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Research Article

Comparative Standardization of *Moringa oleifera* L. Leaf Extracts: Evaluation of Maceration vs. Infusion Using Aqueous Solvent

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Herbal plants traditionally used to treat various diseases and serves as basis for modern drug development. The traditional medicines in Indonesia must meet safety, quality, and efficacy standards, including extract standardization and screening phytochemical. Pharmaceutical industry activities are closely related to implementation of standardization, from raw materials to finished product, in order to ensure efficacy, batch-to-batch consistency, stability, and safety. This study aims to support the utilization of Indonesia herbal plants, particularly moringa leaf. The extract evaluation must be qualified through phytochemical screening and standardization tests. The screening phytochemical result showed both methods contained alkaloids, flavonoids, tannins, saponins, terpenoids, and glycosides. Organoleptically, both extract exhibited similar characteristics besides infusion extract showing a more intense color. The water-soluble extractive values of maceration and infusion methods were 63.95% and 64%. Most non-specific parameters were within the specified limits, including loss on drying (9,07% and 10,23%), specific gravity (1,017 g/mL and 1,007g/mL), total ash content (6,08% and 7,1%), moisture content (9,40% and 10,82%), heavy metal contaminations were negative, while microbial contaminations were at 1,2 x 105 CFU/mL and 3,35 x 102 CFU/mL. Overall, both maceration and infusion methods produced M. oleifera extracts with similar phytochemical profiles and fulfilled most of the evaluated standardization parameters. Infusion produced a higher extraction yield and lower microbial contamination, whereas maceration showes lower moisture content and loss on drying values. However, neither method met all quality requirements nor considered superior overall based on the parameters evaluated, and further optimization is required to obtain a better extract standardization result.

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Indonesia is an archipelagic country possessing abundant biodiversity, including approximately 30,000 plant species, which around 7,000 are considered to have medicinal potential[1]. Herbal medicines from natural sources such as plants, animals, and minerals have been traditionally used for generations according to local cultural practices. This empirical knowledge developed over centuries,

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has become a valuable foundation for modern drug discovery and contributes significantly to the advancement of pharmaceutical sciences.

Moringa oleifera L., also known as “miracle tree”, widely recognized for its extensive pharmacological properties. This plant was from India, Moringa is well distributed and thrives in tropical regions, including Indonesia. Different parts of Moringa plant have been utilized as traditional medicinal purposes. In Ayurvedic medicine, the stem sap is used to treat fever[2], while in Indonesia, particularly in North Maluku, boiled M. leaves are consumed to reduce uric acid levels. In Central Sulawesi, fresh leaf extracts were used to treat conditions such as malaria, stroke, and hypertension[3]. M. leaves also widely consumed as a nutritional food source[4].

Phytochemical studies have revealed that M. leaves contains a lot of secondary metabolites such as flavonoids, alkaloids, tannins, steroids, saponins, and glycosides[2,5]. Previous studies have reported moderate antioxidant activity of aqueous M. leaf extract, with an IC_{50} value of approximately 217.21 mg/g, largely attributed to its flavonoid content[6]. Aqueous extracts have demonstrated potential in improving hemoglobil levels in women with anemia [7]. Quercetin, one of the flavonoids present in M. leaves, plays an important role as a strong antioxidant, exhibits anti-inflammatory properties, and provides cardioprotective effects by reducing oxidative stress [8]. It also shows antityrosinase activity or as a skin-brightening agent[9].

The wide range bioactive compounds of *M. oleifera* leaves can be potentially to become health products. Traditionally, people were commonly used extraction methods such as boiling or infusion, where the resulting infusion is consumed directly to treat various conditions including hypertension, fever, cough, and respiratory discomfort[10–12]. Variations in extraction methods may lead to inconsistencies extract results and various concentration of active compounds, especially may affect its quality, safety, and efficacy.

