

Research Article

Extraction and Characterization of Essential Oils from Lemongrass and *Artemisia absinthium* for Perfume Formulation

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Abstract

Perfume extraction is the process of isolating fragrant compounds from raw materials using methods like distillation, solvent extraction, expression, or enfleurage. In this work, essential oil, which is suitable for perfume formulation, is extracted from lemongrass with the help of solvent extraction method. The experiment was conducted by varying the time of extraction. The yield of oil was measured for samples produced by setting the extraction time at 4hr, 8hr and 10hr. The extracted essential oil was incorporated into a perfume formulation with the addition of a fixative and a carrier solvent. The Perfume preparation was done by taking different ratio of notes; these notes are top notes, middle note and base notes respectively. The highest yield I obtained from the experiment (0.83%) conducted for the time duration of 10hr from 70g of lemongrass. As time passes, the ethanol solvent evaporates, leaving the essential oil concentrated in the mixture. In this study the essential oil which was obtained for extraction time of 10hrs was characterized for properties such as boiling point, stain test and physical properties. The success of this work could stimulate the growth of the perfume industry and create job opportunities by utilizing locally available, low-cost raw materials.

Keywords

Lemon Grass, Solvent Extraction, Essential Oil, Perfume

1. Introduction

The term *perfume* originates from the Latin expression *per fumum*, meaning “through smoke.” The craft of perfumery began in ancient Mesopotamia and Egypt, where Tapputi, recognized as the earliest known chemist and perfume maker, lived and worked. From these regions, the use of fragrances spread to Rome and Arab societies, where incense-based formulations were common. From the twelfth century onward, the importance of perfumery began to rise again across different regions of the world, with France becoming a

leading center for perfume production and innovation [1].

Perfume is composed of aromatic compounds, essential oils, solvents, and fixatives blended in specific proportions to produce a pleasant scent. Proper storage—particularly protection from heat and light—helps maintain the stability and longevity of the fragrance. Natural materials such as flowers, leaves, bark, and various plant parts serve as major sources of aromatic substances used in perfumery [2]. Different parts of the same plant can yield different fragrances;

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for instance, the orange tree produces both orange oil and petitgrain from its blossoms and leaves. Because fragrances require large amounts of raw materials to obtain relatively small quantities of concentrated essence, the production process is difficult and expensive. In ancient Greek societies, scent was regarded as a significant symbol of beauty [3].

In Ethiopia, perfumes hold considerable economic and cultural importance. They are used to impart pleasant smells, mask undesirable odors, distinguish products, and support the identity of various household and personal care items. Ethiopia has a long tradition of using perfumes, yet the country imports an average of 112,589.908 kg of perfume annually to meet consumer demand [4]. Recently, demand for essential oils has grown due to their multifunctional properties, which make them valuable in cosmetics, food processing, pharmaceuticals, agriculture, and the fragrance industry. Extraction techniques greatly affect the purity of essential oils. Ethanol extraction can yield pure aromatic compounds without dissolving unwanted materials. Concretes—such as semisolid waxes or thick oily substances can also help extract hydrophobic components, while other essential oils are obtained through distillation and mechanical expression [5].

Essential oils are widely used in food as flavor additives, in pharmaceuticals, and in fragrance products such as aftershaves and perfumes. Their application in aromatherapy represents about 2% more usage compared to other markets. Both natural and synthetic components of essential oils are used to enhance food flavor. Additionally, essential oils have antibacterial activity and are employed as root canal sealers [6], antiseptics, and feed supplements for livestock such as cows and piglets [7]. The biological activity of essential oils is closely related to the presence of volatile compounds within them [8]. These oils consist of terpenes, alcohols, esters, aldehydes, ketones, acids, epoxides, sulfides, and amines [9]. The major chemical groups found in essential oils are terpene and aroma compounds [10].

Medicinal plants represent a significant natural resource and play an essential role in primary healthcare, particularly in rural areas. Among these plants is *Artemisia absinthium* (wormwood), native to Mediterranean climates and commonly found in dry, nitrogen-rich soils such as roadsides. This plant naturally grows in many parts of northern and central Ethiopia [11].

