 4** and **Figure. 5**. A total of 189 nonpolar compounds were detected within a retention time range of 4.44 to 31.70 minutes. Based on functional group analysis, the identified compounds included pentacyclic triterpenoids, monoterpenes, monoterpenoid esters, sesquiterpenes, triterpene alcohols, sesquiterpene alcohols, terpene alcohols, cyclic terpenes, sterols, sterol acids, secosteroid alcohols, steroid saponins, cardenolide steroids, fatty acyls, fatty esters, fatty acids, fatty acid esters, fatty alcohols, fatty aldehydes, cyclic esters, cyclic esters of carboxylic acids, ethers, alkenynes, and phenols. Overall, lomo contains terpenes, sterols, fatty acids, cyclic esters, ethers, alkenynes, and phenols in the approximate ratios of 68:61:44:11:2:2:1.

Terpenes have been found in *Protium Javanicum*. The LCMS test results contain terpenes named 3-(3,4-dihydro-2H-1,5-benzodioxepin-7-yl)-7H-furo[3.2g]chro-men-7-one and 10-(1,3-benzodioxol-5-yl)-9H-[2]benzofuro[6.5-g][1,3]benzodio-xol-7-one (helioxhantin) [5]. The results of the lomo extract test using n-hexane showed 19 peaks with an area of 21.52% - 1.24% (**Figure 6** and **Table 4**). Compounds classified as terpenes in lomo are 3-Carene (peak 1); (1S,2E,6E,10R)-3,7,11,11-Tetramethylbicyclo [8.1.0]undeca-2,6-diene (peak 15);α-Amyrin (peaks 28 and 27); Caryophyllene (peak 12); Lupeol (peak 29); Cyclohexane, 1-ethenyl-1-methyl-2,4-bis(1-methylethenyl)-,[1S-(1a,2ß,4ß)]- (peak 10); Tau-Cadinol acetate (peak 17); D:B-Friedo-B':A'-neogammacer-5-en-3-ol, (3ß)- (peak 30); Bicyclo[3.1.0]hex-2-ene, 2-methyl-5-(1-methylethyl)- (peak 5); Cyclohexene, 4-ethenyl-4-methyl-3-(1-methylethenyl)-1-(1-methylethyl)-, (3R -trans)- (peak 7); ß-Pinene (peak 6). Terpene has a basic isoprene structure and the terpene groups found in lomo are pentacyclic triterpenoid (12), monoterpene (12), monoterpenoid ester (1), sesquiterpene (28), triterpene alcohol (4), sesquiterpene alcohol (4), terpene alcohol (1), cyclic terpene (1), terpene (5) (**Figure 4**).

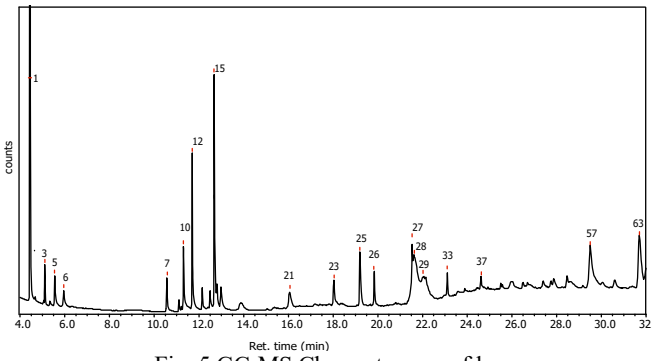

Fig. 5 GC-MS Chromatogram of lomo

Terpenes in plants are well recognized for their antibacterial activity against both antibiotic-susceptible and resistant bacterial strains. Their antimicrobial mechanism involves disruption of cell membranes and inhibition of protein and DNA synthesis. In addition to their antibacterial properties, terpenes and terpenoids have demonstrated potential as anticancer, anti-inflammatory, antioxidant, and anti-allergic agents [34].

Essential oils are complex mixtures of lipophilic compounds, including terpenes, monoterpenes, sesquiterpenes, and phenylpropanoids, the latter characterized by aromatic rings with propene side chains [28]. Additional constituents of essential oils include oxygenated compounds containing functional groups such as esters, aldehydes, ketones, alcohols, and phenols [35]. Phytochemical screening for alkaloids, flavonoids, phenols, and saponins can be performed using specific reagents, including Mayer–Wagner, Mg–HCl, $FeCl_3$, HCl–moisture, and Liebermann–Burchard reagents. Extraction of Protium javanicum has been conducted using ethyl acetate, a semipolar solvent with a polarity index of 0.228 [5]. In contrast, extraction of lomo essential oil in this study employed n-hexane, a less polar solvent with a polarity index of 0.009 [36].