In modern pharmaceutical practice, extraction methods may influence the quality, stability, and bioactivity of herbal extracts. Extraction methods are classified into cold and hot techniques. Cold extraction methods include maceration. It is suitable for thermolabile compounds due to its low-temperature process. On the other hand, hot extraction methods include infusion, it uses hot water at 90°C for a shorter extraction time. Although both methods use aqueous solvents, differences in extraction temperature and duration may affect chemical composition and physicochemical characteristics of the extract. The heat effect of the infusion can enhance the release of water-soluble constituents from the plant matrix, whereas the maceration methods relies on passive diffusion of metabolites into the extraction medium[13]. This may influence the extract quality and standardization.

According to the Decree of the Indonesian Ministry of Health No. 55/MENKES/SK/I/2000, traditional medicines in Indonesia must fulfill the quality, safety, and efficacy requirements[14], including specific and non-specific parameter of standardization based on the Indonesian Herbal Pharmacopoeia[15]. However, comparative evaluation studies about the standardization of aqueous *M. oleifera* leaf extracts prepared by two traditionally relevant extraction methods namely maceration and infusion are still limited.

Therefore, this study aims to evaluate the effect of maceration and infusion methods on phytochemical profile and standardization parameters of aqueous *M. oleifera* leaf extracts, also to support the development of standardized and safe herbal products.

Results and Discussion

Extraction Yield

M. oleifera leaves powder was extracted using maceration and infusion methods with 1000 mL of aquadest as the solvent. The obtained liquid extracts were thickened in an oven at 50-60°C until thick extracts were formed. The extraction yield of both extracts were 18,986% for maceration and 25,157% for infusion. The higher yield obtained from the infusion method may be associated with heating process, which can facilitate the release and

dissolution of water-soluble constituents from the plant material. This finding is supported by previous studies on *M. oleifera* leaf aqueous infusion prepared at 90°C for 15 minutes showed a higher total polyphenol content than *M. oleifera* leaf tea prepared at 70°C for 5 minutes[16].These findings indicate suggest that heating during aqueous infusion may enhance to improve solvent penetration into the plant matrix and facilitate the dissolution of soluble constituents into the extraction medium[13]. Therefore, the higher extraction yield obtained from the infusion method in the present study may be related to the use of heated water. However, differences in extraction methods may also affect extraction efficiency, even when the same solvent is used[17,18]. Both extract were further used for screening phytochemicals and standardization relating to stability and quality assurance of the extracts. Standardization was referring to general requirements established by Indonesian Ministry of Health through evaluation of specific and nonspecific parameters [19].

Phytochemical Screening

The Phytochemical analysis of both *M. oleifera* leaf thick extracts showed the presence of alkaloids, flavonoids, tannins, saponins, glycosides, and triterpenoids. These findings are consistent with previous studies reporting the presence of similar phytochemical constituent in *M. oleifera* leaves[16]. Although both methods showed similar phytochemical profiles, elevated temperature may affect thermolabile secondary metabolites. Previous studies on *M. oleifera* reported that high-temperature treatment can alter phenolic, flavonoid, and tannin contents, with prolonged heating potentially causing thermal degradation of these compounds [20]. However, no differences in the detected phytochemical groups were observed in the qualitative screening conducted in this study. The result are presented in **Table 1.**

Table 1. Phytochemical screening of *M. oleifera* Leaves Extract

No	Screening	Reagent	Maceration Result	Infusion Result	Observation
1	Alkaloids	Mayer	+	+	White precipitate
		Bouchardat	+	+	Brown precipitate
		Dragendorff	+	+	Orange precipitate
2	Flavonoids	HCl 2N, Mg powder, H_2SO_4, amyl alcohol	+	+	Reddish phase in upper layer
3	Saponins	Hot water, shaken	+	+	Soapy foam
		HCl 2N	+	+	Soapy foam
4	Tannins	$FeCl_3$	+	+	Greenish-black
		Gelatin	+	+	White precipitate
		Gelatin-NaCl	+	+	White precipitate
5	Glycosides	Liebermann Buchard	-	-	Orange color
		Borntrager	+	+	Reddish-pink color
6	Steroid/ Triterpenoid	Lieberman Buchard	+	+	Orange color
		Salkowski	+	+	Yellow phase

