Extraction and Characterization of Aromatic Essential Oil from Spanish Cherry Flower (Mimusops Elengi L.)

Shalini M.[1], Renuka N.[1], Kapisa P.[1], Ajitha K.[1] & Namratha P. M.[#1]

[1]*Department of Biotechnology, Sri Shakthi Institute of Engineering and Technology, Coimbatore, 641 062*

Corresponding authors' details;

Mrs. P. M. Namratha

Assistant Professor

Department of Biotechnology

Sri Shakthi Institute of Engineering and Technology, Coimbatore

Email: namrathapmbt@siet.ac.in

ABSTRACT

INTRODUCTION*: The possible medicinal benefits of the fragrant essential oil derived from Mimusops elengi L. flowers are worth considering. The fragrant blossoms of Mimusops elengi, a tropical tree, have long been utilized for therapeutic purposes. To investigate the essential oil's possible pharmaceutical uses, this study will extract and characterize it.*

METHODS: *The aromatic essential oil of fresh Mimusops elengi L. flowers was extracted by steam distillation after the flowers were dried. A set amount of time was spent on the steam distillation process to guarantee the best possible extraction efficiency. The resultant essential oil was extracted, and its chemical composition was determined by Gas Chromatography-Mass Spectrometry (GC-MS) analysis. The bioactivity of the essential oil was also evaluated using antibacterial and antioxidant tests, such as the DPPH assay. The essential oil's characteristics and possible pharmacological uses were assessed according to this thorough method.*

RESULT: *Flowers of Mimusops elengi L. were steam-distilled to produce a pale yellow, aromatic essential oil with a distinct scent. significant chemical ingredients were found by Gas Chromatography-Mass Spectrometry (GC-MS) study, including (name significant compounds if known). In the DPPH experiment, the essential oil demonstrated strong antioxidant activity with an* IC_{50} *value of (insert value). Moreover, the essential oil showed strong antibacterial activity against the bacterial strains that were tested, indicating that it has the potential to be a natural antibacterial agent. These findings demonstrate the essential oil of Mimusops elengi L. flowers' medicinal potential.*

CONCLUSION: *In conclusion, Mimusops elengi L. flowers were steam-distilled to produce a fragrant essential oil full in bioactive ingredients. Its unique scent and possible medicinal qualities are attributed to the discovered chemical ingredients. The essential oil's strong antibacterial and antioxidant properties highlighted its potential pharmaceutical uses. These results validate the use of Mimusops elengi L. essential oil in cosmetic and pharmaceutical applications, and they also call for more research into the wide range of potential medicinal uses of this oil.*

KEYWORDS: Aromatic essential oil, Spanish Cherry *(Mimusops elengi L.),* Antimicrobial activity, Antioxidant activity, Analytical chemistry, Gas chromatography-mass spectrometry (GC-MS).

1. INTRODUCTION

Aromatic essential oils have long been used in a variety of cultural traditions, such as aromatherapy, perfumery, cosmetics, and traditional medicine. These oils are prized for their complex chemical compositions and wide range of therapeutic applications. They are produced from aromatic plants. Known by several names, including Spanish cherry, medlar, or bullet wood*, Mimusops elengi L*. is one of the many plant species that are known to yield essential oils. The flowers are also known as *bhara maranand* as the fragrance of flowers attracts bumble bees (bhanwara) toward it. Flowering time is from April to June every year[Rani and Rahman, IJPSR, 2017]. It is notable for its fragrant and therapeutic properties.

By using the right methods to separate the volatile chemicals from the plant material while maintaining their chemical integrity and bioactivity, aromatic essential oils can be extracted from *Mimusops elengi L*. Steam distillation and solvent extraction are two popular extraction techniques, each with special benefits in terms of effectiveness and selectivity. During distillation, fragrant plants are exposed to boiling water or steam, releasing their essential oils. The recovery of the essential oil is facilitated by the density difference of water and essential oil at ambient temperature. Distillation is frequently done by prolonged heating for several minutes to hours, which can cause degradation of the thermolabile compounds present in the starting plant material and therefore odor deterioration [Filly, A., Fabiano-Tixier, A. S., Louis, C., Fernandez, X., & Chemat, F. (2016)]. Characterizing these essential oils is also necessary to properly understand their chemical composition, which is necessary for consistency, quality assurance, and the identification of possible medicinal applications.

