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Exploring the phytochemical constituents of *Plumeria obtusa* L. root and stem extracts through GC-MS analysis

J. Jaahnavi, S.P. Thamaraiselvi◆, M. Ganga, N. Sritharan* and P. Malathi**

Department of Floriculture and Landscaping, Horticultural College and Research Institute, Tamil Nadu Agricultural University, Coimbatore-641003, Tamil Nadu, India

** Department of Rice, Tamil Nadu Agricultural University, Coimbatore-641003, Tamil Nadu, India*

*** Department of Soil Science and Agricultural Chemistry, Tamil Nadu Agricultural University, Coimbatore-641003, Tamil Nadu, India*

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Abstract

This study investigates the bioactive phytochemicals present in the root and stem extracts of *Plumeria obtusa* L., commonly known as the 'Great white frangipani' using gas chromatography-mass spectrometry (GC-MS). Traditionally used in various medicinal applications, *P. obtusa* is valued for its therapeutic properties. The GC-MS analysis identified a wide array of bioactive compounds, including ethyl alpha-d-glucopyranoside, 2,3-dihydrobenzofuran, n-decanoic acid and methyl beta-d-glucopyranoside. These compounds exhibit significant pharmacological activities such as antioxidant, anticancer, antimicrobial and anti-inflammatory effects. Glycosides like ethyl alpha-d-glucopyranoside and methyl beta-d-glucopyranoside showed strong antioxidant and skin-moisturizing properties, indicating their potential for pharmaceutical and cosmetic applications. Fatty acids such as n-decanoic acid and methyl palmitate displayed anti-inflammatory and antimicrobial properties, making them suitable for treating infections and inflammation related conditions. Additionally, plumericin, a terpenoid, demonstrated potent antibacterial, antifungal and antiviral properties, while 9,12-octadecadienoic acid methyl ester showed promise as an analgesic and anticancer agent. The study highlights the potential of *P. obtusa* extracts for applications in pharmaceuticals, cosmetics and agriculture. The findings underscore the need for further research to explore the therapeutic potential of these bioactive compounds and to develop new applications in various industries.

1. Introduction

Plants offer everything essential for human survival, including food, fiber, shelter and especially natural remedies to treat a wide range of ailments (Sharma *et al.*, 2021). Plants play a significant role in ethnopharmacology and are widely used by numerous cultures across the globe to treat various health conditions (Sharma and Alam, 2022). Bioactive compounds from plants are present in all parts of the plant, including the bark, leaves, flowers, roots, fruits and seeds. Plant extracts and their active constituents are widely recognized for demonstrating significant biological activities, particularly antimicrobial and antioxidant properties (Musini *et al.*, 2013).

Gas chromatography-mass spectrometry (GC-MS) is a key tool for precise and detailed chemical evaluation of phytochemicals in plant extracts. It helps to identify bioactive constituents such as long-chain hydrocarbons, alcohols, acids, esters, alkaloids, steroids, amino compounds and nitrocompounds (Muthulakshmi and Mohan, 2012). Volatile compounds, such as terpenoids, alkaloids and flavonoids are identified and assessed through their mass spectra (Singh *et al.*, 2024). The demand for herbal products has grown worldwide, with more people in both developed and developing countries using plantbased health solutions. *Plumeria obtusa* L., commonly known as Great white frangipani , is an evergreen tree, grown as an ornamental plant for its attractive and fragrant flowers. On commercial scale, essential oil extracted from its flowers is used in perfume industry (Choudhary *et al.*, 2014; Sulaiman *et al.*, 2008).Various parts of the plant have traditionally been used to treat a range of conditions, including diabetes mellitus, wounds, skin diseases, as well as for their diuretic, purgative and abortifacient properties. Additionally, these plant parts are utilized in cosmetics, aromatherapy, as ornaments and for ceremonial offerings (Bihani *et al.*, 2021). The plant exhibits a broad spectrum of pharmacological activities, including antimicrobial, antiproliferative, antimutagenic, anti-inflammatory, antiulcerogenic, algicidal, antioxidant, insecticidal and wound-healing properties. Therefore, isolating phytoconstituents from plants and assessing their key pharmacological properties is crucial in the future development of new drugs (Srivani and Mohan, 2023).