One challenge in perfume formulation is determining the correct proportion of essential oils and other constituents to prevent skin irritation while enhancing the fragrance's intensity and longevity. Another issue arises during extraction,

as heat, solvents, and oxygen exposure can alter or degrade aromatic compounds, affecting their scent and quality. Despite the growing demand for perfumes in Ethiopia—for medicinal products, soap production, household use, personal hygiene, and insecticidal applications—the country lacks local perfume industries and relies heavily on expensive imports. Most imported perfumes are synthetic mixtures that can be of lower quality, potentially harmful, or expired. Yet Ethiopia possesses abundant natural raw materials capable of supporting local perfume production. Among these resources is *Artemisia absinthium*, valued for its aromatic and medicinal qualities.

The goal of this research is to examine the potential of locally available plant materials to replace imported perfume ingredients. This study focuses on producing perfume from natural sources rather than synthetic chemicals to reduce adverse effects linked to artificial compounds. Encouraging the use of locally grown plants could support the establishment of small-scale extraction enterprises and create economic opportunities. As the use of body perfumes continues to rise in Ethiopia, developing local sources of raw materials becomes both beneficial and necessary. This research specifically investigates the extraction and characterization of oil from *Artemisia absinthium*, the formulation of perfumes from its leaves, the physico-chemical properties of the extracted oil, the composition and concentration of the formulated perfumes, and the extraction and blending processes involved

2. Materials and Methods

2.1. Sampling and Experimental Site

Artemisia Absinthium leaves (Local name, Arite) was collected from a different part of Bule hora in Oromia, regional states, eastern part of Ethiopia used as a raw material for this study.. Bule Hora is located southern part of the capital city of Ethiopia on the distance of 467km from Addis Ababa. Bule Hora University found in Oromia regional state of West Gujii zone. The altitude of the study area range from 250 m to 500 m. The climate condition of area study highlands 34%, middle land 55% and lowland 11%. The annual temperature range is 15 °C and rainfall range from 500 mm to 1250 mm. The study samples were collected from located at Bule Hora.

2.2. Process Flow Diagram of Perfume Extraction and Formulation

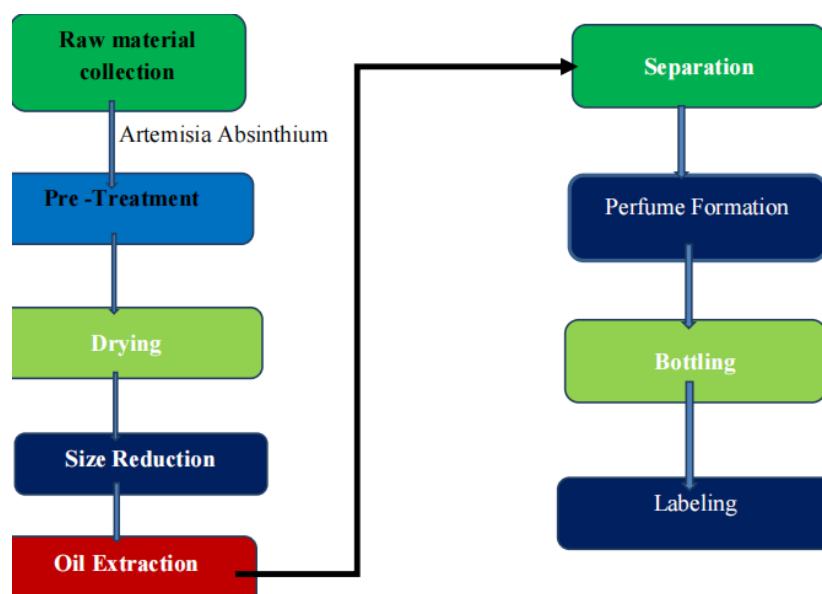


Figure 1. Process flow diagram for perfume extraction and formulation.

