



Research Article

Phytochemical Study and Characterization of the Fixed Oil of *Melothria Maderaspatana* Fruit

Wade Moustapha^{1,*} , Thiam Abdoulaye¹, Mbow Bedie¹, Sy Papa Biram¹, Diop Serigne Mbacke³, Diop Awa¹, Fall Alioune¹, Sene Madieye², Fofana Mouhamadou¹

¹Department of Chemistry, Cheikh Anta Diop University, Dakar, Senegal

²Department of Pharmacy, Cheikh Anta Diop University, Dakar, Senegal

³Department of Chemistry, Institut de Technologie Alimentaire, Dakar, Senegal

Abstract

This study aims to evaluate the phytochemical composition of *Melothria maderaspatana* (L.) Cogn. fruits, a plant recognized in African and Indian pharmacopeias, and to physicochemical characterize its fixed oil extract, in order to enhance its potential in phytomedicine. Fruits harvested in Taïba Ndiaye (Senegal) in December 2021 underwent qualitative phytochemical screening on hexane, ethyl acetate, methanolic, and aqueous extracts, followed by Soxhlet oil extraction (yield: 7.98%). Detected secondary metabolites include polyphenols (except hexane extract), flavonoids (aqueous extract), alkaloids (hexane and aqueous extracts), sterols/polyterpenes (except aqueous extract), leucoanthocyanins (except hexane extract), coumarins (hexane/ethyl acetate extracts), and gallic tannins (aqueous extract); saponins, mucilages, and catecholic tannins were absent. Oil characterization according to AFNOR standards reveals: iodine value (II) = 4.8 ± 0.07 g I₂/100 g, acid value (IA) = 1.0 ± 0.1 mg KOH/g, saponification value (IS) = 145.8 ± 0.05 mg KOH/g, peroxide value (IP) = 8.0 ± 0.3 µg O₂/g, and ester value (IE) = 144.8 ± 0.05 mg KOH/g. These results indicate a non-drying oil with low unsaturation, oxidation stability, and low free fatty acid content, highlighting the potential of *M. maderaspatana* as a source of lipids and bioactive compounds for nutraceutical and therapeutic applications, warranting complementary fatty acid analysis and toxicological evaluation.

Keywords

Melothria Maderaspatana, Phytochemical Study, Fixed Oil

1. Introduction

Since time immemorial, humans have valued the soothing and analgesic properties of plants. Over the centuries, human traditions have cultivated the knowledge and application of medicinal plants. While certain medical practices may appear strange or even magical, others, by contrast, seem more ra-

tional and efficacious. Nevertheless, all seek to relieve suffering and enhance human well-being [1]. Today, herbal treatments are regaining prominence as the effectiveness of conventional medications declines. Bacteria and viruses have gradually adapted to drugs and are becoming increasingly

*Correspondence: Wade Moustapha (wade101997@gmail.com)

Received: 24 January 2026; Accepted: 4 February 2026; Published: 21 February 2026



Copyright: © The Author(s), 2026. Published by Science Publishing Group. This is an **Open Access** article, distributed under the terms of the Creative Commons Attribution 4.0 License (<http://creativecommons.org/licenses/by/4.0/>), which permits unrestricted use, distribution and reproduction in any medium, provided the original work is properly cited.

resistant. Consequently, scientific researchers are constantly conducting new studies, particularly in the field of phytochemistry, with the goal of finding new and increasingly effective remedies to alleviate suffering and improve human health [2]. *Melothria maderaspatana* is one of the popular herbs of Tamil Nadu, India. This herb is useful in treating Kapha and Pitta imbalances with weakened constitutions. It is rich in phenolic compounds that contribute to its medicinal properties. *Melothria maderaspatana* is a time-tested traditional remedy, considered a highly effective treatment for colds, acidity, toothaches, asthma, dry coughs, hypertension, and diabetes. It is an excellent expectorant. It is used regularly in various ways as part of the diet to improve overall health. It is rich in phenolic compounds that contribute to its medicinal properties [3, 4]. Some traditional healers also use tea made from the leaves of this plant to relieve jaundice. Considering these properties and the benefits of the leaves in traditional medicine, this work aims to conduct phytochemical studies and characterize the fixed oils of *Melothria maderaspatana* fruits [5].

2. Material and Methods

2.1. Materials

2.1.1. Plant Material

The plant was harvested in December 2021 in the commune of Taïba Ndiaye, a town located in the Thiès region of western Senegal, at geographic coordinates 15°3'0" N and 16°52'60" W. The plant material consisted of the fruit of *Melothria maderaspatana*. After harvesting, the fruits were dried in the dark at room temperature in the GRSB (Research Group on Bioactive Substances) laboratory at Cheikh Anta Diop University in Dakar and identified at IFAN (Fundamental Institute of Black Africa). They were ground into a fine powder using an electric grinder and then carefully stored in jars to prevent contamination.



Figure 1. The entire plant of *Melothria maderaspatana*.



Figure 2. Powder from the fruits of *Melothria maderaspatana*.