Notes: (+) present, absent

Extract standardization is defines as the process of ensuring that extracts, extract products, or herbal medicines has constant and fully defines parameter values [19]. The quality of extract must meet the requirement to ensure that raw materials meet standards before being processed into final product. The standardization extract of *M. oleifera* aqueous leaf from both extraction methods were evaluated by specific parameters such as identity, extract organoleptic, and water-soluble compound content, and several nonspecific parameters such loss on drying, specific gravity, water content, total

ash content, qualitative heavy metal contamination, and microbial contamination using total plate count method. The result has been reported in **table 2.**

Table 2. Standardization Extract of *M. oleifera* leaves extract

No	Parameters	Maceration Result	Infusion Result	Standards [20]
1.	Organoleptic			
	Odor	Distinctive odor	Distinctive odor	Distinctive odor
	Color	Green-brownish	Yellow-brownish	Green-brownish
	Tastes	Bitter	Bitter	Bitter
	Form	Thick	Thick	Thick
2.	Water solubility	63,95%	64%	>4,9%
3.	Loss on drying	9,07%	10,23%	<10%
4.	Water content	9,40%	10,82%	<10%
5.	Total ash content	6,08%	7,1%	<9%
6.	Specific gravity	1,017 g/mL	1,007 g/mL	-
7.	Heavy metal contamination	-	-	negative
8.	Microbial contamination	1,2 x (10^5) CFU/mL	3,35 x (10^2) CFU/mL	<(10^5)CFU/mL

Specific Standardization Parameters

As shown in table 2, the specific parameter evaluated in this study included extract identity, organoleptic extract, and water solubility. The result showed that both *M. oleifera* leaf extracts produced using different extraction methods had similar characteristics with distinctive odor, bitter taste, and thick consistency. However, the infusion extract has darker color than maceration extract. This result suggest that higher temperature may dissolved more soluble constituents, resulting in a more concentrated color extract than maceration method.

The water-soluble extractive value indicated the amount of compounds can be extracted or dissolved in water solvent [19]. The water-soluble content of both extraction methods met the requirement of Indonesian Herbal Pharmacopeia, which specifies a minimum value is 4,9% [19]. It showed that uses of aquadest as solvent effectively dissolves polar compounds in the extract [21]. Compared with the previous study, which proposed a minimum water-soluble extractive value of 41% for *M. oleifera* leaf extract, whereas the values obtained in the present study were higher[22].

Non-specific Standardization Parameters

Also shown in **table 2**, the nonspecific parameters were evaluated to provide the stability and quality of extract. The determination of specific gravity reflects the fluidity characteristics of liquid or thick extract [22]. In this study, the thick extract were diluted until 5% concentration. The result of specific gravity values obtained were relatively similar to aquadest (1 g/mL).

The water content was analyzed to evaluate the amount of water or moist liquid inside the thick extract. The maceration method met the requirement, whereas the infusion extract exceeded the specified limit. Meanwhile, loss on drying test was used to evaluate the amount of compounds contained in extract that are lost during the drying process [20]. Similiarly, the maceration extract met the requirement for loss on drying, whereas the infusion method also exceeded the limit. The higher moisture content and loss on drying observed in the infusion extract may be associated with the different extraction conditions, particularly the heating process used during infusion. In addition, heating factor may increase the solubility of compounds into the extraction medium [23]. The moisture contents observed were lower than that reported by previous

study, who reported a moisture content by 75,85% in aqueous *M. oleifera* leaf extract[18]. This difference may be related to the different forms of extract and concentration processes used in the two studies. Higher water content in extract may increase the risk of microbial contamination[19].

The loss on drying values also differed from those reported in previous studies by 10,66% for Jantho and 12,80% for Lampeneurut[18,24]. This difference may be related to differences in sample form and processing conditions, as the previous study evaluated *M. oleifera* leaf material, whereas the present study evaluated thick extracts.

The total ash content was determined to evaluate the total mineral content that present in the extracts. The total minerals comes from internal factors, which are the mineral content from plant, and external factors, including dust or other substances[25]. Both extraction methods met the required standard. The infusion extract showed a slightly higher total ash content than the maceration extract, indicating a difference in the amount of mineral and inorganic constituents recovered by the two extraction methods. Compared with previous studies on *M.* oleifera leaf material, the total ash values obtained in the present study were higher[18]. This difference may be also related to difference in sample form and processing conditions, as the present study evaluated thick extracts.