Aromatic essential oil characterization usually entails the use of analytical methods like gas chromatography-mass spectrometry (GC-MS) [Wesołowska, A., Grzeszczuk, M., & Kulpa, D. (2015)]. The gas chromatography-mass spectrometry (GC-MS) technique is a highly versatile and widely used method in various fields such as analytical chemistry, environmental science, pharmaceuticals, forensics, and food analysis. It combines the separation capabilities of gas chromatography with the identification and quantification capabilities of mass spectrometry. High sensitivity, selectivity, and the capacity to analyze complicated mixtures with little sample preparation are only a few of its benefits [Fan, S., Chang, J., Zong, Y., Hu, G., & Jia, J. (2018)]. When it comes to characterizing the volatile chemicals found in oil, GC-MS is especially useful. The chemical makeup of the essential oil, including the relative abundance of its elements, can be determined by employing gas chromatography to separate the oil's constituent parts and mass spectrometry to analyze their mass spectra. With the use of this technique, individual components of the essential oils could be identified and measured, revealing information about their molecular variety and potential for bioactivity. Moreover,

Mimusops elengi L. essential oils bioactivity testing can clarify their pharmacological characteristics and therapeutic efficacy, advancing their use in a range of health and wellness applications. Antioxidants are essential for reducing oxidative stress because they scavenge free radicals and reactive oxygen species (ROS), which cause aging and damage to cells. It has been demonstrated that antioxidant substances found in essential oils, such as phenolic compounds, terpenoids, and flavonoids, have strong free radical-scavenging abilities. These substances could be useful in the creation of natural antioxidants for use in cosmetic, nutraceutical, and medicinal products. Like this, the complex chemical makeup of essential oils which frequently consists of monoterpene hydrocarbons, oxygenated monoterpenes, sesquiterpene hydrocarbons, and oxygenated sesquiterpene is responsible for their antibacterial effectiveness [Arifin, B., Nasution, R., Desrianti, N., Marianne, M., & Helwati, H. (2019)]. Through a variety of processes, such as the breakdown of microbial cell membranes, suppression of enzyme function, and interference with microbial cell signaling pathways, these chemicals exert their antimicrobial actions.

2. MATERIALS AND APPROACHES

2.1 PLANT MATERIAL

We collected fresh *Mimusops elengi L.* flowers from our college's campus. The presence of numerous, robust *Mimusops elengi L.* trees with blooming blooms was a deciding factor in the selection of the collecting siteRout, P. K., Sahoo, D., & Misra, L. N. (2010). The flowers were meticulously examined to verify their botanical identity and quality upon collection. According to accepted botanical descriptions of *Mimusops elengi L.* flowers, morphological traits such flower colour, shape, size, scent, petal arrangement, and reproductive mechanisms were noted Satish, S., Raghavendra, M. P., Mohana, D. C., & Raveesha, K. A. (2008)..Care was taken when handling the flowers to prevent infection or harm. To preserve moisture and freshness while being transported to the lab, they were put in hygienic, ventilated containers that were lined with damp paper towels. The flowers underwent additional examination in the laboratory to verify their botanical identity.

2.2 LYOPHILIZATION

Pre-freezing:

The flowers were cleaned and sorted, then laid out in a single layer on trays or racks and frozen at a temperature lower than the freezing point of water, which is normally between -20°C and -40°C. Before the lyophilization procedure, the flowers' cellular integrity and structure are preserved by pre-freezing them Nair R., & Chanda S. (2007).

Primary Drying (Freezing):

The flowers were put in the lyophilization chamber after they had been pre-frozen. To produce a vacuum and start the freezing process for the flowers, the chamber was evacuated. In this stage, the water molecules in the flowers crystallize into ice.

Secondary Drying (Sublimation):

Following the freezing of the flowers, a slow temperature increase in the lyophilization chamber caused the frozen water molecules to sublimate, or move from the solid to the vapor phase without first passing through the liquid phase 4. Nair, R., & CHANDA, S. (2007).. Through this technique, the flowers' moisture content was successfully reduced but their structure and medicinal ingredients were kept intact.

Gathering of Lyophilized Flowers:

After the lyophilization process was finished, the dried flowers also known as freeze-dried or lyophilized flowers were carefully taken out of the chamber. After that, the flowers were kept dry and away from oxidation in sealed bags or airtight containers until they were needed again Nasution, R., Azwar, A. I., & Helwati, H. (2019).As they are resilient and conserved, lyophilized *Mimusops elengi L*. flowers are ideal for essential oil extraction because they guarantee the conservation of volatile aromatic components and bioactive elements. The plant material can be transported and stored more easily without sacrificing quality due to the lyophilization procedure, which also makes the material appropriate for further extraction and characterization research.

2.3 STEAM DISTILLATION

One popular technique for obtaining essential oils from plant materials including flowers like those of *Mimusops elengi L.* is steam distillation Sujatha, K. (2022). This process is based on the idea that volatile aromatic chemicals can be gently extracted from plant material while maintaining their chemical integrity by using steam. The steps involved in the steam distillation of *Mimusops elengi L.* flowers to obtain essential oil are explained in detail below:

Configuration and Equipment Prepared:

An apparatus for distillation is usually made up of a receiving flask, a distillation column or condenser, and a round-bottom flask. A source of heat, such as an electric heater or hot plate. Pure water to produce steam.

Filling the Plant Material:

The previously documented lyophilized *Mimusops elengi L.* flowers are carefully put into the distillation apparatus's round-bottom flask. The target yield of essential oil and the apparatus's capacity are two examples of variables that may affect the quantity of plant material required.