2.1.2. Laboratory Equipment

The laboratory equipment used during our work consists of: Beakers, Erlenmeyer flasks, test tubes, balances, pipettes, graduated cylinders, water bath, spatula, round-bottom flask, filter pump, aluminum foil, magnetic stir bar, oven, plastic funnel, filter paper, magnetic stirrer, bulb, Soxhlet, condenser and rotary evaporator.

2.2. Methods

2.2.1. Extraction Methods

Five grams of finely powdered *Melothria maderaspatana* fruit were placed in an Erlenmeyer flask with 50 mL of hexane. The mixture was covered with aluminum foil to prevent solvent evaporation. After 24 hours in the dark at room temperature, the mixture was filtered, a physical method that separates the solvent from the residue. The resulting residue was then macerated again using a solvent of higher polarity. This process was repeated with all the solvents used: ethyl acetate, methanol, and water [6].



Figure 3. Different extracts from different solvents.

2.2.2. Phytochemical Characterization Techniques

Phytochemical screening constitutes a qualitative analysis relying on precipitation or staining reactions. These reactions establish the presence or absence of secondary metabolites potentially present in a plant sample. In this study, the screening targeted the detection of: polyphenols, flavonoids, alkaloids, sterols and polyterpenes, leucoanthocyanins and catechols, coumarins, saponins, mucilage, and catechin and gallic tannins. The presence of these various chemical groups was tested using the techniques described by Ronchetti and Russo [6-8].

a. Polyphenol Detection Test

To detect polyphenols, we added 2 mL of each extract to each of the two tubes (the control and the test) and then added a few drops of a 2% ferric chloride (FeCl_3) alcoholic solution. The appearance of a bluish-black or greenish-black color, more or less dark, indicates that the test is positive, confirming the presence of polyphenols.

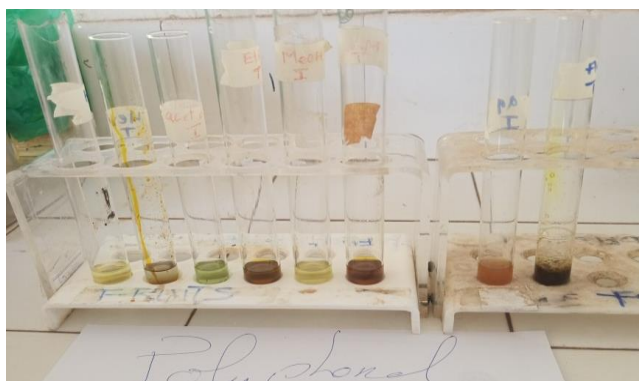


Figure 4. Demonstration of polyphenols.

b. Flavonoid Detection Test

To detect flavonoids, the Shibata reaction was used. This involves adding 1 mL of aqueous extract to 1 mL of concentrated hydrochloric acid (HCl) with a few magnesium shavings. The appearance of a color ranging from orange to purple-red indicates the presence of flavonoids.

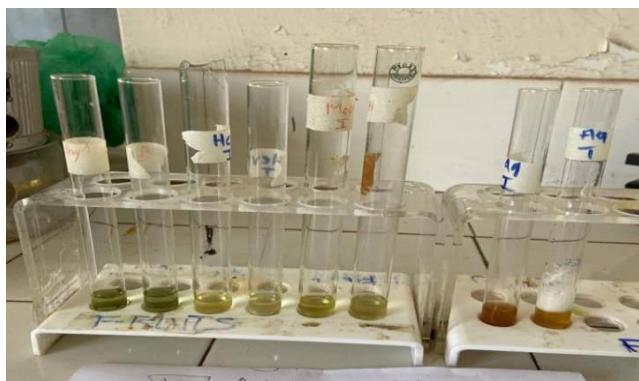


Figure 5. Highlighting flavonoids.

c. Alkaloid Detection Test

This test is based on the ability of alkaloids to combine with heavy metals. 1 mL of each extract (hexane, ethyl acetate, methanolic, and aqueous) is resuspended in a few mL of half-strength HCl. The formation of a yellow precipitate after the addition of a few drops of Mayer's reagent (1.35 g HgCl_2 + 5 g KI in 100 mL of dilute H_2O) indicates the presence of alkaloids.



Figure 6. Identification of alkaloids.

d. Sterol and Polyterpene Detection Test

Sterols and polyterpenes were detected using the Liebermann reaction. One mL of each extract was dissolved in one mL of acetic anhydride. 0.5 mL of concentrated sulfuric acid (H_2SO_4) was then added to the triturate. The appearance of a purple ring at the interphase, which then turns blue and finally green, indicates a positive reaction.



Figure 7. Demonstration of sterols and polyterpenes.

e. Leucoanthocyanin and Catechol Detection Test

Leucoanthocyanins are characterized by the cyanidin reaction. One mL of extract is added to one mL of concentrated HCl without magnesium shavings and heated for 15 minutes in a water bath. In the presence of leucoanthocyanins, a cherry-red or purplish color develops. Catechols produce a reddish-brown color.