Hence, the study aims to thoroughly investigate the root and stem extracts of *P. obtusa* to identify the biochemical compounds responsible for its extensive pharmaceutical properties, which hold significant potential for future applications.

2. Materials and Methods

2.1 Collection of plant material

Fresh root and stem parts of *P. obtusa* cuttings were collected from the *Plumeria* germ plasm being maintained by the Department of Floriculture and Landscaping, Tamil Nadu Agricultural University,

Corresponding author: Dr. S.P. Thamaraiselvi

Associate Professor, Department of Floriculture and Landscaping, Horticultural College and Research Institute, Tamil Nadu Agricultural University, Coimbatore-641003, Tamil Nadu, India

E-mail: thamaraiselvi.sp@tnau.ac.in

Tel.: +91-9843338666

Coimbatore district, Tamil Nadu, India for the present investigation. The plant authentication number for *Plumeria obtusa* L. was obtained from Botanical Survey of India, Southern Regional Centre, Coimbatore with Certificate No. BSI/SRC/5/23/2024/Tech./412 dt. 23.09.2024.

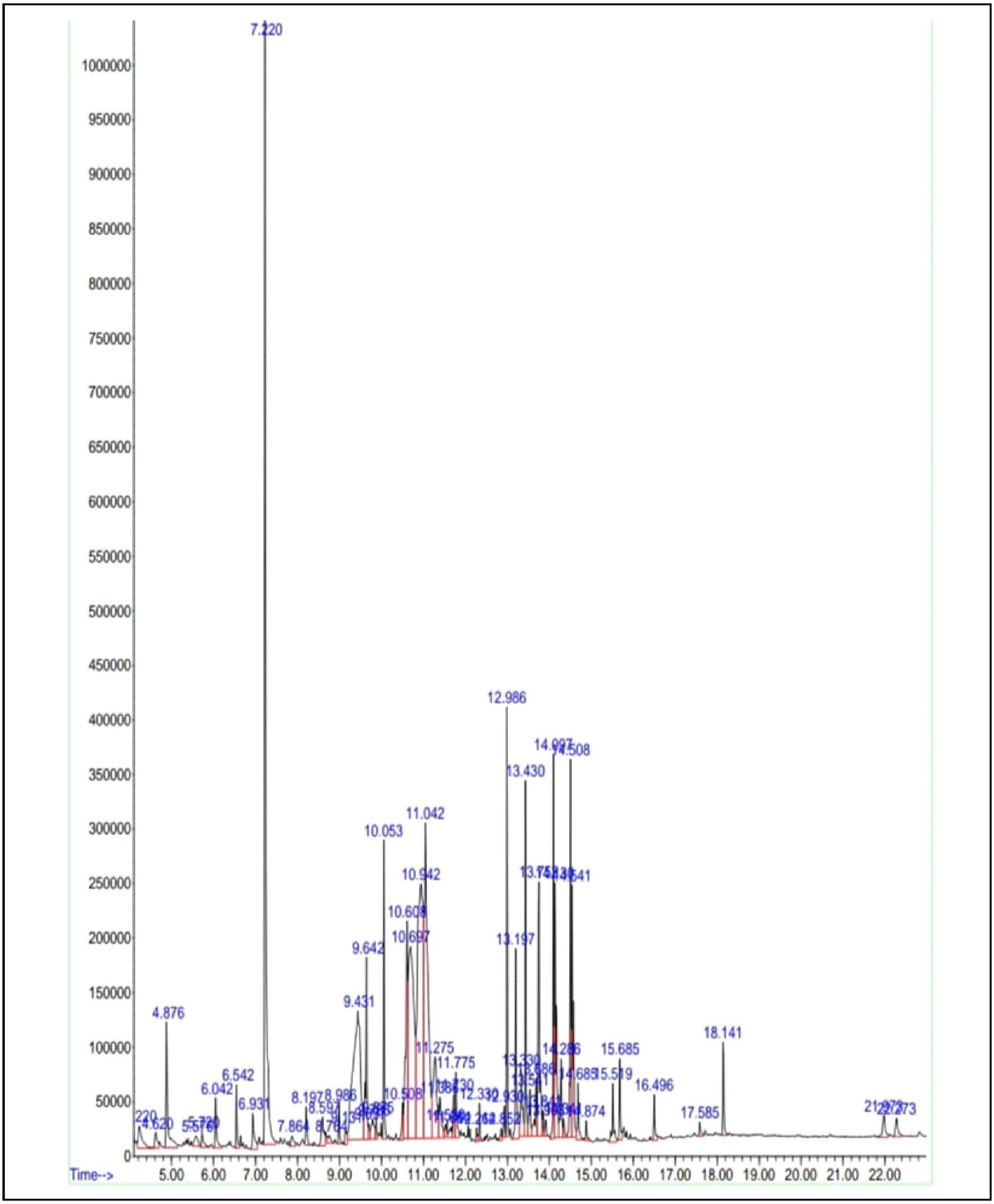

Figure 1: GC-MS elucidation of bioactive compounds in methanolic root extract of *P. obtusa*.

2.2 Preparation of methanolic root and stem extracts of *P. obtusa*

The root and stem pieces of *P. obtusa* were collected and washed twice with de-ionized water and then allowed to dry naturally in a cool environment. After thorough drying, the root and stem pieces were pulverized in a grinder and then stored in an airtight container for further use (Guha *et al.*, 2010; Sultana *et al.*, 2009). The active constituents were extracted by maceration using 70% methanol and water. 50 g of the macerated plant material was weighed in to 500 ml conical flask and 300 ml of methanol was added and left to stand for three days while stirring at intervals. The extracts were then filtered and dried with a rotary evaporator (Brinkmann, R110). The concentrates were dispensed into labelled sample vials and stored in refrigerator at 4°C.