Addition of water:

The plant material is placed in a round-bottom flask with enough water supplied. During the distillation process, the water is used as a carrier to generate steam, which transports the volatile aromatic chemicals from the flowers.

Heating and Production of Steam:

After connecting the distillation equipment and turning on the heat source, the water in the round-bottom flask gradually warms up. Steam is produced as the water heats up and rises through the plant matter.

Vaporization and Distillation:

The volatile aromatic compounds found in the plant material are gradually evaporated as the steam moves through the blooms of *Mimusops elengi L.* These substances, which include essential oils, are transported into the condenser with steam and evaporated water vapor.

Condensation and Collection:

After entering the condenser, the steam and vaporized components are cooled and condensed back into liquid form Roqaiya, M., Begum, W., Majeedi, S. F., & Saiyed, A. (2015). The condensation process is aided by the condenser, which is usually made up of a coil or several tubes encircled by coolant or cold water. The essential oil and water-based condensed mixture is gathered in the receiving flask.

Essential oil separation

Essential oils float on the surface of the condensed mixture because they are less dense than water Wong, K. C., & Teng, Y. E. (1994). Using a separatory funnel or decantation, the essential oil is extracted from the water.

Storage

To maintain its quality and potency, the extracted essential oil is moved to an airtight, dark container and kept out of direct sunlight in a cool, dry environment.

Determining Yield:

By weighing or measuring the collected oil, one can determine the amount of essential oil that can be extracted from the process of steam distillation. The essential oil extracted from *Mimusops elengi L.* flowers is suitable for further characterization and assessment of its potential medicinal activities because steam distillation preserves its fragrant qualities and bioactive ingredients.

2.4 SOLVENT EXTRACTION

The dried *Mimusops elengi L.* petals were ground into a fine powder with a mechanical grinder or a mortar and pestle.

Methanol Extraction: We weighed and transferred 10 grams of powdered *Mimusops elengi L.* flowers into a dry, clean container. To make sure the powdered flowers were fully submerged in the solvent, 100 milliliters of methanol were added Shailajan, S., & Gurjar, D. (2015). After sealing the container, the mixture was stirred with a magnetic stirrer for around three hours at room temperature to extract the solvent. The mixture was filtered to remove any solid residues and separate the liquid extract after the extraction period. The light brown liquid extract that had been filtered was gathered in a sanitized container. During the extraction and collecting process, precautions were taken to prevent any contamination.

2.5 GAS CHROMATOGRAPHY-MASS SPECTROMETRY (METHOD)

By GC-MS equipment (Thermo Scientific Co., Thermo GCTRACE ultra, version 5.0, Thermo MS DSQ II). The experimental conditions of the GC-MS system included TR 5MS capillary standard non-polar column, dimension of 30 mts, ID of 0.25 mm, and film thickness of 0.25 μm. The flow rate of the mobile phase (carrier gas: helium) was set at 1.0 mL/min. In the gas chromatography division, the temperature (oven temperature) was 40°C raised to 250°C at 5°C/min, and the injection volume was 1 μl. The samples dissolved in chloroform were run fully at a range of 50650 m/z, and the results were compared by using the Wiley Spectral library search program Baliga, M. S., Pai, R. J., Bhat, H. P., Palatty, P. L., & Boloor, R. (2011). The constituents were identified after comparison with those available in the computer library (NIST and Willey) attached to the GC-MS instrument and the results obtained have been tabulated.

2.6 ANTIOXIDANT ASSAY

2.6.1 DPPH Assay

The free radical-scavenging assay of different extracts was measured in terms of hydrogen donating or radical-scavenging ability using the stable radical DPPH. Stock solutions of extracts (0.001 g/ml) were prepared in DMSO. Different concentrations (20, 40, 60, 80, and 100 µg) of test solutions were prepared from stock and made up to 2 ml with methanol. A solution of DPPH (0.1 mmol) in methanol was prepared and 1 ml of this solution was added to each of the above test solutions (B. JAYALAKSHMI et al, 2015). The mixture was shaken vigorously and left to stand at room temperature for 3 min and the absorbance of each test solution was measured at 520 nm (KY Pin et al, 2010). Ascorbic acid (AA) was used as a standard or positive control and DMSO was used as a negative control. The capability to scavenge the DPPH radical was calculated using the following

Equation:

DPPH· scavenging effect (%) = [(Ac– Ab|Ac) × 100] (1)

were, Ac is absorbance of the negative control, Ab is the absorbance of the test solution (B. Jayalakshmi et al, 2015)