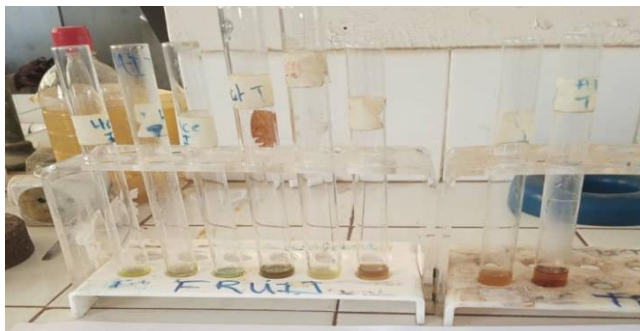


Figure 8. Highlighting leucoanthocyanins and catechols.

f. Coumarin Detection Test

To 5 mL of each extract, 2 mL of warm distilled water are added. The solution is divided between two test tubes. The presence of coumarins is tested after adding 0.5 mL of a 25% ammonium hydroxide (NH_4OH) solution to one of the tubes and observing fluorescence under a 365 nm UV lamp. Intense blue fluorescence in the tube containing the ammonia indicates the presence of coumarins.

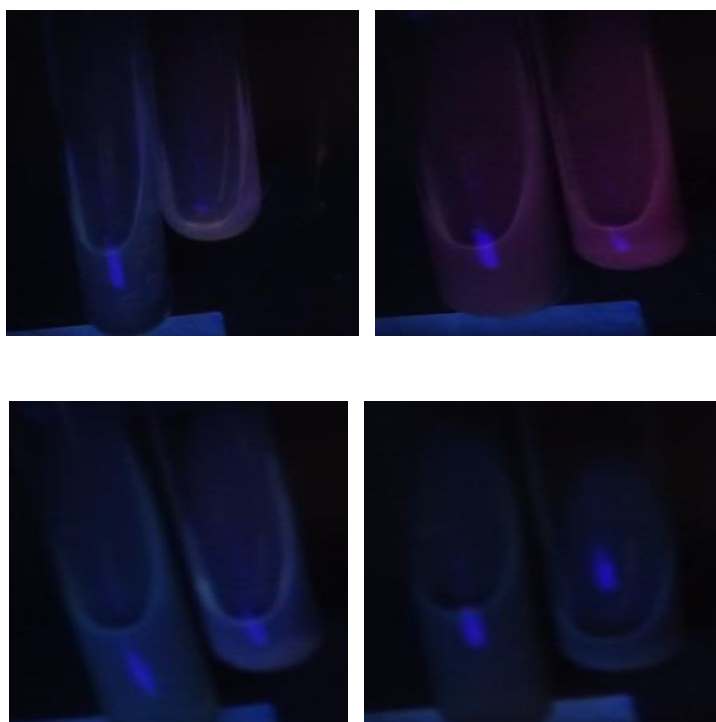


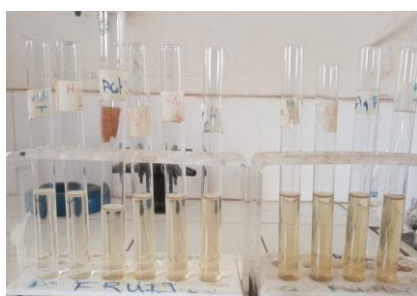
Figure 9. Demonstration of coumarins.

g. Saponin Detection Test

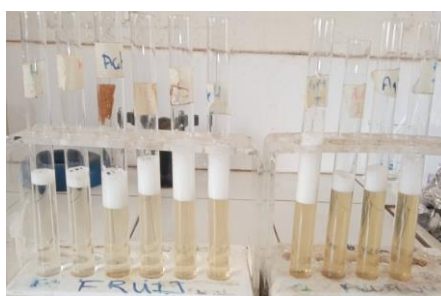
1 g of plant material is added to 100 mL of distilled water and gently boiled for 30 minutes. Filter after cooling, pour 1 mL of the extract into each test tube, and dilute to 10 mL with

distilled water if necessary.

Gently shake each tube for 30 seconds. After 15 minutes of stand, a persistent foam greater than 1 cm in height indicates the presence of saponins.



Before the commotion



Right after the commotion



15 minutes after shaking

Figure 10. Demonstration of saponins.

h. Mucilage Detection Test

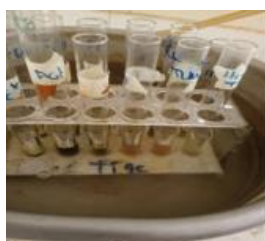
Mucilages are plant substances, composed of polysaccharides, that swell upon contact with water, taking on a viscous, sometimes sticky, gelatin-like consistency. To 1 mL of a 10% decoction, 5 mL of absolute ethanol are added. The formation of a flocculent precipitate upon mixing indicates the presence of mucilages.



Figure 11. Demonstration of mucilage.

