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A COMPARATIVE ANALYSIS OF ESSENTIAL OIL YIELD FROM *MENTHA PIPERITA* (MINT) USING VARIOUS EXTRACTION METHODS

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ABSTRACT

Essential oils are widely utilized in the pharmaceutical, cosmetics and food industries because of their fragrant and healing qualities. This study provides a comparative examination of the amount of essential oil obtained from Mentha piperita (mint) utilizing three different extraction techniques: steam distillation, enfleurage and Soxhlet extraction. The efficacy of extraction techniques has a substantial impact on the quantity of essential oils.

Keywords: *Mint, Extraction, Oils, Yield.*

Introduction

Essential oils are the fragrant and volatile liquids obtained from plants. The flavor and fragrance additives used in culinary, industrial and pharmaceutical products are primarily obtained from oils. Essential oil contains volatile chemicals that give it a distinct scent. Essential oils are produced and derived from plant sources using various extraction methods. Various techniques such as solvent-free microwave extraction, solar distillation, CO_2 supercritical fluid extraction, hydro diffusion and steam distillation are employed to produce essential oils.

Peppermint (*Mentha piperita*), is a type of mint that is a result of crossbreeding between water mint and spearmint. The leaves measure between 4 and 9 cm in length and 1.5 to 4 cm in width. They are dark green with reddish veins, have a pointed tip, and rough edges with large teeth. The foliage and branches typically possess a slight fuzziness. The blooms have a purple hue and are approximately 6-8 mm in length. They possess a corolla with four lobes, measuring around 5 mm in diameter. Peppermint is characterized by its rapid growth, with a tendency to propagate swiftly once it has sprouted (Zaidy and Dahiya, 2015).

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Table 1: Extraction Methods for Essential Oils

Method	Abbreviation	Principle	Pros	Cons
Hydrodistillation/steam distillation	HD/SD	Heating reflux using water or steam	Low cost, non-poisonous, high reproducibility, harmless, and simple operating	Long heating time and high aroma loss
Organic solvent extraction	OSE	Similar solubility	Higher yield but difficult to completely separate from solutes and fully recycle and reuse, even bringing negative effects on human health	Difficult to completely separate from solutes and fully recycle and reuse, even bringing negative effects on human health
Cold pressing	CP	Mechanical pressure	Simpler process, lower energy consumption, less environmental pollution; operating at room temperature retains the original aroma and more benefits of the EOs; turbid and impure	Turbid and impure
Supercritical fluid extraction	SFE	Special dissolution effect of supercritical fluids	Faster extraction speed, higher extraction yield, less loss of active ingredients, and low critical temperature and pressure; expensive and difficult to control the final concentration; poses a potential safety hazard	Expensive, difficult to control the final concentration; poses a potential safety hazard
Ultrasound-assisted extraction	UAE	Mechanical wave with an effective frequency generally ranging from 20 to 50 kHz	High product yield, low organic solvents, short processing time, and low maintenance costs	High equipment requirements and costs; not suitable for industrial large-scale production
Microwave-assisted extraction	MAE	Electromagnetic waves with wavelengths from 0.01 to 1 m and frequencies from 0.3 to 300 GHz	High utilization of energy, high extraction rate, and short extraction time, avoiding the chemical modification of the oil components	High equipment requirements and costs; not suitable for industrial large-scale production
Solid-phase microextraction (SPME)	SPME	Similar solubility	No solvent; simpler, lower cost, more selective and flexible when paired with appropriate detectors GC, LC, and CE	Perform no detailed extraction

The essentials oils are frequently utilized for their distinct taste and their medicinal or fragrant characteristics, in a diverse range of items including food, medicine, and cosmetics. The extraction of essential oils is a highly time-consuming and labour-intensive procedure. Scientists are actively seeking new sources of biocides with broad spectrum actions due to the growing resistance of microbes to existing chemicals and medications. Throughout history, plants and their byproducts, such as essential oils, have been utilized in traditional medicine (Virendra, 2007). Mint oil possesses various applications. Mint extract can be utilized to impart a refreshing minty taste to beverages, infuse mint flavour into culinary items like chocolates and frosting, and serve many natural purposes such as repelling ants and alleviating chest congestion. Antioxidants are present in almost all plant-based foods. Antioxidants have the main function of safeguarding cells from oxidative stress induced by free radicals, which are regarded as the principal catalyst for the aging process.