2.7 Antibacterial Assay

The antibacterial susceptibility of prepared compounds against Gram-positive and Gram-negative bacterial strains; B.subtilis and E.coli was evaluated using disc diffusion/Kirby Bauer method. Nutrient agar was inoculated with the given microorganisms by spreading the bacterial inoculums on the media (Balaji Kaveti et al,2011). Briefly, a 10 mm sample were placed on freshly-grown bacterial suspension (with a concentration of ~10 4 and ~10 colony forming unit (CFU)/ mL of selected bacteria in LB (Luria Bertani) was spread on the nutrient agar plates. Small sterile paper disks of uniform size (10 mm) were impregnated with as prepared samples (Extract) and then placed on the nutrient agar plates. Disks impregnated with Ciprofloxacin and pure water was placed on nutrient agar for positive control. Plates were then incubated at 37 °C for 24 h (B. JAYALAKSHMI et al.2015). The resulting bacterial colonies' distance inhibition zones around the disks were then recorded. The relative antibacterial effect was found by measuring the clear zones of inhibition formed around the discs using a Vernier caliper instrument (Tarun Pal Singh et al, 2018). The antimicrobial test for all microorganisms and fabrics was made in triplicate.

3. RESULT AND DISCUSSION

3.1 Steam Distillation

Fig 1. Steam Distillation – Essential Oil

3.2 Gas Chromatography-mass spectroscopy

Among the identified phytocompounds, D-Limonene,alpha.-Phellandrene, Citronellyl butyrate, Levomenthol, Carvone, Caryophyllene oxide are identified as essential oil substances that could be already reported to have biologically functional compounds , here in we reported those compounds are present in our extraction from *Mimusops elengi L.* plant. The total identified compounds are listed as Table. (Table 1).

S.No	RT	RT Compound Name	Molecular weight	Molecular Formula
1	5.5072	Bicyclo[3.1.0]hex-2-ene, 2-methyl-5-(1-methylethyl)-	93.0	C10H16
2	6.2091	Bicyclo[3.1.0]hex-2-ene, 4-methyl-1-(1-methylethyl)-	93.0	C10H16
3	6.2093	Bicyclo[2.2.1]heptane, 2,2-dimethyl-5-methylene-	93.0	C10H16
4	6.2095	Bicyclo[3.1.0]hex-2-ene, 4-methyl-1-(1-methylethyl)-	93.0	C10H16
5	6.701	Bicyclo[3.1.0]hex-2-ene, 4-methyl-1-(1-methylethyl)-	93.0	C10H16
6	6.9525	Benzenamine, 2-ethyl-6-methyl-	91.0	C9H13N
7	6.9535	2-Methyl-.beta.-alanine, N-benzyl-N-methyl-, methyl ester	134.0	C13H19NO2
8	6.9538	Benzenamine, 2,4,6-trimethyl-	91.0	C9H13N
9	6.9539	2-Methyl-.beta.-alanine, N-benzyl-N-methyl-, methyl ester	134.0	C13H19NO2
10	6.9541	1,3-Diphenyl-2-(methylamino)propanol	134.0	C16H19NO
11	6.9576	Sulfoxide, methyl phenethyl	91.0	C9H12OS
12	7.0389	D-Limonene	93.0	C10H16
13	7.0897	1-Phenyl-1-decanol	107.0	C16H26O
14	7.4761	2,4,6-Octatriene, 2,6-dimethyl-	93.0	C10H16
15	7.4762	.alpha.-Phellandrene	93.0	C10H16

16	8.0693	Linalyl isobutyrate	107.0	C14H24O2
17	8.4445	2-Cyclohexen-1-ol, 1-methyl-4-(1-methylethenyl)-, trans-	109.0	C10H16O
18	8.6818	2-Cyclohexen-1-ol, 1-methyl-4-(1-methylethenyl)-, trans-	109.0	C10H16O
19	8.8546	(1R,2R,5R)-5-Methyl-2-(prop-1-en-2-yl)cyclohexanol	111.0	C10H18O
20	9.0119	Heptane, 4-methylene-	84.0	C8H16
21	9.012	Cyclohexanone, 5-methyl-2-(1-methylethyl)-, trans-	112.0	C10H18O
22	9.0121	1,3-Cyclohexanedione, 4-propyl-	112.0	C9H14O2
23	9.1535	(4-Methyl-piperidin-1-yl)-acetic acid, (2-oxo-2,3- dihydro-benzo[e]indol-1-ylidene)-hydrazide	112.0	C20H22N4O2
24	9.1535	Pyrazol-5-ol, 1-acetyl-3,4-dimethyl-, acetate (ester)	111.0	C9H12N2O3
25	9.1611	Hexanoic acid, 3,7-dimethyl-6-octenyl ester	109.0	C16H30O2
26	9.1611	Cyclohexanol, 5-methyl-2-(1-methylethyl)-, acetate, (1.alpha.,2.beta.,5.beta.)-	95.0	C12H22O2
27	20.01	Citronellyl butyrate	95.0	C14H26O2
28	9.1633	Cyclohexanone, 5-methyl-2-(1-methylethyl)-, trans-	112.0	C10H18O
29	9.1726	Pyrazol-5-ol, 1-acetyl-3,4-dimethyl-, acetate (ester)	111.0	C9H12N2O3
30	9.3407	Levomenthol	95.0	C10H20O
31	9.3407	Citronellyl butyrate	95.0	C14H26O2
32	9.4429	2-Hexanol, 3,3,5-trimethyl-2-(3-methylphenyl)-	135.0	C16H26O
33	9.5383	.alpha.-Terpineol	107.0	C10H18O