2.3 GC-MS analysis of root and stem extracts of *P. obtusa*

The volatile components of the methanolic extract of *P. obtusa* root and stem extracts were characterized using GC-MS, employing an Agilent Technologies model 7890A gas chromatograph equipped with a Mass Selective Detector model 5975C (MSD) operating under electron ionization (70 V) with ion source temperature set at 250^{o}C. For analysis of this extract, a capillary column Agilent DB5MS (30 mm × 0.25 mm × 0.25 µm) was used. Helium (99.9%) was the high-purity carrier gas used, with a ml/min flow rate. The injector mode was split (1:60), with an injection volume of 1 µl. The oven temperature program began at 100° and maintained for 0.5 min before increasing to 140° at 20°/min, keeping it there for a minute and then finally going up to 280° at 11°C/min over 20 min. Mass hunter software was used for peak area measurement and data processing. The identification of components was based on a comparison of their mass spectra with those contained in the NIST Wiley 2008 library.

2.4 Identification of bioactive compounds

Peaks were identified using databases namely; Wiley mass spectral library (W9N11) and the National Institute of Standards and Technology (NIST) through GC-MS for the identification of unknown volatile compounds. Information on the biological activities of these compounds was obtained from Dr. Duke's Phytochemical and Ethnobotanical Databases and the molecular weight and molecular formula were verified using PubChem.