Test for the detection of catecholic and gallic tannins

The detection of catecholic tannins was performed using Stiasny's reagent. Five (5) mL of each extract were evaporated to dryness. After adding 15 mL of Stiasny's reagent to the residue, the mixture was maintained in a water bath at 80°C for 30 min. The observation of a precipitate in large flakes characterized the gallic tannins.



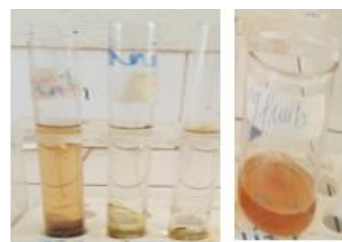
Dry evaporation



Dry extract + stiasny



Figure 14. Extraction of fixed oil.



After 30 minutes in the bain-marie

Figure 12. Demonstration of catechumenal tannins.

For gallic tannins, we filtered the previous solution. The filtrate was collected and saturated with sodium acetate. If the addition of 3 drops of FeCl_3 causes an intense blue-black color, this indicates the presence of gallic tannins.

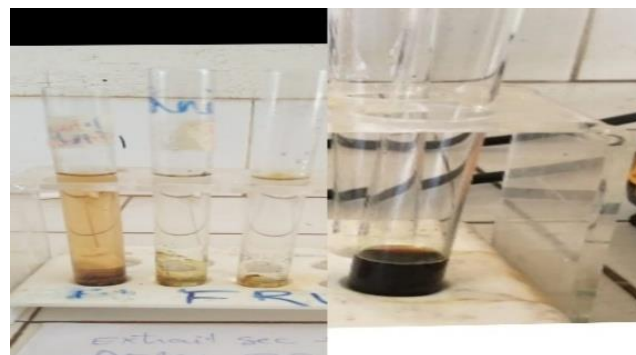


Figure 13. Demonstration of gallic tannins.

2.2.3. Oil Extraction

100 grams of powdered plant material were wrapped in filter paper to form a thimble, then placed in the Soxhlet extractor. Six hundred milliliters of hexane were added to the extraction flask, and the system was refluxed for 1 hour to maximize oil recovery. Five extraction cycles were completed, with the first cycle lasting 34 minutes while subsequent cycles ranged from 10 to 12 minutes due to the initial complete wetting and solvent saturation of the solid matrix. The hexane-oil mixture was then concentrated using a rotary evaporator, and the crude fixed oil was air-dried to ensure complete solvent removal.

2.2.4. Oil Characterization

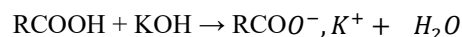
Determining chemical indices is a simple and basic method for obtaining an initial analytical assessment of the nature of a fat.

1) Acid Value

The acid value (AV) corresponds to the number of mg of potassium hydroxide required to neutralize the free fatty acids present in 1 g of fat. It is expressed in mg/g. Acidity corresponds to the free fatty acid content. It is expressed as a percentage by mass and is frequently based on the oleic acid content.

The determination of this value was carried out according to the AFNOR NF T60-204 standard. To determine this acid value, a 1:1 (v: v) ether/ethanol mixture (solution A) and 100 mL of a 0.01 M ethanolic KOH solution (solution B) were first prepared. The titration is performed according to the

following reaction.



Thus, a volume of 20 mL of solution A is added to 0.5 g of fat. The resulting mixture is titrated with solution B in the presence of phenolphthalein until it turns pink. A blank (without the fat) is prepared in the same way.

The acid value is given by the following relationship:

$$I_A = \frac{(V_E - V_B) \cdot C_{\text{KOH}} \cdot M_{\text{KOH}}}{m_{\text{cg}}} \quad (1)$$

V_B : volume poured for the blank; V_E : volume poured for the sample; C_{KOH} : concentration of the KOH solution; M_{KOH} : molar mass of KOH and m_{cg} : mass of fat used.

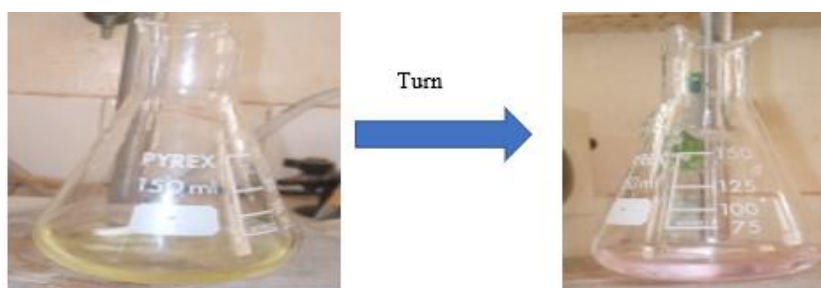
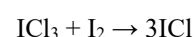


Figure 15. Determination of the Acid Value.