34	9.8983	n-Caproic acid vinyl ester	99.0	C8H14O2
35	9.9638	photocitral B	109.0	C10H16O
36	9.9638	2-Cyclohexen-1-ol, 2-methyl-5-(1-methylethenyl)-, cis-	91.0	C10H16O
37	10.3345	Diphenethylamine, .alpha.-methyl-	148.0	C17H21N
38	10.3531	Carvone	108.0	C10H14O
39	10.4792	3-Cyclohexen-1-one, 2-isopropyl-5-methyl-	110.0	C10H16O
40	10.7081	Cinnamaldehyde, (E)-	103.0	C9H8O
41	10.9194	Ethanone,1-(2-furanylcyclopropyl)-	107.0	C9H10O2
42	10.9194	4-Isopropylcyclohexa-1,3-dienecarbaldehyde	107.0	C10H14O
43	10.9353	1,3-Benzodioxole, 5-(1-propenyl)-	104.0	C10H10O2
44	10.978	Cyclohexanol, 5-methyl-2-(1-methylethyl)-, acetate, (1.alpha.,2.alpha.,5.beta.)-	95.0	C12H22O2
45	10.9781	Cyclohexene, 4-methyl-1-(1-methylethyl)-, (R)-	95.0	C10H18O
46	11.7538	1,2-Cyclohexanediol, 1-methyl-4-(1-methylethenyl)-	108.0	C10H18O2
47	11.9772	5-Chlorovaleric acid, 3,5-dimethylphenyl ester	122.0	C13H17ClO2
48	11.9773	(2S,6R,7S,8E)-(+)-2,7-Epoxy-4,8-megastigmadiene	134.0	C13H20O
49	11.9786	Phenylpropanamide	104.0	C9H11NO
50	11.9788	Felbamate	104.0	C11H14N2O4
51	11.9788	Disulfide, methyl (methylthio)phenylmethyl	168.0	C9H12S3
52	11.9788	1H-Inden-2-ol, 2,3-dihydro-1-methoxy-, cis-	121.0	C10H12O2
53	12.4952	1,2-Cyclohexanediol, 1-methyl-4-(1-methylethenyl)-	108.0	C10H18O2
54	12.796	Bicyclo[7.2.0]undec-4-ene, 4,11,11-trimethyl-8-	147.0	C15H24

		methylene-,[1R-(1R*,4Z,9S*)]-		
55	12.9718	Acetic acid, cinnamyl ester	134.0	C11H12O2
56	13.4634	(1R,5R)-2-Methyl-5-((R)-6-methylhept-5-en-2-yl)bicyclo[3.1.0]hex-2-ene	119.0	C15H24
57	13.9832	Benzamide, 4-ethyl-N-(3,4-dimethoxyphenethyl)-	164.0	C19H23NO3
58	14.8372	Caryophyllene oxide	161.0	C15H24O
59	16.818	Methyl 2-(benzoyloxy)ethanoate	135.0	C10H10O4
60	16.8184	Benzyl Benzoate	105.0	C14H12O2