3. Results

GC-MS is regarded as the "Gold standard" for substance identification because of its precise testing capabilities. This technology has been used to identify hundreds of components in natural and biological systems (Kabir and Furton, 2021). Numerous phytochemical compounds were observed in *P. obtusa* root extract by using this method. The present findings of GC-MS revealed the bioactive compounds in methanolic root extract of *P. obtusa* (Table 1, Figure 1). Analysis of peak area, retention time and molecular formulae confirmed these phytochemicals. The compounds were predicted using the NIST database. The major 20 compounds identified in root extract of *P. obtusa* (Table 1) are ethylalpha-d-glucopyranoside (11.39%), 2,3-dihydrobenzofuran(10.96%), n-decanoicacid (9.39%), methylbeta-d-glucopyranoside (8.78%), 2-(2-butoxyethoxy)ethyl thiocyanate(7.91%), 7-octadecenoic acid methyl ester(4.13%), methylbeta-d-galactopyranoside (3.75%),4'-methoxybiphenyl-3-carboxylic acid (3.16%), linoleic acid ethyl ester (3.06%), 9,12-octadecadienoic acid (Z,Z)-methyl ester (2.70%), hexadecanoic acid ethyl ester (2.68%), 2,2-diethoxytetrahydrofuran (2.65%), methylpalmitate (2.49%), ethyl oleate (2.40%), ethyl4-ethoxybenzoate (1.93%), 2,6-dimethylbenzoquinone-4-oxime (1.80%), diborane(6) (1.77%), plumericin (1.48%), 7-hydroxy-6-methoxy-2H-1-benzopyran-2-one (0.99%) and 6,10,14,18,22-tetracosahexaene (0.85%).

Table 1: Phytochemical compounds identified in the methanolic root extract of *P. obtusa*

S.No.	Chemical compound	Molecular formula	Molecular weight (g/mol)	Area %	Retention time
1.	Ethylalpha-d-glucopyranoside	$C_8H_{16}O_6$	208.21	11.39	10.942
2.	2,3-Dihydrobenzofuran	C_8H_{8O}	120.15	10.96	7.220
3.	n-Decanoic acid	$C_{10}H_{20}O_2$	172.64	9.39	11.041
4.	Methylbeta-d-glucopyranoside	$C_7H_{14}O_6$	194.18	8.78	10.697
5.	2-(2-Butoxyethoxy)ethyl thiocyanate	$C_9H_{17}NO_2S$	203.30	7.91	9.431
6.	7-Octadecenoic acid, methyl ester	$C_{19}H_{36}O_2$	296.5	4.13	14.130
7.	Methylbeta-d-galactopyranoside	$C_7H_{14}O_6$	194.18	3.75	10.608
8.	4'-methoxybiphenyl-3-carboxylic acid	$C_{14}H_{12}O_3$	228.24	3.16	13.752
9.	Linoleic acid ethyl ester	$C_{20}H_{36}O_2$	308.5	3.06	14.508
10.	9,12-Octadecadienoic acid (Z,Z)- methyl ester	$C_{19}H_{34}O_2$	294.47	2.70	14.097
11.	Hexadecanoic acid ethyl ester	$C_{18}H_{36}O_2$	284.47	2.68	13.430
12.	2,2-Diethoxytetrahydrofuran	$C_8H_{16}O_3$	160.21	2.65	11.275
13.	Methyl palmitate	$C_{17}H_{34}O_2$	270.5	2.49	12.986
14.	Ethyl oleate	$C_{20}H_{38}O_2$	310.5	2.40	14.541
15.	Ethyl 4-ethoxybenzoate	$C_{11}H_{14}O_3$	194.23	1.93	10.053
16.	2,6-Dimethylbenzoquinone-4-oxime	$C_8H_9NO_2$	151.16	1.80	9.642
17.	Diborane(6)	B_2H_6	33.71	1.77	4.876
18.	Plumericin	$C_{15}H_{14}O_6$	290.27	1.48	15.685
19.	7-Hydroxy-6-methoxy-2H-1-benzopyran-2-one	$C_{10}H_8O_3$	176.17	0.99	13.330
20.	2,6,10,14,18,22-Tetracosahexaene	$C_{24}H_{38}$	326.6	0.85	18.141

Table 2 : Phytochemical compounds with their biological activity in *P. obtusa* root extract