The heavy metal contamination was evaluated to assured that the extract was not contain heavy metal such as cadmium, lead, copper, and other heavy metals exceeding the limits that have been required. High contamination of heavy metal might interfere and toxic for body functions, particularly in the digestive system [26]. The process of determining heavy metals in extract in this study used qualitative identification, by destroying metal bonds within the sample matrix using nitric acid and hydrochloric acid to release free metal ions for analysis [27]. The results showed that both extract were free from detectable heavy metal contamination or contained levels below the qualitative test. Further quantitative analysis may be performed using instrument such as atomic absorption spectrophotometry.

The microbial contamination was evaluated to determine the number of microorganisms and the presence of microbial in the extract. The infusion method met the requirement evaluation value, whereas the maceration method exceeded the limit. The result of infusion methods is lower contamination than maceration methods, where can be influenced by heating factors which have the potential to reduce the number of microbes[28]. Therefore, the implementation microbial contamination of aquadest-based extract required sterility during the extraction process and controlled environment to ensure standardized microbial contamination results.

Overall, infusion method showed advantages in extraction yield and microbial quality, while the maceration method showed advantages in loss on drying and moisture content parameters. Therefore, neither method can be considered superior overall based on the standardization parameter evaluted in this study

Conclusion

Taken together, this study demonstrated that both maceration and infusion produced aqueous *M. oleifera* leaf extract with similar phytochemical profiles. Infusion provided a higher yield and lower microbial contamination but exceeded the limits for loss on drying and moisture content, whereas maceration met these limits but exceeded the microbial contamination limit. Thus, neither method fulfilled all standardization requirements. Therefore, quantitative test for bioactive compound of each method have to be done in future work and also optimitization of sample and solvent ratio for better extract standardization result.

Materials and Methods

This study used true experimental laboratory design, with laboratory analysis to identify secondary metabolites and standardization of maceration and infusion extraction methods using aqueous solvent.

The research was carried out from February to April 2026 at Pharmacognosy Laboratory of Hermina Health Institute. All evaluations were performed in duplocate (n=2), and the result are presented as mean values.

Sample

The powdered simplicia of *M. oleifera* leaves was produced and cultivated for research purposes by UPT Materia Medica Kota Batu, Indonesia, located at an altitude 875 masl with an average temperature of 20-25°C. The plant material was identified and authenticated as *M. oleifera* Lam. by UPT Materia Medica Kota Batu, and the identification documented under certificate number 400.7.29.2/3704/102.20/2025. This sample was used for evaluation of maceration and infusion extraction methods, with aqueous as solvent.

Instruments and Materials

The instruments included an analytical balance (Vibra), erlenmeyer glass (Pyrex®), beaker glass (Iwaki®), test tubes (Pyrex®/Iwaki®), oven (Model DHG-9030A/Memmert), crush porcelain, pycnometer (Pyrex®), petri dish (Onemed), incubator (Memmert), waterbath (LabTech), desiccator, vortex (DLab), dan measuring glassware (Pyrex®).

The sample used was powdered dried *M. oleifera* leaves from UPT materia medica. Aquadest or distilled water was used as the extraction solvent. Reagents included hydrochloric acid merck, sulfuric acid merck, ferric chloride merck, Dragendorff reagent merck, Mayer reagent, Bouchardat reagent, amyl alcohol merck, sodium hydroxide smartlab, potassium iodide merck, chloride acid merck, nutrient agar himedia, dimethyl sulfoxide merck.