2.3. Experimental Methods

The experimental work has been done in the laboratory of Bule hora University, School of Chemical Engineering Department Research Laboratory

2.3.1. Preparation and Pre-treatment of *Artemisia absinthium*

The plant material used in this study consisted of *Artemisia absinthium* leaves (locally known as Ariti), which were collected from different areas of Bule Hora in the Oromia Regional State, eastern Ethiopia. After collection, the leaves were rinsed with tap water to eliminate dust and other impurities, then air-dried at room temperature in a clean, dust-free environment. Once fully dried, the material was ground into a fine powder using a mortar and pestle to increase the surface area for extraction.

2.3.2. Size Reduction and Sieve Analysis of the Leave

The moisture was removed from the *Artemisia absinthium* by exposing it to dry air at room temperature in a dust-free environment. The dried plant material was then crushed using a mortar and pestle. The crushed sample was sieved through a series of sieves arranged in descending sizes: 2.5 mm, 1.7 mm, 1.5 mm, 1 mm, 0.75 mm, 0.5 mm, and 0.25 mm, to obtain particle size ranges of 2.5–1.5 mm, 1.5–0.75 mm, and 0.75–0.25 mm. This procedure was carried out to investigate the effect of particle size on the yield and quantity of essential oil.

2.4. Maceration Extraction Method

The experimental work was carried out using the maceration extraction technique through solvent extraction. The solvents used in this process were n-hexane, ethanol, and methanol. Results from the maceration extraction, including extraction time, particle size, and solvent type, were employed as the initial parameters for the study.

2.4.1. Operation of Maceration Extraction

The maceration method is a type of solid–liquid extraction in which bioactive compounds (solute) are obtained by immersing the plant material in a specific solvent for a designated period. The procedure involves 20g of the pulverized plant *Artemisia absinthium* sample was added into the flask to soak with three suitable solvents (Ethanol, Methanol and Hexane) in a closed vessel at room temperature. Then, it was thoroughly shaken using mechanical shaker at 120 rpm for (24hr, 48hr and 72hr) at room temperature. This was allowed to continue for 24hrs, 48hrs and 72hrs. The experiment would have repeated by placing the same amount of the sample into the flask again by following the same procedure.

2.4.2. Refining of *Artemisia Absinthium* Oil

Refining *Artemisia absinthium* oil involves removing the oil from organic solvents, eliminating impurities, and bleaching to improve its color. In this study, common refining techniques such as decantation, vacuum filtration, and rotary evaporation were employed.

2.4.3. Decantation *Artemisia Absinthium*

Decantation is the process of separation of liquid (oil and solvent) from solid (*Artemisia Absinthium* sluge) and other immiscible (non-mixing) liquids, by removing the liquid layer at the top from the layer of solid below. The process can be carried out by tilting the mixture after pouring out the top layer. Usually this process is not very efficient in this separation, as thin layer of the remaining oil cannot be easily obtained from the mixture. Hence, other separation methods such as vacuum filtration and rotary evaporation was used.

2.4.4. Rotary Evaporation of *Artemisia Absinthium* Oil

A rotary evaporator is a laboratory device used for the gentle and efficient removal of solvents from oil samples through evaporation. The process involves mechanically rotating a flask under vacuum, which increases the solvent's surface area, accelerates evaporation, and minimizes the risk of "bumping," where rapid vapor formation displaces the liquid. The vacuum lowers the solvent's boiling point and facilitates its separation from the oil.

2.5. Procedure

The mixture of solvent and desired oil is placed in a round-bottom flask, ensuring it is less than half full for optimal results. The water bath is filled, and a glass bump trap is attached to prevent the solution from entering the main part of the rotary evaporator. The flask is set to rotate, with speed adjusted according to the solution volume. The vacuum is gradually applied until solvent condensation is visible on the cold finger or in the receiving flask, or until the solvent begins to bubble. The water bath is then heated; the vacuum allows solvent evaporation at a lower temperature than standard boiling. Once all solvent is removed, the vacuum is released, the flask is returned to atmospheric pressure, rotation is stopped, and the flask is removed from the bath. The receiving flask is detached to collect the pure oil. If residual solvent remains, it can be returned to the flask, and the procedure repeated.