Table 1. Bioactive compound identified in *Mimusops elengi L.* extract

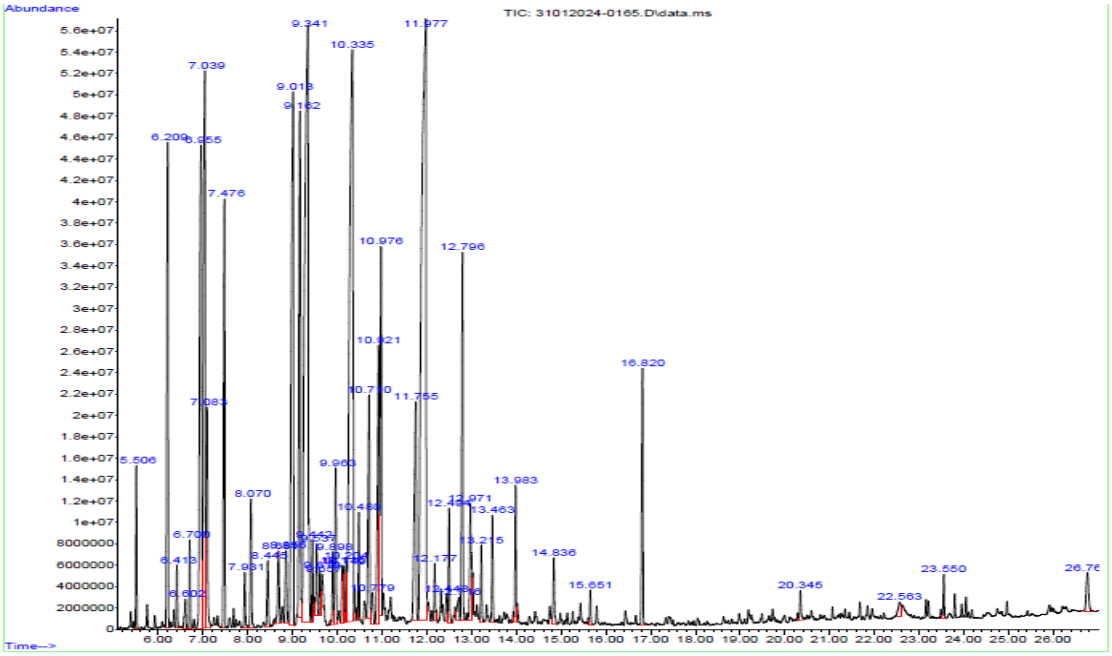

Fig 2. Characterization of Bioactive Compounds by GC-MS Analysis

3.3 Antioxidant Assay

The free radical scavenging activity of *mimusops elengi L.* flower extracts in various assays is presented in Table 1. Both petals and sepals methanolic extract from *Mimusops elengi L.* flowers demonstrated antioxidant activities Natungnuy, K., & Poeaim, S. (2018). The antioxidant capacity of methanolic extract from sepals revealed higher antioxidant activities than petals, significantly different for all assays ($p < 0.05$). The methanolic extract from sepals showed the antioxidant capacity of 206.72±10.38mgTE /g extract in DPPH respectively. However, methanolic extract from petals showed 135.03±5.64 mg/g extract, respectively.

Methanolic extracts	Antioxidant Activity	IC Values
	DPPH (mgTE/g extract)	DPPH
Petals	135.03±5.64	151.79
Sepals	206.72±10.38	98.20

Table 2. Antioxidant Assay – DPPH Assay

3.4 Antibacterial Assay

Sample	Pathogenic Bacteria	Concentration (µg/ml)	Zone of inhibition (mm)
Extract	*E.coli*	5 10 25 50 100	1 3 6 7 9
Extract	*B. subtilis*	5 10 25 50 100	1 3 7 9 10

Table 3: Antibacterial activity of sample against pathogenic bacteria

The antibacterial activity of the alcoholic extract of *Mimusops elengi L.* was examined by disc diffusion method for both gram-positive (Bacillus subtilis) and gram-negative (Escherichia coli) bacteria. Significant inhibition in growth was observed in both colonies. Inhibition zones were observed and measured using a vernier caliper for different concentrations. At 100 µl concentration, the alcoholic extract showed noticeable inhibition against the tested organisms. For Bacillus subtilis maximum inhibition(10mm) was shown and for Escherichia coli (9mm) was shown.

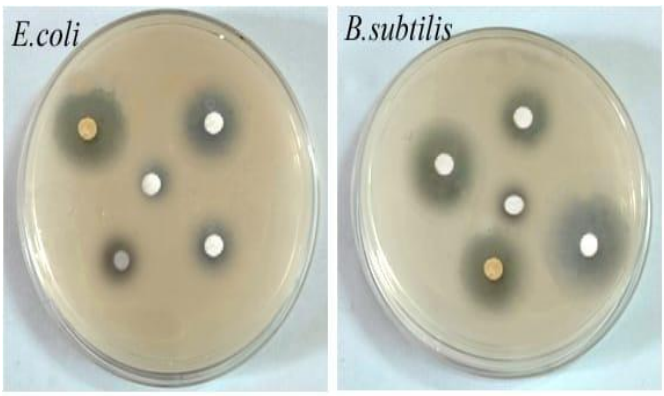

Figure 3: Antibacterial Assay: Zone of inhibition formed in *E.coli* and *Bacillus subtilis*

4. CONCLUSION

In conclusion, it has been effectively accomplished to extract and characterize aromatic essential oil from *Mimusops elengi L.* flowers utilizing solvent extraction with ethanol. The extracted essential oil has a wide range of chemical components, which add to its unique scent and possible medicinal benefits. As a natural antioxidant and antibacterial agent, *Mimusops elengi L.* essential oil has the potential to be very active in antioxidant and antimicrobial assays. These results highlight *Mimusops elengi L.*'s importance as a valuable source of bioactive chemicals with potential use in pharmacology. To clarify mechanisms of action and investigate more general uses in the food, cosmetic, and pharmaceutical industries, more research is necessary. All things considered, this research advances our knowledge of and ability to use natural products for a variety of medical applications.

5. ACKNOWLEDGMENT

This is the B. Tech final year project of the first, second, third, and fourth author. We acknowledge the Department of Biotechnology, Sri Shakthi Institute of Engineering and Technology for providing an ambient environment for the completion of the project.

Declaration

Conflict of interest: The authors report no conflicts of interest.

Funding: The Source of funding is nil.

Ethical Clearance: Nil.

Permission To Reproduce: Nil.