Maceration

Sample (100 g) of leaf powder were macerated with 1000 mL aquadest (1:10) for 18 hours nearly cold brew extraction technique at low temperature of 4°C to maintain stability and minimize degradation during the extraction process[29,30]. The filtrate were concentrated using oven at 60°C, and extracted yield was calculated.

$$\%\text{Yield} = \frac{\text{Extract mass (g)}}{\text{Simplicia mass (g)}} \text{ x } 100\%$$

Infusion

Sample (100 g) of leaf powder were infused with 1000 mL Aquadest (1:10) for 15 minutes after reaching 90°C [14]. The filtrate was concentrated using oven at 60°C , and extracted yield was calculated.

$$\%\text{Yield} = \frac{\text{Extract mass (g)}}{\text{Simplicia mass (g)}} \text{ x } 100\%$$

Screening Phytochemical

Phytochemical screening to identify secondary metabolites on aqueous extract of both methods includes alkaloids, flavonoids, saponins, tannins, steroids/terpenoids, and glycosides using standard qualitative reagents.

Alkaloids

Sample (300 mg) was added with 1mL of 2N HCl acid and 9 mL of Aquadest, heated for 2 minutes, cooled, and filtered. The obtained filtrate was added with 2 drops of Mayer reagent, Bourchadat reagent, and Dragendorff reagent[31]. The formation of a white precipitate with Mayer reagent, a brown precipitate with Bourchardat reagent, and an orange precipitate with Dragendorff reagent indicated the presence of alkaloids.

Flavonoids

Sample (1 g) was added with 10 mL of hot aquadest, boiled for 5 mins, filtered while still hot. The Filtrate (5 mL) was added with 0,1 magnesium powder, 1 mL hydrochlorid acid, and 2 mL amyl alcohol, then shake[31]. The appearance of red, yellow, or orange color in the amyl alcohol indicated the presence of flavonoids.

Saponins

Sample (100 mg) was added with 10 mL of hot water and vigorously shaken for 10 seconds.The formation of stable foam with height 1-10 cm indicated the presence of saponins, addition of 2N hydrochloric acid confirmed the presence of saponins[31].

Tannins

Sample (50 mg) was boiled in 10 mL of aquadest for 3 minutes, filtered, and the filtrate added with 1% gelatin solution, NaCl-gelatin solution[32], and $FeCl_3$ reagent[31]. The presence of white precipitate after addition gelatin solution confirmed the presence of tannins, and the formation of greenish-black color after addition of $FeCl_3$ reagent indicated the presence of tannins.

Steroids/Terpenoids

Sample (100mg) was added with 2 drops of concentrated acetic acid and 1 drops of concentrated sulfuric acid (Liebermann-Burchard reaction). The appearance of orange, red, or yellow color indicated the presence of terpenoid, while green color indicated the presence of steroid[24,32]. In the salkowski method, sample (200 mg) added with 1 mL chloroform and 1 mL concentrated sulfuric acid, two phases with red or yellow coloration indicated the positive presence of sterols[33].

Glycosides

Sample (500 mg) was added with concentrated acetic acid and sulfuric acid, the greenish-blue color indicated the presence of glycosides[34]. In borntrager reaction, the sample was reacted with 2 mL chloroform and 2 mL ammonia solution[35]. The pink-reddish color was considered positive for glycosides.

Standardization

Extract Identity and Organoleptic Test

Extract identification included plant part uses, organoleptic evaluation covered form, color, odor, and taste [14].

Water-soluble extraction value

Extract (2 g) were macerated with 40 mL water-chloroform solution for 24 hours. The filtrate (20 mL) was evaporated and dried at 105°C until constant weight was obtained. The water-soluble extractive value was calculated [19].

$$\text{Water-soluble\%} = \frac{\textit{water-soluble mass (g)}}{\textit{extract mass (g)}} \times \frac{40}{20} \times 100\%$$

Loss on Drying

Extract (1 g) was placed into a previously heated and tared crucible porcelain, placed in an oven under open condition and heated at 105°C for 30 minutes. The crucible transferred into desiccator in closed condition and allowed to cool to room temperature before weighing. The heating process was repeated until a constant weight [19]. The loss on drying value was then calculated.

$$\text{Loss on drying} = \frac{\textit{Weight before heat} - \textit{after heat}}{\textit{weight before heat}} \times 100\%$$

Specific Gravity

The empty pycnometer, pycnometer filled with water at 25°C temperature, and pycnometer filled with 5% concentration extract (1 g in 20 mL aquadest) were weighing using the same pycnometer[19]. Then the specific gravity value was then calculated.