In this study, n-hexane was used as a solvent. The sterol group detected was 61 types, one of which was ß-Sitosterol (peak 63) **(Figure. 5** and **Table 3)**. The aromatic compound in lomo is DL-α-Tocopherol (phenol group, Ret. time 28.46 minutes). Meanwhile, compounds classified as long-chain hydrocarbons or (fatty) in lomo are Oleic acid (peak 57), 3-(octadecyloxy)propyl ester; Phytol (peak 25); 1-Hexadecanol, 2-methyl- (peak 21, 23, 19); Heptacos-1-ene (peak 26) **(Figure. 5** and **Table 3)**. Based on the length of the carbon chain, fatty acids are divided into short-chain fatty acids (2-4 carbon chains), medium-chain fatty acids (6-12 carbon chains), long-chain fatty acids (14-18 carbon chains), and very long-chain fatty acids. Saturated fatty acids are fatty acids without double bonds [23], [34,35].

F. Antioxidant Capacity Analysis (IC50) of Lomo

Antioxidant capacity analysis provides an indication of the ability of bioactive compounds in lomo (*Protium javanicum Burm. f.*) to scavenge free radicals. The IC_{50} value represents the concentration of a bioactive compound required to inhibit 50% of free radical activity. Lower IC_{50} values correspond to stronger antioxidant capacity, whereas higher values indicate weaker activity. According to established classifications, IC_{50} values of <50 ppm are considered very strong, 50–100 ppm strong, 101–150 ppm moderate, 151–200 ppm weak, and >200 ppm very weak [16].

As shown in **Table 4**, lomo exhibited relatively weak antioxidant activity. Despite this classification, secondary metabolites extracted using methanol demonstrated higher antioxidant capacity compared to aqueous and n-hexane extracts. The differences in activity are influenced by solvent polarity: water (1.0), n-hexane (0.009), and methanol (0.762) [36], [38]. Solvent polarity affects the solubility and reactivity of compounds, where nonpolar solvents have a polarity index <0.4, slightly polar 0.5–0.9, medium 1.0–1.3, high 1.4–1.7, and ionic compounds >2.0. Methanol contains C—H, O—H, and C—O bonds, whereas nonpolar solvents predominantly consist of hydrocarbons with C—H bonds, slightly polar compounds contain N—H bonds, and medium-to-high polarity compounds include C—O and O—H bonds. A total of 189 nonpolar compounds were identified in lomo using GC–MS. The interaction of DPPH with nonpolar compounds is weaker compared to semipolar and polar compounds. Gulcin (2023) reported that DPPH is more soluble in polar organic solvents than in nonpolar solvents at room temperature. DPPH remains stable in the dark, does not dimerize, and exists as a free monomer in alcohol solvents. Phenolic groups interact effectively with DPPH due to their electron-rich structures, which readily donate hydrogen atoms [39]. GC–MS data support the observed weak antioxidant capacity of the n-hexane extract. Notably, DL-α-Tocopherol, a phenolic compound, was detected at 0.88% (**Table 4**). The —OH group of tocopherol donates hydrogen to DPPH, and its antioxidant activity is facilitated by electron delocalization within the aromatic ring, stabilizing the resulting radical.

TABLE 4
RESULTS OF THE ANALYSIS OF ANTIOXIDANT CAPACITY (IC50) OF LOMO

Solven	N	Mean (IC_{50}) mg/ mL	SD	Min. (IC_{50}) mg/mL	Med. (IC_{50}) mg/mL	Maks. (IC_{50}) mg/mL
water	3	9.043	0.153	8.910	9.010	9.210
n-hexane	3	1367.053	25.818	1351.34	1352.97	1396.85
methanol	3	5.800	0.100	5.700	5.800	5.900

The antioxidant activity of plant extracts is strongly associated with their phenolic and flavonoid content. Total phenolic content (TPC), commonly expressed in mg GAE/g, is often reported to positively correlate with the results of antioxidant assays. A comparison of lomo with other natural herbs: ginger extracts exhibited high phenolic and flavonoid content with strong DPPH scavenging activity; ethanol/methanol extracts showed IC_{50} values reflecting strong radical scavenging. IC_{50} ranges vary by extract; high phenolic content correlated with antioxidant activity. Hybrid ginger 5.81 mg/mL in Ethanol; Local ginger 0.34 mg/mL in methanol; Hybrid garlic 4.80 mg/mL in methanol; Local garlic 4.55 mg/mL in methanol. [40]. Ginger waste extract showed clear antioxidant activity tied to phenolic content. The antioxidant activity ranged from 72.9 to 111.9 μmol TE/g depending on extraction conditions [41]