Mentha leaves possess a unique fragrance and refreshing taste, resulting in the production of a pale-yellow oil. Mint flourishes in close proximity to bodies of water, such as pools, lakes, and rivers, as well as in chilly and damp areas with partial shade. Mint is herb with relaxing properties that helps with indigestion and stomach upset by promoting the production of bile. Compounds in mint oil are beneficial in managing congestion. Mint has the ability to facilitate the opening of the nasal passages, as well as the lungs and bronchi. Its antifungal qualities make it beneficial for allergies and asthma. Perillyl alcohol, a phytonutrient found in it, has demonstrated the ability to inhibit the development of skin, colon, and lung cancer. There are multiple methods for obtaining mint oil, such as solvent extraction, supercritical fluid extraction, and steam distillation. Steam distillation is the most widely used and conventional technique for obtaining mint oil. Therefore, this study utilizes different extraction techniques for the extraction of mint oil from the Mint leaves.

Materials and Methods

A sample (leaves) of freshly harvested mint was picked in the early morning hours. The leaf sample was thoroughly cleansed and left to air dry for a duration of 30 minutes in the laboratory. Thereafter, various techniques were used for extraction of mint oil namely Steam Distillation, Enfleurage and Soxhlet extraction. Also, GC-MS analysis was done to identify the components of the essential oil.

Fig 1: Chopped Mint Leaves

- **Steam Distillation:** A precisely measured quantity of 60 grams of fresh mint leaves was carefully weighed and placed into a round bottom flask with a capacity of 500 milliliters. The flask already had 250 milliliters of distilled water. The flask was equipped with a rubber stopper that was linked to a condenser and heated progressively until it reached a temperature of 80 °C. When the temperature reached 100 °C, the boiling process began, causing the essential oil to separate from the sample substrate. During the ongoing heating process, the essential oil extracted from the sample combines with the water vapor and is gathered in a receiver bottle/tube through the condenser. The condensate was cooled by utilizing ice to prevent the evaporation of the essential oil. Subsequently, the condensate was moved to a separating funnel, resulting in the formation of two clearly distinguishable layers: oil and water.

Fig 2: SD Apparatus

- **Enfleurage:** A precisely measured quantity of 60 grams of the dry material was weighed and then crushed using a mortar and pestle in order to expose a larger surface area. The pulverized sample was transferred into a 500 ml beaker and combined with 70 ml of mild-tasting olive oil, which was heated. This mixture was prepared to facilitate the effective absorption of the essential oil. The beaker was enveloped with aluminum foil and vigorously agitated until the sample was evenly dispersed inside the oil. It was subsequently permitted to remain undisturbed for 24 hours at ambient temperature to ensure adequate absorption. A volume of 140 ml of ethanol was introduced to extract the essential oil, while the light-flavored olive oil and the remaining sample residue were retained. The Ethanol extract was separated by decantation and subjected to a water bath at a temperature of 80 °C in order to evaporate the Ethanol, resulting in the isolation of the essential oil.

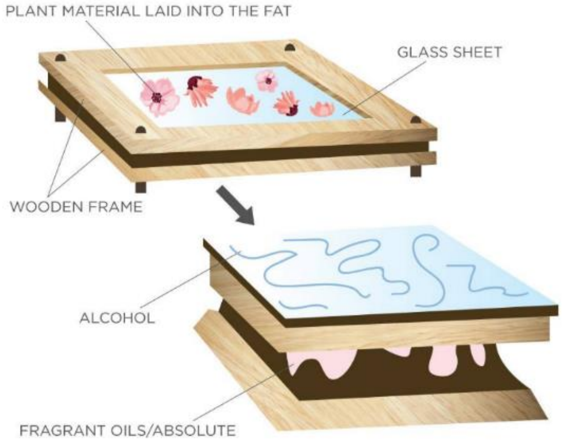

Fig. 3: Enfleurage Procedure

- **Soxhlet Extraction:** The solvents typically employed for this technique are commonly hexane, ether or methanol. The solvent is put into a round bottom flask, and chopped leaves are placed in a thimble, which is then inserted into the centre of the extractor. The Soxhlet apparatus is subjected to a temperature of 60 degrees Celsius. As the solvent reaches its boiling point, the resulting vapor ascends through the vertical tube and enters the condenser located at the top. The liquid condensate is collected by the filter paper thimble located in the center, which holds the oil to be extracted. After the extraction process, the mixture containing the oil was separated by distillation.

Fig. 4: Soxhlet Apparatus

- **GC-MS:** The GC-MS technique was utilized to conduct the component analysis of the mint essential oils, which were separated and detected at different periods during the analysis based on their boiling points.

Result and Discussion

Soxhlet extraction achieved the highest yield at 4.0%, attributed to continuous solvent cycling and direct heating, ensuring thorough extraction. Steam distillation produced comparatively higher yield of 1.31%. On the other hand, enfleurage yielded the lowest oil percentage at 0.95%.