$$\text{Specific gravity} = \frac{W_2 - W_0}{W_1 - W_0} \times 100\%$$

Expl:
W_0 = weight of the empty pycnometer (g)
W_1 = weight of the pycnometer + water (g)
W_2 = weight of the pycnometer + extract (g)

Moisture Content

In gravimetric method, an empty crucible porcelain was heated, cooled in a desiccator, and weighed. Sample (1 g) was placed into the crucible and dried at 105°C for 5 hours, then weighed again. The drying and weighing process was continued at 1-hour intervals until the last two weighing was not more than 0,25% [19]. The moisture balance value was then calculated.

$$\text{Moisture balance\%} = \frac{W_1 - W_2}{W_1 - W_0} \times 100\%$$

Expl:
W_0 = weight of empty crush (g)
W_1 = weight of crush + sample before heating (g)
W_2 = weight of crush + sample after heating (g)

Total Ash Content

Sample (2 g) was placed into a porcelain crucible, that previously has been tared. The crucible was ignited until all charcoal disappeared and no smoke remained. The crucible was cooled and weighed [19]. The total ash content value was then calculated.

$$\%\text{Ash Content} = \frac{(C-A)}{B} \times 100\%$$

Expl:
A = weight of empty crush (g)
B = weight of crush + sample before ashing (g)
C = weight of crush + sample after ashing (g)

Microbial Contamination (Total Plate Count Method)

The total plate count was performed using serial dilution method. Sample (1 g) was dissolved in 10 mL of 10% DMSO solution and homogenized to obtain a 10^{-1} dilution. Test tubes contained 9 mL of 10% DMSO solution were prepared, and put 1 mL of the 10^{-1} dilution into the first tube to obtain a 10^{-2} dilution, followed by serial dilution up to 10^{-5}. Every serial dilution (1 mL) was transferred into petri dish, followed by the addition of Nutrient agar medium and mixed thoroughly. The plates were incubated at 35-37°C for 24 hours [14,36]. Colonies ranging from 30-300 colonies were counted.

Heavy metal contamination (Qualitative test)

Sample was destructed using nitric acid (HNO_3) and hydrochloric acid (HCl) reagent, then the sample solution was used for heavy metal contamination test.

In Copper contamination, sample solution (1 mL) was added with 3 drops of potassium iodide solution with the presence of dark brown color, and 3-5 drops of sodium hydroxide with the presence of blue precipitate[37].

In Lead contamination, sample solution (1 mL) was added with dilute HCl reagent. The lead contamination were indicated by the presence of white precipitate[27,38]. Then, test was continued using potassium iodide reagent with the same procedure, it contains lead indicated with formation of yellow precipitate [27]. In Cadmium contamination, sample solution was added with 5 drops of sodium hydroxide, the white precipitate comfirmed the presence of cadmium contamination [39].

Reference

1. Widayati A, Wulandari ET. Edukasi manfaat tanaman obat dan pengolahannya dengan metode CBIA di Desa Bulusulur, Kabupaten Wonogiri, Jawa Tengah. ABDIMAS ALTRUIS: Jurnal Pengabdian Kepada Masyarakat. 2018 Apr 30;01(01):25–30.
2. Pareek A, Pant M, Gupta MM, Kashania P, Ratan Y, Jain V, et al. Moringa oleifera: An Updated comprehensive review of its pharmacological activities, ethnomedicinal, phytopharmaceutical formulation, clinical, phytochemical, and toxicological aspects. International Journal of Molecular Sciences. 2023;24(3).
3. BPOM RI. Acuan Sediaan Herbal. Direktorat Obat Asli Indonesia. 2012;73–5.
4. Marhaeni LS. Daun Kelor (Moringa oleifera) sebagai sumber pangan fungsional dan antioksidan. Jurnal Agrisia. 2021;Vol.13(2):40–53.
5. Park MO, Park C Il, Jin SJ, Park MR, Choi IY, Park CH, et al. Comparison in content of total polyphenol, flavonoid, and antioxidant capacity from different organs and extruded condition of Moringa oleifera Lam. Processes. 2022;10(5).
6. Luthfiyani D, Pradana C, Rahmi EP, Muti AF. Kajian aktivitas antioksidan : potensi ekstrak air daun Kelor (Moringa oleifera Lam.) dan Secang (Caesalpinia sappan L.) sebagai anti hiperglikemia. 2020;17(02):352–9.
7. Suzana D, Suyatna FD, Azizahwati, Andrajati R, Sari SP, Mun'im A. Effect of Moringa oleifera Leaves extract against hematology and blood

biochemichal value of patients with iron deficiency anemia. 2017;9(1):79–84.