Comparison across several related spices showing quantitative antioxidant ranking; Z. officinale extract had the highest DPPH activity (IC_{50} = 14.93 μg/mL) among Zingiberaceae herbs. highest activity (98.42%), followed by K. galanga (86.13%), A. galanga (85.04%), Z. officinale (74.76%), and C. xanthorrhiza (43.74%). [42]. C. longa is the greatest source of natural antioxidants among 12 Indonesian indigenous Zingiberaceae herbs. C. longa contain 94.85 % of antioxidants while, Z. zerumbet contain 8.45% with the lowest antioxidants. This study conduct using Rhizome part of 12 Indonesian indigenous Zingiberaceae species herbs: (1) K. galanga, (2) B. rotunda, (3) C. longa, (4) Z. cassoumounar, (5) C. heynana, (6) A. purpurata, (7) Z. officinale, (8) Z. zerumbet, (9) C. manga, (10) C. aeruginosa, (11) C.xanthorrhiza, and (12) C. zedoar [43]

TABLE 3
IDENTIFICATION OF ESSENTIAL OIL COMPOSITION OF LOMO USING GC-MS

No	Ret. Time	Hit# 1	FM	MW	Hit# 2	FM	MW	Hit# 3	FM	MW	Rel. Area (%)
1	4.44	3-Carene	$C_{10}H_{16}$	136	(1R)-2,6,6-Trimethylbicyclo[3.1.1]hept-2-ene	$C_{10}H_{16}$	136	(1S)-2,6,6-Trimethylbicyclo[3.1.1]hept-2-ene	$C_{10}H_{16}$	136	21.52
15	12.68	(1S,2E,6E,10R)-3,7,11,11-Tetramethylbicyclo[8.1.0]undeca-2,6-diene	$C_{15}H_{24}$	204	Cyclohexane, 1-ethenyl-1-methyl-2-(1-methylethenyl)-4-(1-methylethylidene)-	$C_{15}H_{24}$	204	?-Elemene	$C_{15}H_{24}$	204	9.10
28	21.62	a-Amyrin	$C_{30}H_{50}O$	426	ß-Amyrin	$C_{30}H_{50}O$	426	Olean-12-en-3-ol, acetate, (3ß)-	$C_{32}H_{52}O_2$	468	9.02
57	29.49	Oleic acid, 3-(octadecyloxy)propyl ester	$C_{39}H_{76}O_3$	592	Pregnan-18-oic acid, 20-hydroxy-, (5a)-	$C_{21}H_{34}O_3$	334	22-Tricosenoic acid	$C_{23}H_{44}O_2$	352	5.93
63	31.70	?-Sitosterol	$C_{29}H_{50}O$	414	ß-Sitosterol	$C_{29}H_{50}O$	414	17-(1,5-Dimethylhexyl)-10,13-dimethyl-4-vinylhexadecahydrocyclopenta[a]phenanthren-3-ol	$C_{29}H_{50}O$	414	5.77
12	11.70	Caryophyllene	$C_{15}H_{24}$	204	Bicyclo[7.2.0]undec-4-ene, 4,11,11-trimethyl-8-methylene-,[1R-(1R*,4Z,9S*)]-	$C_{15}H_{24}$	204	Isocaryophillene	$C_{15}H_{24}$	204	5.48
27	21.53	a-Amyrin	$C_{30}H_{50}O$	426	ß-Amyrin	$C_{30}H_{50}O$	426	4,4,6a,6b,8a,11,12,14b-Octamethyl-docosahydropicene-3,13-diol	$C_{30}H_{52}O_2$	444	4.24
25	19.20	Phytol	$C_{20}H_{40}O$	296	3,7,11,15-Tetramethylhexadec-2-en-1-yl acetate	$C_{22}H_{42}O_2$	338	Phytol, acetate	$C_{22}H_{42}O_2$	338	3.44
29	22.03	Lupeol	$C_{30}H_{50}O$	426	a-Amyrin	$C_{30}H_{50}O$	426	D:B-Friedo-B':A'-neogammacer-5-en-3-ol, (3ß)-	$C_{30}H_{50}O$	426	3.12
10	11.31	Cyclohexane, 1-ethenyl-1-methyl-2,4-bis(1-methylethenyl)-, [1S-(1a,2ß,4ß)]-	$C_{15}H_{24}$	204	Cyclohexane, 1-ethenyl-1-methyl-2,4-bis(1-methylethenyl)-	$C_{15}H_{24}$	204	8-Isopropenyl-1,5-dimethyl-cyclodeca-1,5-diene	$C_{15}H_{24}$	204	3.08
21	16.05	1-Hexadecanol, 2-methyl-	$C_{17}H_{36}O$	256	Hexadecane, 1,1-bis(dodecyloxy)-	$C_{40}H_{82}O_2$	594	10-Heneicosene (c,t)	$C_{21}H_{42}$	294	1.92
23	18.03	1-Hexadecanol, 2-methyl-	$C_{17}H_{36}O$	256	Heptacos-1-ene	$C_{27}H_{54}$	378	10-Heneicosene (c,t)	$C_{21}H_{42}$	294	1.75
17	12.99	Tau-Cadinol acetate	$C_{17}H_{28}O_2$	264	1-Isopropyl-4,7-dimethyl-1,2,3,5,6,8a-hexahydronaphthalene	$C_{15}H_{24}$	204	1H-Cycloprop[e]azulene, 1a,2,3,4,4a,5,6,7b-octahydro-1,1,4,7-tetramethyl-, [1aR-(1aa,4a,4aß,7ba)]-	$C_{15}H_{24}$	204	1.70
30	22.14	D:B-Friedo-B':A'-neogammacer-5-en-3-ol, (3ß)-	$C_{30}H_{50}O$	426	Lupeol	$C_{30}H_{50}O$	426	1-Naphthalenepropanol, a-ethyldecahydro-4-hydroxy-a,2,5,5,8a-pentamethyl-, [1S-[1a(R*),2a,4a,4aß,8aa]]-	$C_{20}H_{38}O_2$	310	1.70