Reference

Akhtar, N., Ali, M., & Alam, M. S. (2009). Pentacyclic triterpenes from the stem bark of Mimusops elengi L. Acta Poloniae Pharmaceutical and Drug Research, 66(5), 549-552.

Azhagumurugan, C., & Rajan, M. K. (2014). GC-MS analysis of phytochemical constituents and nematicidal activities of leaf extract of Magilam, Mimusops elengi. World Journal of Zoology, 9(4), 239-243.

Baliga, M. S., Pai, R. J., Bhat, H. P., Palatty, P. L., & Boloor, R. (2011). Chemistry and medicinal properties of the Bakul (Mimusops elengi Linn): A review. Food Research International, 44(7), 1823-1829.

Bhagwat, P. S., & Agarwal, S. PHARMACOLOGICAL EVALUATION OF MIMUSOPS ELENGI FRUIT AND BARK.

Gami, B., Pathak, S., & Parabia, M. (2012). Ethnobotanical, phytochemical and pharmacological review of Mimusops elengi Linn. Asian Pacific Journal of Tropical Biomedicine, 2(9), 743-748.

Ganesh, G., Abhishek, T., Saurabh, M., & Sarada, N. C. (2014). Cytotoxic and apoptosis induction potential of Mimusops elengi L. in human cervical cancer (SiHa) cell line. Journal of King Saud University-Science, 26(4), 333-337.

Gowri, S. S. (2020). GC-MS analysis of Majidea zanquebarica J. Krikex Oliv.(Sapindaceae) seed extract. Journal of Pharmaceutical Sciences and Research, 12(5), 619-623.

Gupta, P. C. (2013). Mimusops elengi Linn.(Bakul)-A potential medicinal plant: A review. Int J Pharm Phytopharmacol Res, 2(5), 332-339.

Hosni, K., Kerkenni, A., Medfei, W., Ben Brahim, N., & Sebei, H. (2010). Volatile oil constituents of Rosa canina L.: Quality as affected by the distillation method. Organic Chemistry International, 2010.

HUSEN, A., ARIF, M., RIZVI, A., SRIVASTAVA, M., SHAFI, S., BETH, M. R. M., & ABDELRAHEM, A. S. A. (2022). Medicinal importance of Spanish cherry: An ornamental tree in human welfare from Dibrugarh District (Assam) India. Journal of Pharmaceutical Negative Results, 984-995.

Jayashree, K. V., Pakutharivu, T., Anitha, T. A., Sharmila, S. T., & Gopukumar, S. T. (2017). EVALUATION OF ANTI-INFLAMMATORY AND THROMBOLYTIC ACTIVITY OF MIMUSOPS ELENGI. J. appl. sci. comput, 5(7), 699-713.

Kadam, P. V., Deoda, R. S., Shivatare, R. S., Yadav, K. N., & Patil, M. J. (2012). Pharmacognostic, phytochemical and physiochemical studies of Mimusops Elengi Linn stem bark (Sapotaceae). Der Pharmacia Lettre, 4(2), 607-613.

Kadam, P. V., Yadav, K. N., Deoda, R. S., Shivatare, R. S., & Patil, M. J. (2012). Mimusops elengi: A review on ethnobotany, phytochemical and pharmacological profile. Journal of Pharmacognosy and Phytochemistry, 1(3), 64-74

Khan, I., & Khan, A. (2018). Medicinal plants as alternative treatments for oral health problems. Asian Journal of Pharmaceutical and Clinical Research, 58-64.

Khatun, M., Sahu, K. R., & Mondal, A. K. (2023). Ultrastructural and Spectroscopic Analysis of Lignin of Stone Cells in Mimusops elengi L.(Sapotaceae) Fruit Mesocarp.

Korkmaz, N., Ceylan, Y., Hamid, A., Karadağ, A., Bülbül, A. S., Aftab, M. N., ... & Şen, F. (2020). Biogenic silver nanoparticles synthesized via Mimusops elengi fruit extract, a study on antibiofilm, antibacterial, and anticancer activities. Journal of Drug Delivery Science and Technology, 59, 101864.

Kumar, R., Kumar, R., Prakash, O., Srivastava, R. M., & Pant, A. K. (2019). GC-MS analysis of the hexane extract of Limnophila indica (L.) Druce, its total phenolics, in-vitro antioxidant, anti-inflammatory and antifeeding activity against Spilosoma obliqua. J. Entomol. Zool. Stud, 7, 970-975.

López Villarreal, S. M., Elizondo Luévano, J. H., Pérez Hernández, R. A., Sánchez García, E., Verde Star, M. J., Castro Ríos, R., ... & Chávez Montes, A. (2022). Preliminary study of the antimicrobial, anticoagulant, antioxidant, cytotoxic, and anti-inflammatory activity of five selected plants with therapeutic application in dentistry. International journal of environmental research and public health, 19(13), 7927.

Majumdar, R., Bag, B. G., & Ghosh, P. (2016). Mimusops elengi bark extract mediated green synthesis of gold nanoparticles and study of its catalytic activity. Applied Nanoscience, 6, 521-528.