Table 2: % Yield of Mint Leaves Extract using Different Methods

Method of Extraction	Percentage (%) Yield
Steam distillation	1.31
Enfleurage	0.95
Soxhlet Extraction (direct heating)	4.0

The GC-MS analysis was conducted on mint oil samples obtained from different techniques. Figure 5 depicts the GC-MS Analysis for Mint oil obtained from Steam Distillation. Table 3 shows the chemical constituents of Mint leaves essential oils obtained from steam distillation extraction method.

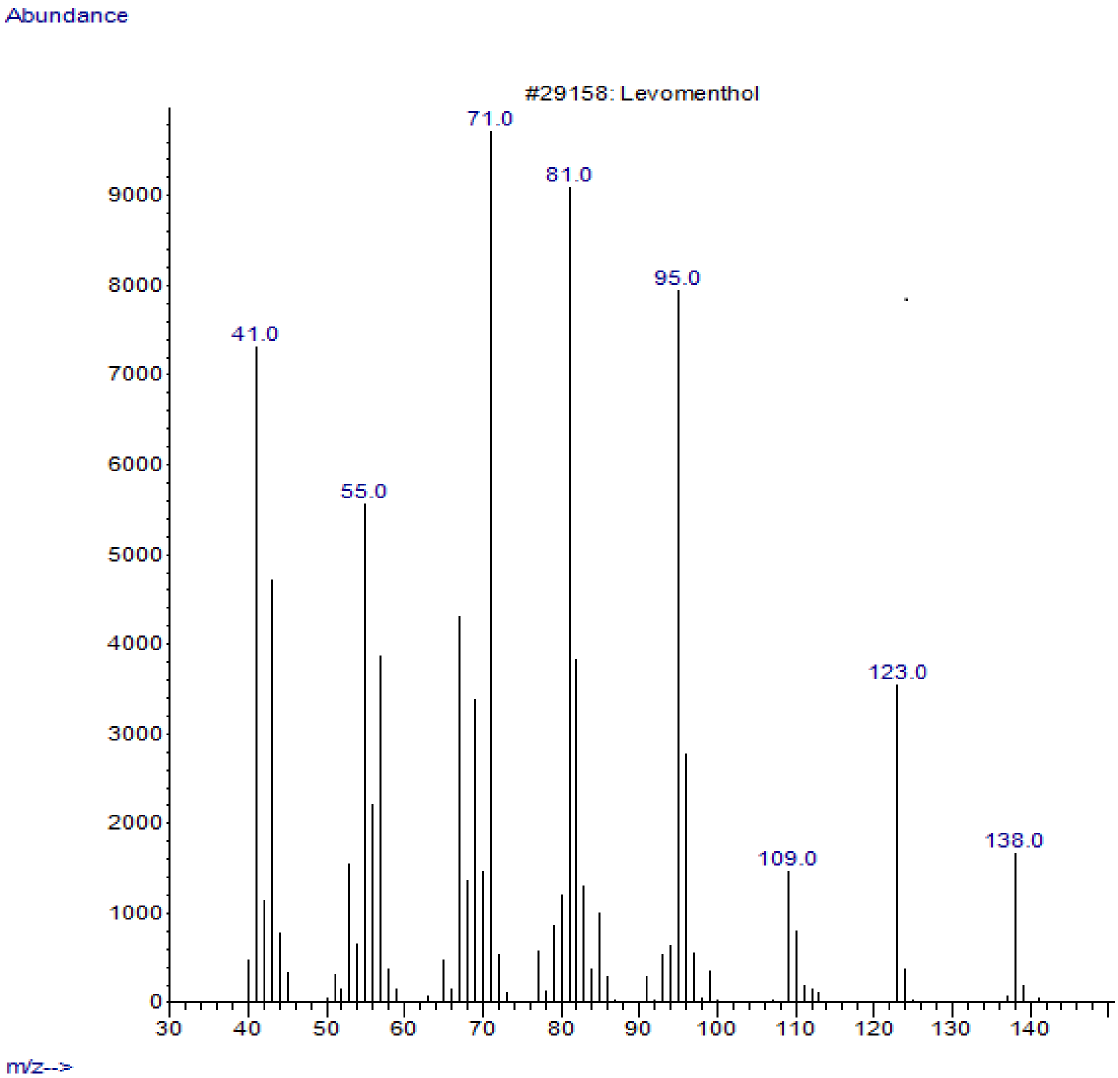

Fig. 5: GC-MS Analysis for Mint oil Obtained from Steam Distillation

Table 3: Chemical Constituents of Mint Leaves Essential oils Obtained from Steam Distillation Extraction Method