2.6. Determination of the Yield of Oil Extracted

20g (W1) of the sample was placed in a closed vessel and 200ml of the solvent was added into a closed vessel for each run repeatedly. Then, it was thoroughly shaken using mechanical shaker at 120 rpm for (24hr 48hr and 72hr) at room temperature. After extraction and purification, the sample was weighted (W2), then yield calculated was Mass of oil Extraction percentage oil yield = Mass of the sample*100%

$$W2 \% \text{ Oil Yield} = W1 * 100\% \quad (1)$$

where,

W1=Sample weight before extraction and

W2= Sample weight of oil after purification

2.7. Characterization of Refined *Artemisia Absinthium* Oil

The oil obtained under the specified operating conditions was analyzed for its physical properties, including moisture content (volatile matter), specific gravity, viscosity, pH, and refractive index, as well as chemical properties such as saponification value, iodine value, and acid value.

2.7.1. Determination of Saponification Value

Five grams of the oil were placed in a conical flask, and 25 mL of 0.5 M potassium hydroxide (KOH) was added. The mixture was gently boiled for approximately 30 minutes, with regular shaking every 5 minutes. A few drops of phenolphthalein indicator, as specified by the International Standards Organization, were added to the warm solution, which was then titrated with 0.5 M HCl. The endpoint was reached when the pink color of the indicator just disappeared. The same procedure was carried out for the blank. The saponification value (SV) is calculated using:

$$\text{Saponification value (SV)} = M * (V1 - V2) * N \quad W \quad (2)$$

Where,

M= is equivalent mass of the potassium hydroxide.

N= Normally of hydrochloric acid used for titration. V1= Average volume in ml of standard hydrochloric acid required for the blank.

V2=Average volume in ml of standard hydrochloric acid required for the sample.

W= The weight of the sample taken.

2.7.2. Ester Value, Content of Esters and Combined Alcohols

Determining the ester content is important for evaluating many essential oils. The ester value is defined as the amount of potassium hydroxide (in milligrams) needed to neutralize the acids released during the hydrolysis of esters in 1 g of perfumery material. The ester value can be calculated using the formula:

$$\text{Ester value} = \text{Saponification value} - \text{Acid value} \quad (3)$$

2.7.3. Determination of Iodine Value

Five grams of the sample were weighed into a conical flask, and 10 mL of iodine monochloride was added to dissolve the oil. Then, 5 mL of Dam's reagent was added using a safety pipette in a fume hood. The flask was stoppered and the contents were vigorously swirled before being placed in the dark for 1 hour and 30 minutes. After this period, 20 mL of 10% aqueous potassium iodide and 15 mL of water were added

using a measuring cylinder. The mixture was titrated with 0.1 M sodium thiosulfate solution until the yellow color nearly disappeared. A few drops of starch indicator were then added, and titration was continued dropwise with vigorous shaking until the blue color disappeared.

The same procedure was used for a blank test and other samples. The iodine value (I.V) was given by the expression:

$$\text{Iodine Value (IV)} = 12.69 * (V1 - V2) M \quad (4)$$

where,

C = Concentration of sodium thiosulfate used;

V1=Volume of sodium thiosulfate used for the blank;

V2= Volume of sodium thiosulfate used for determination,

M = Mass of the sample.

2.8. To Characterize Physical Properties of Perfume Using Sensor Analysis

Sensory properties, including color, aroma, and overall acceptability, of the three perfume formulations containing *Artemisia absinthium* were evaluated using the Hedonic Rating test, as recommended by [12]. Both male and female panelists participated in a carefully designed experiment. Their responses were recorded, and appropriate statistical analysis was performed to assess the significance of differences in average scores and the contribution of each parameter. Panelists rated the samples on a 9-point scale, where 9 indicated “like extremely” and 1 indicated “dislike extremely.”

2.9. Design of the Experiment

A factorial design was employed to study the effect of each factor. In such an experiment, all possible combinations of factor levels are tested, allowing the assessment of individual factor effects as well as interactions between two or more variables. The analysis was conducted using Design Expert software with a general factorial design approach. This experimental design method enables the determination of the significance of both main effects and interaction effects. Additionally, the software was used to develop a mathematical model describing how the main and interaction factors influence the responses [13].