8. Subandi, Suroto, Purwanto B, Wasita B, Soetrisno. Effects of quercetin fraction from Moringa oleifera leaf extract on oxidative markers and histological profile of carotid and coronary arteries: an experimental animal study. 2024;35(2):227–38.

9. Putu N, Laksmiani L, Widiantara IWA, Borneo A, Pawarrangan S. Potency of moringa (Moringa oleifera L .) leaves extract containing quercetin as a depigmentation agent inhibiting the tyrosinase enzyme using in-silico and in-vitro assay. 2022;69:85–92.

10. Dhea Dani BY, Wahidah BF, Syaifudin A. Etnobotani tanaman Kelor (Moringa oleifera Lam.) di Desa Kedungbulus Gembong Pati. Al-Hayat: Journal of Biology and Applied Biology. 2019 Nov 25;2(2):44–52.

11. To'bungan N. Pemanfaatan dan skrining fitokimia infusa daun rumput knop (Hyptis capitata Jacq.). Biota : Jurnal Ilmiah Ilmu-Ilmu Hayati. 2021;5(3):149–54.

12. Rifa Musyaropah, Tri Cahyanto. Studi Pemanfaatan tanaman Kelor (Moringa oleifera) sebagai pengobatan tradisional di Kampung Cibeas Desa Cintaraja Kecamatan Singaparna Kabupaten Tasikmalaya. Flora : Jurnal Kajian Ilmu Pertanian dan Perkebunan. 2025 Jan 2;2(1):44–54.

13. Ojong C, Besong SA, Aryee ANA. Solvent-Based Extraction recovers phytochemicals from medicinal plants demonstrating anticancer and chemopreventive potential: A Review. Molecules. 2026;31(7):1–45.

14. Depkes RI. Parameter standar umum ekstrak tumbuhan obat. 2000.

15. Kemenkes RI. Farmakope Herbal Indonesia Edisi II. 2017;97–103.

16. Rahmawati I, Anggraeni SD, Bernika SO, Julianti AI. Phenolic content and antioxidant activity of Moringa oleifera leaf infusions and tea. AIP Conference Proceedings. 2023;2572(March).

17. Muna L. Aktivitas antioksidan ekstrak air daun kelor (Moringa oleifera) dengan metode DPPH serta analisis kualitatif kandungan metabolit sekunder. Sasambo Journal of Pharmacy. 2022;3(2):91–6.

18. Rachmawati, S R; Suriawati J. Characterisation of Moringa (Moringa Oleifera Lam.) leaf water extracts by chemical and microbiology. Journal of Health Technology and Arts. 2019;10(2):102–16.

19. Kemenkes RI. Farmakope Herbal Indonesia Edisi II. 2017;97–103.

20. Wang Z, Tian Y, Yang M, Yang J, Wang Y, Tao L, et al. Extraction of phenolic compounds from Moringa oleifera Lam . leaves with ultrasonic-assisted deep eutectic solvents. 2024;(August):1–16.

21. Budiarti M, Wijaya NR, Jokopriyambodo W. Chemical characterization of Moringa oleifera Lam. from six growth locations in Central of Java: an initiation of standardization. 2024;17(1):1–13.

22. Kemenkes RI. Farmakope Indonesia edisi VI. Departemen Kesehatan Republik Indonesia. 2020.

23. Adiwinata W eka, Fathan F darian hafiz, Andika A, Nadiroh N lailatun, Roisiyah D, Lestari C dwi, et al. Artikel review fitokimia: efektivitas infusa sebagai metode ekstraksi. 2025;03(02):48–58.