S. No.	Components	RT (min)	Area (%)
1	Isobutyl tetracosyl ether	30.0631	1.13
2	1-decosene	31.3471	2.58
3	Tricosane	32.8638	2.31
4	Eicosane	32.3934	2.83
5	Levomenthol	11.7843	3.54
6	Hexatricontylpentafluoropropanioate	31.148	1.27
7	1-Decanol, 2-methyl	32.565	1.01
8	Estra-1,3,5(10)-trien-17.beta.-ol	29.1979	1.23
9	Carbonic acid, octadecyl vinyl ester	28.4173	1.04
10	1-Decanol, 2-hexyl	31.2522	3.84

Figure 6 depicts the GC-MS Analysis for Mint oil obtained from Enfleurage. Table 4 shows the chemical constituents of Mint leaves essential oils obtained from Enfleurage method.

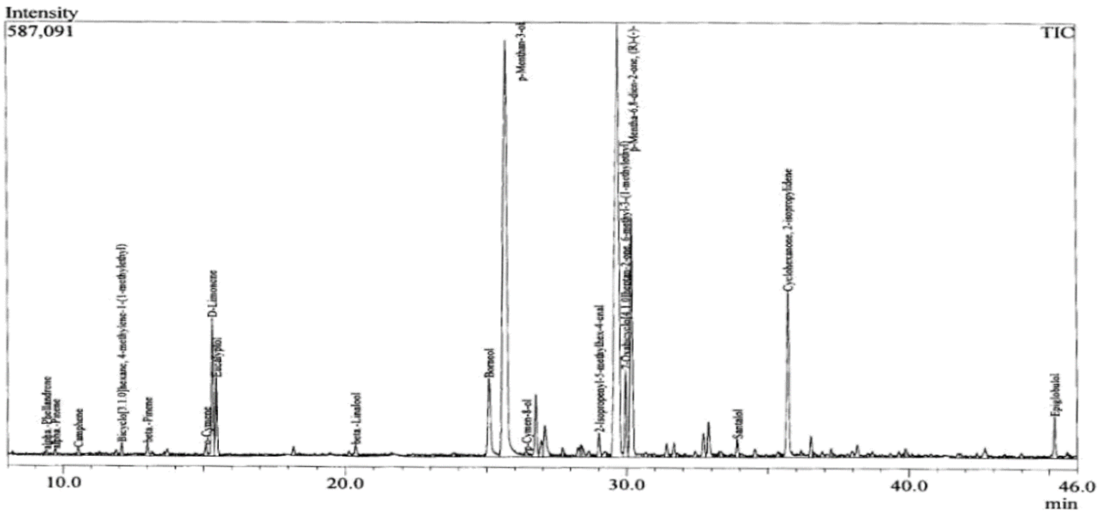

Fig. 6: GC-MS Analysis for Mint oil Obtained from Enfleurage

Table 4: Chemical Constituents of Mint Leaves Essential Oils Obtained from Enfleurage Method

S. No.	Components	RT (min)	Area (%)
1	Alpha-Phellandrene	9.380	4.38
2	Alpha-Pinene	9.704	6.40
3	Camphene	10.550	5.31
4	Bicyclo[3.1.0] hexane, 4-methylene-1-(1-methylethyl)	12.097	1.48
5	Beta-Pinene	13.009	1.25
6	o-Cymene	15.094	2.18
7	D-Limonene	15.333	1.44
8	Eucalyptol	15.472	5.21
9	Beta-Linalool	20.359	7.39
10	Borneol	25.091	2.34
11	p-Menthan-3-ol	25.739	6.91
12	p-Cymen-8-ol	26.403	5.72
13	p-menth-1-en-8-ol	26.718	5.90
14	2-Isopropenyl-5-methylhex-4-enal	29.014	5.01
15	p-Mentha-6,8-dien-2-one	29.740	1.25
16	7-Oxabicyclo[4.1.0]heptan-2-one, 6-methyl-3-(1-methylethyl)	29.973	5.32
17	Alpha-Santalol	33.922	8.48
18	Santalol	33.922	8.48
19	2-isopropylidenecyclohexanone	35.734	1.26
20	1H-cycloprop[e]azulen-7-ol,decahydro--1,1,7-trimethyl-4-methylene	45.198	1.28
21	Caryophyllene oxide	45.199	1.06
22	Epiglobulol	45.198	1.28

Figure 7 depicts the GC-MS Analysis for Mint oil obtained from Soxhlet Extraction. Table 5 shows the chemical constituents of Mint leaves essential oils obtained from Soxhlet Extraction.