3. Results and Discussion

3.1. Percentage Yield of Extraction

The percentage extraction oil yield and the result are summarized the extraction parameters such as particle size, extraction time, and solvent type are some of the factors which are very important to produce both quality and optimum amount of oil. The parameters selected for entire work are as particle size, extraction time, and solvent type.

The extraction yield was used to evaluate the performance of maceration extraction for the extraction of *Artemisia absinthium*. The highest yield obtained from the experiment was 0.83% conducted at time of 10hr and 70g of lemongrass.

Solvent Type and Particle Size on Percentage Oil Yield

The interaction between solvent type and particle size on oil yield shows that the highest yield (3.10%) was achieved using methanol as the solvent with a particle size range of 0.25–0.75 mm, while the lowest yield (0.95%) occurred with hexane and a particle size range of 1.5–2.5 mm. It can be observed that decreasing the particle size leads to an increase in oil yield.

3.2. Extraction Time and Solvent Type on Percentage Oil Yield

The interaction effect of extraction time and solvent type on oil yield, obtained from the general factorial design, indicates that the maximum yield (3.10%) was achieved at the longest extraction time (72 hours), using methanol as the solvent and the smallest particle size range (0.25–0.75 mm). Solubility: The freshly extracted *Artemisia absinthium* essential oil is soluble in common organic solvents and only slightly soluble in water, suggesting it exhibits slightly polar behavior. pH Value: The pH of the oil was measured using a pH electrode as described in Section 3.4. Individual run values were 5.75, 6.24, and 5.85, giving an average pH of 5.95. This indicates that the oil is slightly neutral. Since the preferred pH range for skin and hair care products is 3.5–6.5 [12, 13], the pH of *Artemisia absinthium* oil falls within the suitable range for cosmetic applications and commercial use.

3.3. Iodine Value

The iodine value (IV) represents the amount of iodine (in grams) required to saturate 100 g of an oil sample. It is used to assess the degree of unsaturation of oils and their stability for industrial applications [5, 7]. Oils with lower iodine values are more resistant to oxidation, have longer shelf life, and are of higher quality, whereas higher iodine values indicate lower oil quality.

3.4. Ester Value

Determining the ester content is important for evaluating many essential oils. The ester value can be calculated using the formula: Ester Value = Saponification Value – Acid Value. For *Artemisia absinthium* oil, this gives: Ester Value = 84 – 8.10 = 75.9

$$\text{Ester value} = 75.9 \text{ mg KOH/g oil.}$$

4. Conclusion

This study successfully extracted essential oil from

Artemisia absinthium using the maceration method, systematically investigating the effects of particle size, solvent type, and extraction time. Particle size ranges of 0.25–0.75 mm, 0.75–1.5 mm, and 1.5–2.5 mm, solvents including hexane, ethanol, and methanol, and extraction times of 24, 48, and 72 hours were evaluated. The research confirms that extracting oil from locally available raw materials with strong fragrance is both feasible and rewarding. Utilizing locally sourced materials offers a cost-effective alternative to imported raw materials in Ethiopia. The extracted oil was characterized through physicochemical analyses including acid value, saponification value, iodine value, pH, refractive index, and specific gravity demonstrating its quality and suitability for industrial applications. Further chemical profiling via GC-MS identified 23 compounds accounting for 100% of the oil composition, highlighting the rich chemical diversity of *Artemisia absinthium* essential oil. Overall, this study establishes the potential of *Artemisia absinthium* as a valuable source of high quality essential oil for perfumery, cosmetics, and related applications.

Abbreviations

GC-MS	Gas Chromatography–Mass Spectrometry
ISO	International Standards Organization
SV	Saponification Value
IV	Iodine Value
AOAC	Association of Official Analytical Chemists
Rpm	Revolutions per Minute
ml	Milliliter
ERCA	Ethiopian Revenue and Customs Authority
n-Hexane	Normal Hexane

Author Contributions

Wabi Reggassa Boggale is the sole author. The author read and approved the final manuscript.

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Conflicts of Interest

The author declares no conflicts of interest.

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