2) Iodine Value

The iodine value (II) is defined as the number of grams of iodine fixed per 100 g of fat. It was determined according to the Wijs method (Wolff, 1968). According to the experimental protocol used, 25 mL of cyclohexane and 10 mL of a previously prepared solution C, called Wijs reagent (ICl in 0.1 M acetic acid), are added to 0.5 g of fat in solution. After a few minutes in the dark, 100 mL of distilled water and 15 mL of B (KI at 100 g/L) are added, and the mixture is returned to the

dark for 5 min. The released iodine is titrated with a 0.1 M sodium thiosulfate solution A until decolorization occurs in the presence of starch indicator.



The iodine value is calculated using the formula:

$$I_I = \frac{(V_B - V_E) \cdot C_{\text{Na}_2\text{S}_2\text{O}_3} \cdot M_I \cdot 100 \cdot 10^{-3}}{m_{\text{cg}}} \quad (2)$$

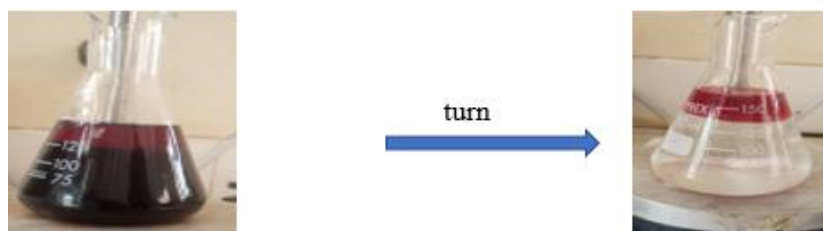


Figure 16. Determination of the Iodine Value.

3) Peroxide Value

The peroxide value is used to characterize a vegetable oil, animal fat, or resin, in the same way as the saponification value, the iodine value (unsaturation), and the acid value (free fatty acids).

This value reflects the number of active oxygen atoms in the organic chains of a fat (lipids, free fatty acids, mono-, di-, and triglycerides) or resin. This active oxygen can be in the form of epoxide or hydroperoxide. The higher the value, the more oxidized the fat [9].

Its determination, carried out according to the protocol described by the AFNOR NF T 60-220 standard, reflects the oxidation state of the oil. The principle states that the fat, in solution in acetic acid and chloroform, is treated with a potassium iodide solution. The released iodine is titrated with a sodium thiosulfate solution [10, 11].

To 0.5 g of fat, 10 mL of chloroform, 15 mL of acetic acid, and 1 mL of potassium iodide solution are added. The mixture is stirred for one minute, and then placed in the dark for 5 minutes. 75 mL of distilled water is added, and the released iodine is titrated with a sodium thiosulfate solution in the presence of 1% starch solution until decolorization occurs. The blank is prepared in the same way.

The peroxide value is given by:

$$I_p = \frac{1000 \cdot (V_E - V_B)}{m_{cg}} \quad (3)$$

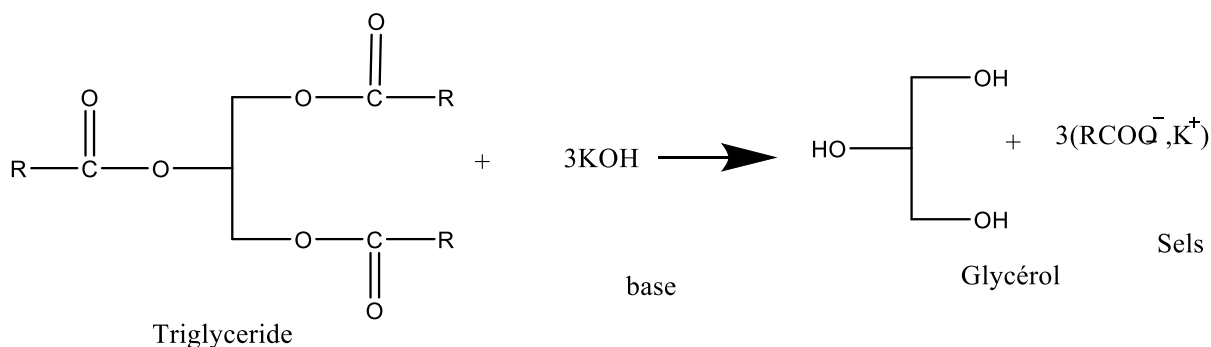


Figure 18. Determination of Peroxide Value.

Saponification reaction of oil triglycerides

To determine the saponification value, a 1:1 (v: v) ether/ethanol mixture (solution A) and 100 mL of a 0.5 M ethanolic KOH solution (solution B) are prepared beforehand.

In a weighted flask containing 0.5 g of fat, 20 mL of A and 20 mL of B are added. The mixture is refluxed for one hour and then cooled. The remaining KOH is then titrated with 0.5 M HCl in the presence of phenolphthalein. A blank is prepared in the same manner. The saponification value is determined according to the following relationship:

mined according to the following relationship:

$$I_s = \frac{(V_B - V_E) \cdot C_{HCl} \cdot M_{KOH}}{m_{cg}} \quad (4)$$

V_B : volume poured for the blank; V_E : volume poured for the sample; C_{HCl} : concentration of the HCl solution; M_{KOH} : molar mass of KOH and m_{cg} : mass of fat used.