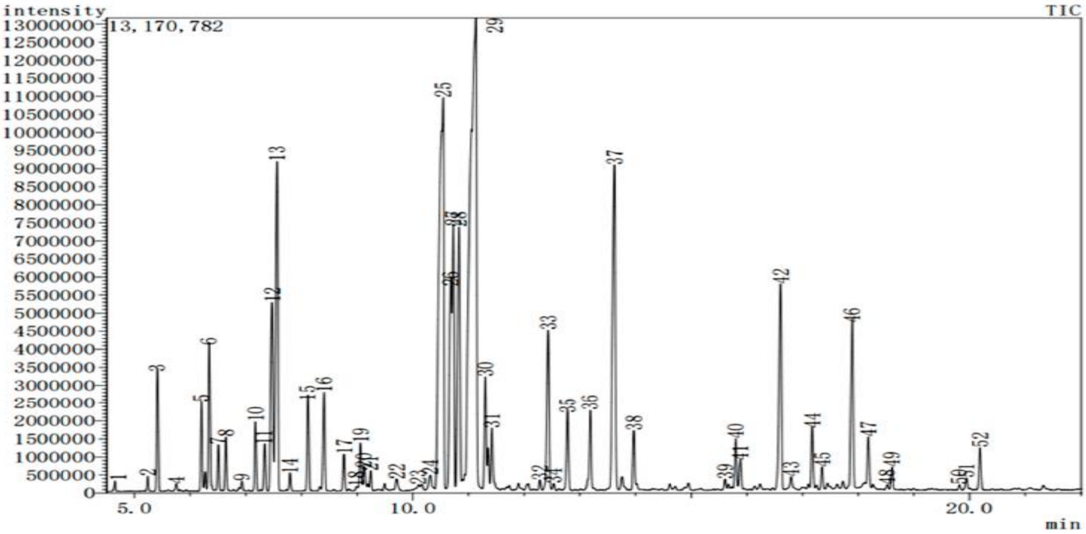

Fig. 7: GC-MS Analysis for Mint oil obtained from Soxhlet Extraction

Table 5: Chemical Constituents of Mint Leaves Essential Oils Obtained from Soxhlet Extraction Method

S. No.	Components	RT (min)	Area (%)
1	menthol	11.13	37.01
2	menthone	10.55	21.83
3	1,8-cineole	7.56	6.36
4	L-menthol acetate	13.62	5.34
5	(+)-menthone	10.73	4.71
6	D-menthol	10.83	3.41
7	B-Caryophyllene	16.61	2.66
8	menthofuran	10.67	2.43
9	(+)-pulegone	12.43	1.94
10	(R)-(+)-limonene	7.47	1.89
11	B-Cyclopentene	17.89	1.62
12	ß-Pinene	6.34	1.41

Several compound were consistently identified across the different extraction methods such as Terpenes (Beta-Pinene, Limonene (D-Limonene and (R)-(+)-limonene, Caryophyllene) and Menthol and Derivatives. These similarities indicate that while the extraction method impacts the yield and specific profile, certain core compounds like terpenes and menthol derivatives are consistently extracted from *Mentha piperita*, contributing to its characteristic properties. It can be also observed that Mint oil, along with its components, finds application in the food, medicinal, fragrance, and flavoring industries. The primary component of it, menthol, is utilized in the production of lozenges, toothpastes, analgesic balms, and cold balms. Oil is utilized to cure specific gastrointestinal diseases such as indigestion, flatulence, and acidity. Peppermint oil inhalation enhances the nasal airflow, resulting in increased air supply to the lungs. Several studies have also asserted that it enhances the efficiency of lung surfactant, hence improving pulmonary function. Also, Mint is a renowned herb that is recognized for its antispasmodic, analgesic and anti-inflammatory properties.

Conclusion

The results indicated that Soxhlet extraction produced the highest yield of essential oil, followed by steam distillation, with enfleurage yielding the least. However, the quality and purity of oils varied, with steam distillation providing the most balanced profile of essential compounds and enfleurage preserving the most components. Mint oil exhibits a hypotensive effect, reducing both heart rate and systolic pressure. Peppermint oil also has cardiovascular effects such as relaxation of bronchial smooth muscles and an increase in ventilation. Peppermint oil inhalation enhances the nasal air force, hence augmenting the supply of air to the lungs. Peppermint is utilized in the production of oral dentifrices due to its ability to provide a sense of overall freshness to the breath and effectively combat halitosis.

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