Muthuswamy, M., Prabuseenivasasn, S., & Kumar, V. (2012). Antibacterial activity of seleced medicinal plants used by the tribal people. Biomedicine, 32(2), 199-206.

Nair, R., & CHANDA, S. (2007). Antibacterial activities of some medicinal plants of the western region of India. Turkish Journal of Biology, 31(4), 231-236.

Nasution, R., Azwar, A. I., & Helwati, H. (2019). Antibacterial activities of perfume: combination flower Magnolia alba, Cananga odorata and Mimusops elengi L, fixed with Pogostemon cablin oil. Indonesian Journal of Pharmaceutical and Clinical Research, 2(1), 19-23.

Padhi, M., & Mahapatra, S. (2013). Evaluation of Antibacterial Potential of Leaf extracts of Mimusops elengi. Int Res J Biological Sci, 2(7), 46-49.

Partap, S. (2012). A review on herbal antioxidants. Journal of Pharmacognosy and Phytochemistry, 1(4), 26-37.

Pokale, P., Shende, S., Gade, A., & Rai, M. (2014). Biofabrication of calcium phosphate nanoparticles using the plant Mimusops elengi. Environmental chemistry letters, 12, 393-399.

Promsomboon, S., Promsomboon, P., Kornpetpanee, S., & Pothisonothai, M. (2011, December). Selection of odor from aromatic flowers for relaxing emotion. In International Symposium on Medicinal and Aromatic Plants 1023 (pp. 29-34).

Rani, S., & Rahman, K. (2017). Molsari (Mimusops elengi Linn.): A boon drug of traditional medicine. International Journal of Pharmaceutical Sciences Research, 8(1), 17.

Renuka, V. B., Pradeep Kumar, M. R., & Savadi, R. V. (2014). Phytochemical screening and evaluation of hepatoprotective activity of Mimusops elengi linn., bark. International Journal of Research in Pharmaceutical Sciences, 5(3), 227-23

Roqaiya, M., Begum, W., Majeedi, S. F., & Saiyed, A. (2015). A review on traditional uses and phytochemical properties of Mimusops elengi Linn. IJHM, 2(6), 20-23.

Rout, P. K., Sahoo, D., & Misra, L. N. (2010). Comparison of extraction methods of Mimusops elengi L. flowers. Industrial crops and Products, 32(3), 678-680.

Ruikar, A., Torane, R., Tambe, A., Puranik, V., & Deshpande, N. (2009). GC-MS study of a steam volatile matter from Mimusops elengi. Int J Chemtech Res Coden, 1(2), 158-161.

Salam, R., Sarker, B. K., Haq, M. R., & Khokon, J. U. (2015). Antimicrobial activity of medicinal plant for oral health and hygiene. Int j nat soc sci, 1(2), 1-12.

Satish, S., Raghavendra, M. P., Mohana, D. C., & Raveesha, K. A. (2008). Antifungal activity of a known medicinal plant Mimusops elengi L. against grain moulds. Journal of Agricultural technology, 4(1), 151-165.

Shailajan, S., & Gurjar, D. (2015). Evaluation of Mimusops elengi L. flowers using pharmacognostic approach. Pharmacognosy Communications, 5(1).

Srivastava, S., Siddiqui, M. A., Arif, M., Javed, A., & Khan, A. (2023). Pharmacological, phytochemical Chemistry and therapeutic qualities of Mimusops elengi.

Subramaniam, J., Murugan, K., Panneerselvam, C., Kovendan, K., Madhiyazhagan, P., Kumar, P. M., ... & Benelli, G. (2015). Eco-friendly control of malaria and arbovirus vectors using the mosquitofish Gambusia affinis and ultra-low dosages of Mimusops elengi-synthesized silver nanoparticles: towards an integrative approach?. Environmental Science and Pollution Research, 22, 20067-20083.

Sujatha, K. (2022). Formulation and evaluation of poly herbal transparent soap containing extracts of Mimusops elengi L., Senna auriculata, and Ocimum basilicum oil. International Journal of Green Pharmacy (IJGP), 16(2).

Sukri, H. H., Gunong, F. S., Idin, N. I., & Mohamed, N. Z. (2021). Floral traits and pollination of Spanish Cherry (Mimusops Elengi Linn.) In Universiti Malaysia Terengganu Campus. Universiti Malaysia Terengganu Journal Of Undergraduate Research, 3(3), 43-52.

Trehan, N., & Kaur, S. (2019). Plant Proteases: Sources, Production Methods And Various Commericial Applications. Agriways, 7(1).

Tun, T. Investigations of some Chemical Constituents and Screening of some Biological Activities of Seeds of Mimusops elengi L.(Ka-yae). Universities Research Journal, 171.

Wong, K. C., & Teng, Y. E. (1994). Volatile components of Mimusops elengi L. flowers. Journal of Essential Oil Research, 6(5), 453-458.