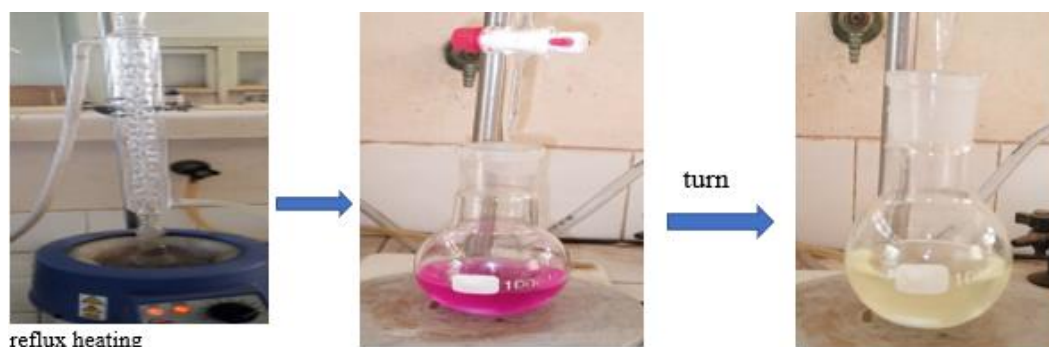


Figure 19. Determination of the Saponification Value.

5) Ester Value

The ester value (EV) of a fat is defined as the number of milligrams of potassium hydroxide (KOH) required to neutralize the acids released by the hydrolysis of esters contained in 1 g of fat. For pure glycerides, the ester value equals the saponification value. In practice, this value is calculated by subtracting the acid value (IA) from the saponification value (IS) using the formula.

(I_A), that is:

$$I_E = I_S - I_A \quad (5)$$

3. Results

In this section, we present the results obtained during the various extractions and phytochemical screening, followed by the characterization of the fixed oil from *Melothria maderaspatana* fruits.

Phytochemical Screening

Phytochemical screening of *Melothria maderaspatana* fruit extracts was performed using standard methods.

Table 1 below presents the results obtained.

Table 1. Phytochemical Screening Results.

Compound family	EXTRAITS			
	Hexanique	Acetate ethyle (AcOEt)	Methanolique (MeOH)	Aqueux
Polyphenols	-	+	+	+
Flavonoïdes	-	-	-	+
Alcaloïdes	+	-	-	+
Sterols et Polyterpènes	+	+	+	-
Catechols	-	-	-	-
Leucoanthocyanes	-	+	+	+
Coumarines	+	+	-	-
Saponosides	-	-	-	-
Mucilages	-	-	-	-
Tanins catechiques	-	-	-	-
Tanins galliques	-	-	-	+

+ = present

- = absent

Phytochemical tests performed on extracts of *Melothria maderaspatana* fruit revealed the presence of:

- 1) Polyphenols in all extracts except the hexane extract.
- 2) Flavonoids only in the aqueous extract.
- 3) Alkaloids in both the hexane and aqueous extracts.
- 4) Sterols and polyterpenes in all extracts except the aqueous extract.
- 5) Leucoanthocyanins and catechols in all extracts except the hexane extract.
- 6) Coumarins in the hexane and ethyl acetate extracts.
- 7) Gallic tannins only in the aqueous extract.
- 8) However, saponins, mucilage, and catecholic tannins were not identified in any extract.

Melothria maderaspatana is rich in secondary metabolites, including polyphenols, sterols and polyterpenes, leucoanthocyanins, catechols, and more.

Phytochemical studies conducted on *Melothria maderaspatana* have revealed the presence of several bioactive compounds, including alkaloids, sterols and polyterpenes, leucoanthocyanins, coumarins, and phenolic compounds. These compounds possess antioxidant, anti-inflammatory, antidiabetic, antitumor, and antimicrobial properties, making it a potential treatment for several diseases.

However, despite the therapeutic potential of *Melothria maderaspatana*, further studies are needed to confirm the efficacy and safety of this plant. Furthermore, it is essential to continue exploring the different parts of the plant to identify new bioactive compounds and their pharmacological activities.

In summary, phytochemical studies on *Melothria maderaspatana* have revealed interesting therapeutic potential for this plant, justifying its promotion as a dietary supplement

or potential medicine.

Results of fixed oil extraction

The oil content of the plant material is estimated by:

$$t_h = \frac{m_h}{m_0} \times 100 \quad (6)$$

m_{huile} : mass of *d'huile extraite*; $m_{huile} = 7.98$ g

m_0 : mass of seed powder used for extraction; $m_0 = 100$ g

$t_h = 7.98\%$

The chemical characterization of the oil extracted from the fruits of MM yielded the following results:

Table 2. Indices characterizing the oil of *Melothria maderaspatana*.