5	5.55	Bicyclo[3.1.0]hex-2-ene, 2-methyl-5-(1-methylethyl)-	$C_{10}H_{16}$	136	Bicyclo[3.1.0]hex-2-ene, 4-methyl-1-(1-methylethyl)-	$C_{10}H_{16}$	136	a-Phellandrene	$C_{10}H_{16}$	136	1.55
7	10.56	Cyclohexene, 4-ethenyl-4-methyl-3-(1-methylethenyl)-1-(1-methylethyl)-, (3R-trans)-	$C_{15}H_{24}$	204	Elemene isomer	$C_{15}H_{24}$	204	(3aS,8aS)-6,8a-Dimethyl-3-(propan-2-ylidene)-1,2,3,3a,4,5,8,8a-octahydroazulene	$C_{15}H_{24}$	204	1.44
19	13.87	1-Hexadecanol, 2-methyl-	$C_{17}H_{36}O$	256	Hexadecane, 1,1-bis(dodecyloxy)-	$C_{40}H_{82}O_2$	594	1-Decanol, 2-hexyl-	$C_{16}H_{34}O$	242	1.39
26	19.84	Heptacos-1-ene	$C_{27}H_{54}$	378	Nonacos-1-ene	$C_{29}H_{58}$	406	Docosyl pentafluoropropionate	$C_{25}H_{45}F_5O_2$	472	1.27
6	5.95	ß-Pinene	$C_{10}H_{16}$	136	3-Carene	$C_{10}H_{16}$	136	Cyclohexane, 1-methylene-4-(1-methylethenyl)-	$C_{10}H_{16}$	136	1.24
42	25.98	Ethyl iso-allocholate	$C_{26}H_{44}O_5$	436	7,8-Epoxylanostan-11-ol, 3-acetoxy-	$C_{32}H_{54}O_4$	502	2-(16-Acetoxy-11-hydroxy-4,8,10,14-tetramethyl-3-oxohexadecahydrocyclopenta[a]phenanthren-17-ylidene)-6-methyl-hept-5-enoic acid, methyl ester	$C_{32}H_{48}O_6$	528	1.18
53	28.60	Ethyl iso-allocholate	$C_{26}H_{44}O_5$	436	7,8-Epoxylanostan-11-ol, 3-acetoxy-	$C_{32}H_{54}O_4$	502	9,10-Secocholesta-5,7,10(19)-triene-3,24,25-triol, (3ß,5Z,7E)-	$C_{27}H_{44}O_3$	416	1.04
3	5.11	Bicyclo[3.1.1]heptane, 6,6-dimethyl-2-methylene-, (1S)-	$C_{10}H_{16}$	136	ß-Pinene	$C_{10}H_{16}$	136	Bicyclo[3.1.0]hexane, 4-methylene-1-(1-methylethyl)-	$C_{10}H_{16}$	136	0.96
33	23.11	17-Pentatriacontene	$C_{35}H_{70}$	490	1-Hexacosene	$C_{26}H_{52}$	364	Octatriacontyl pentafluoropropionate	$C_{41}H_{77}F_5O_2$	696	0.96
52	28.46	a-Tocopheryl acetate	$C_{31}H_{52}O_3$	472	dl-a-Tocopherol	$C_{29}H_{50}O_2$	430	(+)-?-Tocopherol, O-methyl-	$C_{29}H_{50}O_2$	430	0.88
14	12.50	(S,1Z,6Z)-8-Isopropyl-1-methyl-5-methylenecyclodeca-1,6-diene	$C_{15}H_{24}$	204	(1R,2S,6S,7S,8S)-8-Isopropyl-1-methyl-3-methylenetricyclo[4.4.0.02,7]decane-rel-	$C_{15}H_{24}$	204	1H-Cyclopenta[1,3]cyclopropa[1,2]benzene, octahydro-7-methyl-3-methylene-4-(1-methylethyl)-, [3aS-(3aa,3bß,4ß,7a,7aS*)]-	$C_{15}H_{24}$	204	0.84
62	30.59	5H-Cyclopropa[3,4]benz[1,2-e]azulen-5-one, 3,9,9a-tris(acetyloxy)-3-[(acetyloxy)methyl]-2-chloro-1,1a,1b,2,3,4,4a,7a,7b,8,9,9a-dodecahydro-4a,7b-dihydroxy-1,1,6,8-tetramethyl-, [1aR-(1aa,1bß,2a,3ß,4aß,7aa,7ba,8a,9ß,9aa)]-	$C_{28}H_{37}ClO_{11}$	584	Cholesta-22,24-dien-5-ol, 4,4-dimethyl-	$C_{29}H_{48}O$	412	8,14-Seco-3,19-epoxyandrostane-8,14-dione, 17-acetoxy-3ß-methoxy-4,4-dimethyl-	$C_{24}H_{36}O_6$	420	0.77
13	12.15	1,4,7,-Cycloundecatriene, 1,5,9,9-tetramethyl-, Z,Z,Z-	$C_{15}H_{24}$	204	Humulene	$C_{15}H_{24}$	204	cis-a-Bisabolene	$C_{15}H_{24}$	204	0.74