24. Asfahani W, Kurniaty R. Uji parameter spesifik-non spesifik dan skrining fitokimia Daun Kelor (Moringa oleifera L.) berdasarkan tempat tumbuh. Jurnal Bioleuser. 2023;7(3):52–6.

25. Samang RH, Sadik F, Rahman I. Uji Standarisasi parameter spesifik dan nonspesifik serta penetapan kadar total fenolik ekstrak daun kelor (Moringa oleifera). Jurnal Syntax Admiration. 2025;6(1):7–20.

26. Widowaty W, Zakaria A, Yura Nurfiana T. Analisis cemaran logam (Cu dan Zn) pada kopi bubuk. Agroscience. 2020;10(1):79–83.

27. Yanti EF, Laili Z. Analisis logam berat timbal (Pb) dalam body lotion yang beredar di Pasar Jember. Journal of Islamic Pharmacy. 2023;7(2):94–9.

28. Cebri G, Condon S, Manas P. Physiology of the inactivation of vegetative bacteria by thermal treatments : mode of action , influence of environmental factors and inactivation kinetics. 2017;1–21.

29. Janicka P, Maksimowski D, Chwirot A, Oziembłowski M, Por P, Michalczyk K, et al. Antioxidant and antiviral potential of cold-brewed and cold-concentrated plant extracts. 2025;1–19.

30. Polanco-Estibález B, García-Santa-Cruz R, Queirós RP, Serment-Moreno V, González-Angulo M, Tonello-Samson C, et al. High-pressure processing for cold brew coffee : safety and quality assessment under refrigerated and ambient storage. Foods. 2023;

31. Mayasari U, Laoli MT. Karakterisasi simplisia dan skrining fitokimia daun jeruk lemon (Citrus limon (L.) Burm.f.). KLOROFIL: Jurnal Ilmu Biologi dan Terapan. 2018;2(1):7.

32. Yumita A, Hikmawanti NPE, Andini RF, Nurwiati I. Penetapan kadar fenolik total dan kadar tanin ekstrak etanol 96% daun Wijaya Kusuma (Epiphyllum oxypetalum (DC.) Haw.) dengan metode spektrofotometri. Wiyata. 2023;10(02):98–108.

33. Naufal M, Ananta F, Nuralyza I, Solehah K, Pratama IS. Skrining fitokimia ekstrak air dan ekstrak etanol 70 % Propolis Trigona sp . asal Lombok Utara. 2024;5(1).

34. Rubianti I, Azmin N, Nasir M. analisis skrining fitokimia ekstrak etanol Daun Golka (Ageratum conyziodes) sebagai tumbuhan obat tradisional masyarakat Bima. JUSTER : Jurnal Sains dan Terapan. 2022;1(2):7–12.

35. Godlewska K, Pacyga P, Najda A. Investigation of chemical constituents and antioxidant activity of biologically active plant-derived natural products. 2023;1–77.

36. Maryam F, Taebe B, Toding DP. Pengukuran parameter spesifik dan non spesifik ekstrak etanol Daun Matoa (Pometia pinnata J.R & G.Forst). Jurnal Mandala Pharmacon Indonesia. 2020;6(01):1–12.

37. Saniah H, Alawiah T, Mahdiyah D, Rahmadani. Analisis pengaruh waktu pengambilan sampel terhadap kandungan logam berat tembaga (Cu) pada air sungai Sebamban Kabupaten Tanah Bumbu. Jurnal Surya Medika. 2025;11:197–203.

38. Munadi R, Hamid P. Analisis cemaran logam berat pb dan cd pada rumput larut Eucheumacottonii di daerah perairan Kabupaten Kolaka Utara. Cokroaminoto Journal of Chemical Science. 2022;4(1):1–5.

39. Andimala F, Iyabu H, Kilo J La, Isa I, Suleman N, Kunusa WR. Analisis kandungan logam timbal (Pb) dan kadmium (Cd) di pantai kurenai dan perairan pelabuhan di Gorontalo. Dalton : Jurnal Pendidikan Kimia dan Ilmu Kimia. 2024;7(3):197.