Indices	Index values
Iodine value	$4,8 \pm 0,07 \text{ gI}/100\text{g}_{cg}$
Acid value	$1 \pm 0,1 \text{ mgKOH}/\text{g}_{cg}$
Saponification value	$145,8 \pm 0,05 \text{ mgKOH}/\text{g}_{cg}$
Peroxide value	$8 \pm 0,3 \mu\text{gO}_2/\text{g}_{cg}$
Ester value	$144,8 \pm 0,5 \text{ mgKOH}/\text{g}_{cg}$

4. Analys and Discussion

The iodine value is the most useful constant in fat analysis, as it allows us to classify vegetable oils as drying, semi-drying, and non-drying. Indeed, the iodine value provides information on the degree of unsaturation of the fatty acids present in a given oil. It is directly related to the degree of oxidation of an oil. Thus, the more unsaturated an oil is (the more C=C double bonds it contains), the higher its iodine value, and we can use this value to assess the oil's susceptibility to rancidity, knowing that the more unsaturated it is, the more sensitive it will be to oxygen. The iodine value of our oil, $4,8 \pm 0,07 \text{ gI}/100 \text{ g}$ of oil, classifies this oil among non-drying oils, whose iodine values range from 0 to $110 \text{ gI}/100 \text{ g}$ of oil [12].

The iodine value found in this study is significantly lower than the iodine values of olive, peanut, and castor oils, which range from 75 to $94 \text{ gI}/100 \text{ g}$ of oil. Based on this relatively low iodine value of *Melothria maderaspatana* oil, its storage should be relatively safe due to the risk of auto-oxidation. This oil is said to have a low concentration of unsaturated fatty acids.

The acid value of a fat is a good indicator of its spoilage. *Melothria maderaspatana* fruit oil has a value of $(1 \pm 0.1) \text{ mgOH/g}$. This value indicates a low amount of free fatty acids in the oil. This suggests that the oil is relatively fresh and has not been exposed to conditions that could lead to oxidation or spoilage. An acid value of 1 is considered an acceptable quality measure for the oil. However, it is important to note that the acid value should not be the sole measure of oil

quality, and other factors such as color, odor, and flavor should also be considered [13].

The saponification value is a measure of the amount of potassium hydroxide (KOH) required to saponify a given quantity of oil. It is used to determine the purity and quality of oils and fats, as well as their fatty acid content. A high saponification value indicates a high fatty acid content, while a low saponification value indicates a low fatty acid content [14].

In this case, the saponification value is 145.8 mg KOH/g of oil. This means that 145.8 milligrams of KOH would be needed to saponify 1 gram of oil.

This value can be used to determine the number of fatty acids in the oil, as fatty acids react with KOH during saponification. Knowing the saponification value of this fat tells us about the carbon chain length of the fatty acids that make up this fat. The saponification value of a fat is higher the shorter the carbon chain of its fatty acids [15]. The saponification value of *Melothria maderaspatana* oil ($148.8 \pm 0.05 \text{ mgOH/g}$) is lower than that of cottonseed oil ($189\text{--}198$), sunflower oil ($188\text{--}194$), palm oil ($190\text{--}209$), and palm olein ($194\text{--}202$), which are commonly used in food [16].

The peroxide value is a measure of the number of peroxides present in the oil. Peroxides are unstable compounds that form during the oxidation of fatty acids in the oil. The higher the peroxide value, the more oxidized the oil and the lower its quality. The peroxide value found in this study ($8 \pm 0.03 \text{ mg/g}$) is lower than that of conventional edible oils (10 mg/g) such as soybean, corn, and sunflower oils, indicating an early stage of oil oxidation [17]. The ester value of *Melothria maderaspatana* oil ($144.8 \pm 0.5 \text{ mg KOH/g}$) is almost equal to its saponification value ($145.8 \pm 0.05 \text{ mg KOH/g}$). This indicates a low level of free fatty acids [16]. Therefore, pre-refining and packaging precautions must be taken to limit subsequent denaturation that would lead to oil discoloration.

Conclusion and Perspectives

Phytochemical analysis and the characterization of fixed oils are important for understanding the chemical composition and properties of oils. The characteristics evaluated in *Melothria maderaspatana* fruits show that this oil may exhibit interesting overall chemical properties. The phytochemical study highlighted the presence of several chemical compounds found in *Melothria maderaspatana* fruits that are thought to be responsible for the plant's bioactive activities. Indeed, these studies show that these fruits are rich in secondary metabolites, including polyphenols, sterols and polyterpenes, leucoanthocyanins, and catechols. Furthermore, the oil content indicates that *Melothria maderaspatana* is rich in fatty acids. The index values obtained show that *Melothria maderaspatana* seeds are of particular interest, and the oil they contain could be further developed by improving harvesting and/or storage conditions. However, further studies need to be undertaken to assess its chemical composition in fatty acids and its toxicity before considering its use in food.

Abbreviations

GRSB	Research Group on Bioactive Substances
IFAN	Fundamental Institute of Black Africa
AV	Acid Value
MM	Melothria maderaspatana
AFNOR	French Standardization Association)

Conflicts of Interest

The authors declare no conflicts of interest.