47	27.39	9-Desoxo-9-x-acetoxy-3,8,12-tri-O-acetylingol	$C_{28}H_{40}O_{10}$	536	4a,7a-Epoxy-5H-cyclopenta[a]cyclopropa[f]cyclounndecene-2,4,7,10,11-pentol, 1,1a,2,3,4,6,7,10,11,11a-decahydro-1,1,3,6,9-pentamethyl-, 2,7,10,11-tetraacetate	$C_{28}H_{40}O_{10}$	536	9,10-Secocholesta-5,7,10(19)-triene-3,24,25-triol, (3ß,5Z,7E)-	$C_{27}H_{44}O_{3}$	416	0.73
50	27.88	Ethyl iso-allocholate	$C_{26}H_{44}O_{5}$	436	8,14-Seco-3,19-epoxyandrostane-8,14-dione, 17-acetoxy-3ß-methoxy-4,4-dimethyl-	$C_{24}H_{36}O_{6}$	420	4H-Cyclopropa[5',6']benz[1',2':7,8]azuleno[5,6-b]oxiren-4-one, 8-(acetyloxy)-1,1a,1b,1c,2a,3,3a,6a,6b,7,8,8a-dodecahydro-3a,6b,8a-trihydroxy-2a-(hydroxymethyl)-1,1,5,7-tetramethyl-, (1aa,1bß,1cß,2aß,3aß,6aa,6ba,7a,8ß,8aa)-	$C_{22}H_{30}O_{8}$	422	0.68
31	22.35	Ethyl iso-allocholate	$C_{26}H_{44}O_{5}$	436	1-Heptatriacotanol	$C_{37}H_{76}O$	536	Tricyclo[20.8.0.0(7,16)]triacontane, 1(22),7(16)-diepoxy-	$C_{30}H_{52}O_{2}$	444	0.57
37	24.61	Oleic acid, eicosyl ester	$C_{38}H_{74}O_{2}$	562	Octadecanal, 2-bromo-	$C_{18}H_{35}BrO$	346	17-Pentatriacontene	$C_{35}H_{70}$	490	0.54
49	27.74	Oleic acid, 3-(octadecyloxy)propyl ester	$C_{39}H_{76}O_{3}$	592	10-Acetoxy-2-hydroxy-1,2,6a,6b,9,9,12a-heptamethyl-1,3,4,5,6,6a,6b,7,8,8a,9,10,11,12,12a,12b,13,14b-octadecahydro-2H-picene-4a-carboxylic acid, methyl ester	$C_{33}H_{52}O_{5}$	528	Docosanoic acid, 1,2,3-propanetriyl ester	$C_{69}H_{134}O_{6}$	1058	0.47
8	11.11	.alfa.-Copaene	$C_{15}H_{24}$	204	Copaene	$C_{15}H_{24}$	204	Ylangene	$C_{15}H_{24}$	204	0.38
16	12.81	?-Elemene	$C_{15}H_{24}$	204	8-Isopropenyl-1,5-dimethyl-cyclodeca-1,5-diene	$C_{15}H_{24}$	204	1,5-Cyclodecadiene, 1,5-dimethyl-8-(1-methylethylidene)-, (E,E)-	$C_{15}H_{24}$	204	0.36
34	23.59	Ethyl iso-allocholate	$C_{26}H_{44}O_{5}$	436	7,8-Epoxylanostan-11-ol, 3-acetoxy-	$C_{32}H_{54}O_{4}$	502	3-Pyridinecarboxylic acid, 2,7,10-tris(acetyloxy)-1,1a,2,3,4,6,7,10,11,11a-decahydro-1,1,3,6,9-pentamethyl-4-oxo-4a,7a-epoxy-5H-cyclopenta[a]cyclopropa[f]cyclounndecen-11-yl ester, [1aR-(1aR*,2R*,3S*,4aR*,6S*,7S*,7aS*,8E,10R*,11R*,11aS*)]-	$C_{32}H_{39}NO_{10}$	597	0.29
4	5.33	2,6-Octadien-1-ol, 2,7-dimethyl-	$C_{10}H_{18}O$	154	ß-Myrcene	$C_{10}H_{16}$	136	(R)-lavandulyl acetate	$C_{12}H_{20}O_{2}$	196	0.28
44	26.50	Ethyl iso-allocholate	$C_{26}H_{44}O_{5}$	436	7,8-Epoxylanostan-11-ol, 3-acetoxy-	$C_{32}H_{54}O_{4}$	502	Oleic acid, eicosyl ester	$C_{38}H_{74}O_{2}$	562	0.27

40	25.51	Oleic acid, 3-(octadecyloxy)propyl ester	$C_{39}H_{76}O_3$	592	9-Octadecenoic acid, (2-phenyl-1,3-dioxolan-4-yl)methyl ester, cis-	$C_{28}H_{44}O_4$	444	Hexadecanoic acid, 1-(hydroxymethyl)-1,2-ethanediyl ester	$C_{35}H_{68}O_5$	568	0.26
45	26.70	Ethyl iso-allocholate	$C_{26}H_{44}O_5$	436	7,8-Epoxylanostan-11-ol, 3-acetoxy-	$C_{32}H_{54}O_4$	502	1-Heptatriacotanol	$C_{37}H_{76}O$	536	0.26
11	11.55	Epiglobulol	$C_{15}H_{26}O$	222	a-acorenol	$C_{15}H_{26}O$	222	1-Heptatriacotanol	$C_{37}H_{76}O$	536	0.26
41	25.58	Ethyl iso-allocholate	$C_{26}H_{44}O_5$	436	Oleic acid, eicosyl ester	$C_{38}H_{74}O_2$	562	Spirost-8-en-11-one, 3-hydroxy-, (3ß,5a,14ß,20ß,22ß,25R)-	$C_{27}H_{40}O_4$	428	0.25
55	28.81	Ethyl iso-allocholate	$C_{26}H_{44}O_5$	436	7,8-Epoxylanostan-11-ol, 3-acetoxy-	$C_{32}H_{54}O_4$	502	9,10-Secocholesta-5,7,10(19)-triene-3,24,25-triol, (3ß,5Z,7E)-	$C_{27}H_{44}O_3$	416	0.21
20	15.38	13-Heptadecyn-1-ol	$C_{17}H_{32}O$	252	1-Heptatriacotanol	$C_{37}H_{76}O$	536	7,11-Hexadecadienal	$C_{16}H_{28}O$	236	0.20
61	30.06	Ethyl iso-allocholate	$C_{26}H_{44}O_5$	436	9,10-Secocholesta-5,7,10(19)-triene-3,24,25-triol, (3ß,5Z,7E)-	$C_{27}H_{44}O_3$	416	7,8-Epoxylanostan-11-ol, 3-acetoxy-	$C_{32}H_{54}O_4$	502	0.20
35	23.88	Oleic acid, 3-(octadecyloxy)propyl ester	$C_{39}H_{76}O_3$	592	Spirost-8-en-11-one, 3-hydroxy-, (3ß,5a,14ß,20ß,22ß,25R)-	$C_{27}H_{40}O_4$	428	Docosanoic acid, 1,2,3-propanetriyl ester	$C_{69}H_{134}O_6$	1058	0.19
2	4.67	3-Decen-1-yne, (Z)-	$C_{10}H_{16}$	136	Dihydrocarvyl acetate	$C_{12}H_{20}O_2$	196	3-Decen-1-yne, (E)-	$C_{10}H_{16}$	136	0.18
51	27.94	Ethyl iso-allocholate	$C_{26}H_{44}O_5$	436	7,8-Epoxylanostan-11-ol, 3-acetoxy-	$C_{32}H_{54}O_4$	502	Oleic acid, eicosyl ester	$C_{38}H_{74}O_2$	562	0.17