References

- [1] B. Petrovska, « Historical review of medicinal plants' usage », *Pharmacogn. Rev.*, vol. 6, no 11, p. 1, 2012, <https://doi.org/10.4103/0973-7847.95849>
- [2] S. Woo, L. Marquez, W. J. Crandall, C. J. Risener, et C. L. Quave, « Recent advances in the discovery of plant-derived antimicrobial natural products to combat antimicrobial resistant pathogens: insights from 2018–2022 », *Nat. Prod. Rep.*, vol. 40, no 7, p. 1271-1290, 2023, <https://doi.org/10.1039/D2NP00090C>
- [3] M. Mame et al., « Phytochemical Study and Evaluation of the Anti-Inflammatory Activity of Melothria maderaspatana. *Open J Pharmacol Pharmacother.* 2026; 11: 1-15. », <https://doi.org/10.4236/ojpp.2026.111001>
- [4] N. Djabou et H. Allali, « Black elderberry, a plant from traditional North African medicine ».
- [5] Joel S, « Phytochemistry and Biological Activities of Medicinal Plants: Recent Advances », 2023, <https://doi.org/10.38205/rroij.jhs.v1.i1.93674>
- [6] A. Diop et al., « Phytochemical Study and Evaluation of the Anti-Inflammatory Activity of the Ethanolic Extract of the Leaves and Stems of Melothria maderaspatana (Cucurbitaceae) », *Am. J. Plant Sci.*, vol. 16, no 12, p. 1267-1276, 2025, <https://doi.org/10.4236/ajps.2025.1612084>
- [7] A. Michalaki et K. Grintzalis, « A Multiparametric Protocol for the Detailed Phytochemical and Antioxidant Characterisation of Plant Extracts », *Methods Protoc.*, vol. 6, no 2, p. 40, avr. 2023, <https://doi.org/10.3390/mps6020040>
- [8] P. K. Singh, J. Singh, T. Medhi, et A. Kumar, « Phytochemical Screening, Quantification, FT-IR Analysis, and In Silico Characterization of Potential Bio-active Compounds Identified in HR-LC/MS Analysis of the Polyherbal Formulation from Northeast India », *ACS Omega*, vol. 7, no 37, p. 33067-33078, sept. 2022, <https://doi.org/10.1021/acsomega.2c03117>
- [9] W. E. Gilbraith et al., « Classification and Peroxide Value Prediction of Naturally Aged Edible Oils Using Raman and Infrared Spectral Analysis », *Appl. Spectrosc. Pract.*, vol. 3, no 2, p. 27551857251340426, juin 2025, <https://doi.org/10.1177/27551857251340426>
- [10] J. Cai et al., « Variation in physicochemical properties and bioactivities of Morinda citrifolia L. (Noni) polysaccharides at different stages of maturity », *Front. Nutr.*, vol. 9, p. 1094906, janv. 2023, <https://doi.org/10.3389/fnut.2022.1094906>
- [11] K. M. Novidzro et al., « Study of some physicochemical parameters and analysis of mineral elements, chlorophyll pigments and carotenoids in Griffonia simplicifolia seed oil » », *Int. J. Biol. Chem. Sci.*, vol. 13, no 4, p. 2360, nov. 2019, <https://doi.org/10.4314/ijbcs.v13i4.38>
- [12] S. Sakalauskaitė, V. Mikalayeva, S. Sutkuvienė, et R. Daugelavičius, « Mode of the Interaction of Efflux Inhibitor Phenylalanyl-arginyl-β-naphtylamide with Bacterial Cells », *Biomedicines*, vol. 12, no 6, p. 1324, juin 2024, <https://doi.org/10.3390/biomedicines12061324>
- [13] M. P. Pratami et al., « Metabolite profiling of some organs and the potential of Mukia javanica as an antihypertension », *Front. Sustain. Food Syst.*, vol. 8, p. 1487446, janv. 2025, <https://doi.org/10.3389/fsufs.2024.1487446>
- [14] Cable, K., *Making Soaps*, Amethyst Editions, 3rd Quarter, 277 p, p. 9., 2020.
- [15] U. Schuchardt, R. Sercheli, et R. M. Vargas, « Transesterification of vegetable oils: a review », *J. Braz. Chem. Soc.*, vol. 9, no 3, mai 1998, <https://doi.org/10.1590/S0103-50531998000300002>
- [16] J. Cui, W. Huang, C. Chen, Y. Xu, et W. Zhang, « Foodomics insights into refining effects on noni seed oil: Chemical parameters, phytochemicals, lipid profile, volatile compounds, and anti-inflammatory activity », *Curr. Res. Food Sci.*, vol. 11, p. 101117, 2025, <https://doi.org/10.1016/j.crfs.2025.101117>
- [17] Y. Zhou et al., « Could gastrointestinal tumor-initiating cells originate from cell-cell fusion in vivo ? », *World J. Gastrointest. Oncol.*, vol. 13, no 2, p. 92-108, févr. 2021, <https://doi.org/10.4251/wjgo.v13.i2.92>