38	24.69	Ethyl iso-allocholate	$C_{26}H_{44}O_5$	436	7,8-Epoxylanostan-11-ol, 3-acetoxy-	$C_{32}H_{54}O_4$	502	1-Heptatriacotanol	$C_{37}H_{76}O$	536	0.17
22	17.21	ß-Amyrin	$C_{30}H_{50}O$	426	1-Heptatriacotanol	$C_{37}H_{76}O$	536	a-Amyrin	$C_{30}H_{50}O$	426	0.17
9	11.21	8-Isopropenyl-1,5-dimethyl-cyclodeca-1,5-diene	$C_{15}H_{24}$	204	Guaia-1(10),11-diene	$C_{15}H_{24}$	204	Cyclohexane, 1-ethenyl-1-methyl-2,4-bis(1-methylethenyl)-	$C_{15}H_{24}$	204	0.17
32	22.99	Ethyl iso-allocholate	$C_{26}H_{44}O_5$	436	9,10-Secocholesta-5,7,10(19)-triene-3,24,25-triol, (3ß,5Z,7E)-	$C_{27}H_{44}O_3$	416	1-Heptatriacotanol	$C_{37}H_{76}O$	536	0.17
56	29.18	Ethyl iso-allocholate	$C_{26}H_{44}O_5$	436	7,8-Epoxylanostan-11-ol, 3-acetoxy-	$C_{32}H_{54}O_4$	502	9,10-Secocholesta-5,7,10(19)-triene-3,24,25-triol, (3ß,5Z,7E)-	$C_{27}H_{44}O_3$	416	0.16
60	29.80	Ethyl iso-allocholate	$C_{26}H_{44}O_5$	436	9,10-Secocholesta-5,7,10(19)-triene-3,24,25-triol, (3ß,5Z,7E)-	$C_{27}H_{44}O_3$	416	Digitoxin	$C_{41}H_{64}O_{13}$	764	0.15
46	26.83	Ethyl iso-allocholate	$C_{26}H_{44}O_5$	436	7,8-Epoxylanostan-11-ol, 3-acetoxy-	$C_{32}H_{54}O_4$	502	3-Pyridinecarboxylic acid, 2,7,10-tris(acetyloxy)-1,1a,2,3,4,6,7,10,11,11a-decahydro-1,1,3,6,9-pentamethyl-4-oxo-4a,7a-epoxy-5H-cyclopenta[a]cyclopropa[f]cyclounndecen-11-yl ester, [1aR-(1aR*,2R*,3S*,4aR*,6S*,7S*,7aS*,8E,10R*,11R*,11aS*)]-	$C_{32}H_{39}NO_{10}$	597	0.15
24	18.17	1-Heptatriacotanol	$C_{37}H_{76}O$	536	Olean-12-ene-3,28-diol, (3ß)-	$C_{30}H_{50}O_2$	442	Lupeol	$C_{30}H_{50}O$	426	0.03
39	24.76	Ethyl iso-allocholate	$C_{26}H_{44}O_5$	436	7,8-Epoxylanostan-11-ol, 3-acetoxy-	$C_{32}H_{54}O_4$	502	Ergosta-5,22-dien-3-ol, acetate, (3ß,22E)-	$C_{30}H_{48}O_2$	440	0.01

43	26.18	Ethyl iso-allocholate	$C_{26}H_{44}O_5$	436	7,8-Epoxylanostan-11-ol, 3-acetoxy-	$C_{32}H_{54}O_4$	502	3-Pyridinecarboxylic acid, 2,7,10-tris(acetyloxy)-1,1a,2,3,4,6,7,10,11,11a-decahydro-1,1,3,6,9-pentamethyl-4-oxo-4a,7a-epoxy-5H-cyclopenta[a]cyclopropa[f]cyclounndecen-11-yl ester, [1aR-(1aR*,2R*,3S*,4aR*,6S*,7S*,7aS*,8E,10R*,11R*,11aS*)]-	$C_{32}H_{39}NO_{10}$	597	0.01
18	13.70	1-Heptatriacotanol	$C_{37}H_{76}O$	536	6-epi-shyobunol	$C_{15}H_{26}O$	222	Ethyl iso-allocholate	$C_{26}H_{44}O_5$	436	0.01
58	29.71	9,10-Secocholesta-5,7,10(19)-triene-3,24,25-triol, (3ß,5Z,7E)-	$C_{27}H_{44}O_3$	416	Methyl glycocholate, 3TMS derivative	$C_{36}H_{69}NO_6Si_3$	695	Digitoxin	$C_{41}H_{64}O_{13}$	764	0.01
59	29.73	Digitoxin	$C_{41}H_{64}O_{13}$	764	Hexadecanoic acid, 1a,2,5,5a,6,9,10,10a-octahydro-5,5a-dihydroxy-4-(hydroxymethyl)-1,1,7,9-tetramethyl-11-oxo-1H-2,8a-methanocyclopenta[a]cyclopropa[e]cyclodecen-6-yl ester, [1aR-(1aa,2a,5ß,5aß,6ß,8aa,9a,10aa)]-	$C_{36}H_{58}O_6$	586	Olean-12-ene-3,28-diol, (3ß)-	$C_{30}H_{50}O_2$	442	0.00
48	27.56	Ethyl iso-allocholate	$C_{26}H_{44}O_5$	436	9,10-Secocholesta-5,7,10(19)-triene-3,24,25-triol, (3ß,5Z,7E)-	$C_{27}H_{44}O_3$	416	7,8-Epoxylanostan-11-ol, 3-acetoxy-	$C_{32}H_{54}O_4$	502	0.00
36	23.99	Ethyl iso-allocholate	$C_{26}H_{44}O_5$	436	7,8-Epoxylanostan-11-ol, 3-acetoxy-	$C_{32}H_{54}O_4$	502	3-Pyridinecarboxylic acid, 2,7,10-tris(acetyloxy)-1,1a,2,3,4,6,7,10,11,11a-decahydro-1,1,3,6,9-pentamethyl-4-oxo-4a,7a-epoxy-5H-cyclopenta[a]cyclopropa[f]cyclounndecen-11-yl ester, [1aR-(1aR*,2R*,3S*,4aR*,6S*,7S*,7aS*,8E,10R*,11R*,11aS*)]-	$C_{32}H_{39}NO_{10}$	597	0.00
54	28.75	Ethyl iso-allocholate	$C_{26}H_{44}O_5$	436	7,8-Epoxylanostan-11-ol, 3-acetoxy-	$C_{32}H_{54}O_4$	502	9,10-Secocholesta-5,7,10(19)-triene-3,24,25-triol, (3ß,5Z,7E)-	$C_{27}H_{44}O_3$	416	0.00

IV. CONCLUSION

Lomo (*Protium javanicum Burm. f.*) is a leaf characterized by a distinctive aroma and is widely used by the Samawa people as a culinary ingredient in traditional Sumbawa cuisine, West Nusa Tenggara (NTB). Proximate analysis revealed that lomo contains 10.662% moisture, 6.185% ash, 10.662% protein, 0.872% oil, and 71.619% carbohydrates. FTIR analysis indicated the presence of functional groups including O—H, C=C—H, C=O, C—H, C—N, and C—O, with overlapping vibrations suggesting similar bond energies. GC–MS analysis identified 189 compounds in lomo essential oil, classified into terpenes, sterols, fatty acids, cyclic esters, ethers, alkenes, and phenols. Antioxidant activity, as measured by IC_{50}, varied with solvent polarity: aqueous extracts exhibited an IC_{50} of 9.043 mg/mL, n-hexane extracts 1367.053 mg/mL, and methanol extracts 5.800 mg/mL, indicating higher radical-scavenging activity in polar solvents.

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CONFLICT OF INTEREST

The Authors declare no conflict of interest to disclose.

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