S.No.	Chemical compound	Nature of the compound	Biological activity	Reference
1.	Ethylalpha-d-glucopyranoside	Glycosides	Skin moisturizing agent, antituberculous, antioxidant, alpha amylase inhibitory, hypolipidemic, anticonvulsant	Sonia and Singh, 2019
2.	Methylbeta-d-glucopyranoside		Antimicrobial glycoside	Olawumi *et al.*, 2020
3.	Methylbeta-d-galactopyranoside		Anticancer, CNS depressant, smart drug	Perumal *et al.*, 2021
4.	n-Decanoic acid	Fatty acids	Anti-inflammatory agent, antimicrobial activity	Kitahara *et al.*, 2004
5.	Hexadecanoic acid ethyl ester		Antioxidant activity	Mohamad *et al.*, 2020
6.	Methyl palmitate		Food and cosmetic additives cum anti-inflammatory, antioxidantactivity	Pinto *et al.*, 2017
7.	7-Octadecenoic acid methyl ester		Antibacterialactivity	Shettima *et al.*, 2013
8.	Ethyl oleate		Antibacterialactivity	Ankita *et al.*, 2015
9.	Linoleic acid ethyl ester		Antiarthritic, antihistaminic and anti-inflammatory agents	Kolar *et al.*, 2019
10.	9,12-Octadecadienoic acid (Z,Z)-methyl ester		Analgesic, anticancer, anti -inflammatoryactivity	Mohamad *et al.*, 2020
11.	Plumericin	Terpenoids	Antibacterial,antifungal, anti-inflammatory, antiparasitic, antiviral, cytotoxic, algicidalactivity	Coppen and Cobb, 1983
12.	2,6,10,14,18,22 -Tetracosahexaene		Anti-inflammatory and anti-oxidant used in nutraceutical and pharmaceutical industries	Kim and Karadeniz, 2012
13.	2,3-Dihydrobenzofuran	Bicyclic derivative	Anticancer, antifungal, antibac-terial activity	Mohamad *et al.*, 2020
14.	7-Hydroxy-6-methoxy-2H-1 -benzopyran-2-one	Coumarin	Antioxidantactivity	De Siqueira Leite *et al.*, 2015
15.	2,6-Dimethylbenzoquinone-4 -oxime	Quinone	Anticancer agent	Görner, 2019
16.	4'-methoxybiphenyl-3-carboxylic acid	Biphenyl derivative	Antibacterialactivity	Kuppusamy *et al.*, 2018
17.	2,2-Diethoxytetrahydrofuran	Cyclic ether	Antioxidantactivity	Jongcharoenkamol *et al.*, 2023
18.	Ethyl 4-ethoxybenzoate	Esters	Antibacterialactivity	Wright *et al.*, 2021
19.	2-(2-Butoxyethoxy) ethyl thiocyanate	Alcohol	Insecticide	Hideo and Casida, 1971
20.	Diborane(6)	Inorganic compound	Rubber vulcanizer	Borthakur *et al.*, 2019

Twenty compounds identified in *P. obtusa* stem extract (Table 3, Figure 2) are Urs-12-en-24-oic acid 3-oxo-methylester (27.43%), alpha-d-glucopyranoside (9.29%), alpha-amyrin (8.41%)9, 19-cyclolanost-24-en-3-ol (4.66%), 4'-methoxybiphenyl-3-carboxylic acid(4.14%), benzoic acid,4-ethoxy-ethylester (3.93%), 12-oleanen-3-ylacetate, (3alpha)- (3.70%), methylbeta-d-glucopyranoside (3.67%), 2-(2-Butoxyethoxy) ethyl thiocyanate (3.39%), 2,3-dihydrobenzofuran (2.72%), n-hexadecanoicacid (2.06%), alpha-d-galactopyranoside methyl (1.91%), linoleic acid ethyl ester (1.86%), 4-O-methylmannose (1.82%), 9-octadecenoic acid (Z)-ethyl ester (1.46%), 9,12-octadecadienoic acid (Z,Z)-methyl ester (1.30%), beta-amyrin (1.17%), ethyl oleate (1.12%), hexadecanoic acid methyl ester(1.12%) and hexadecanoic acid ethyl ester(1.08%). Biological activities of the phytochemical compounds of both root and stem extracts of *P.obtusa* have been mentioned in (Tables 2 and 4).

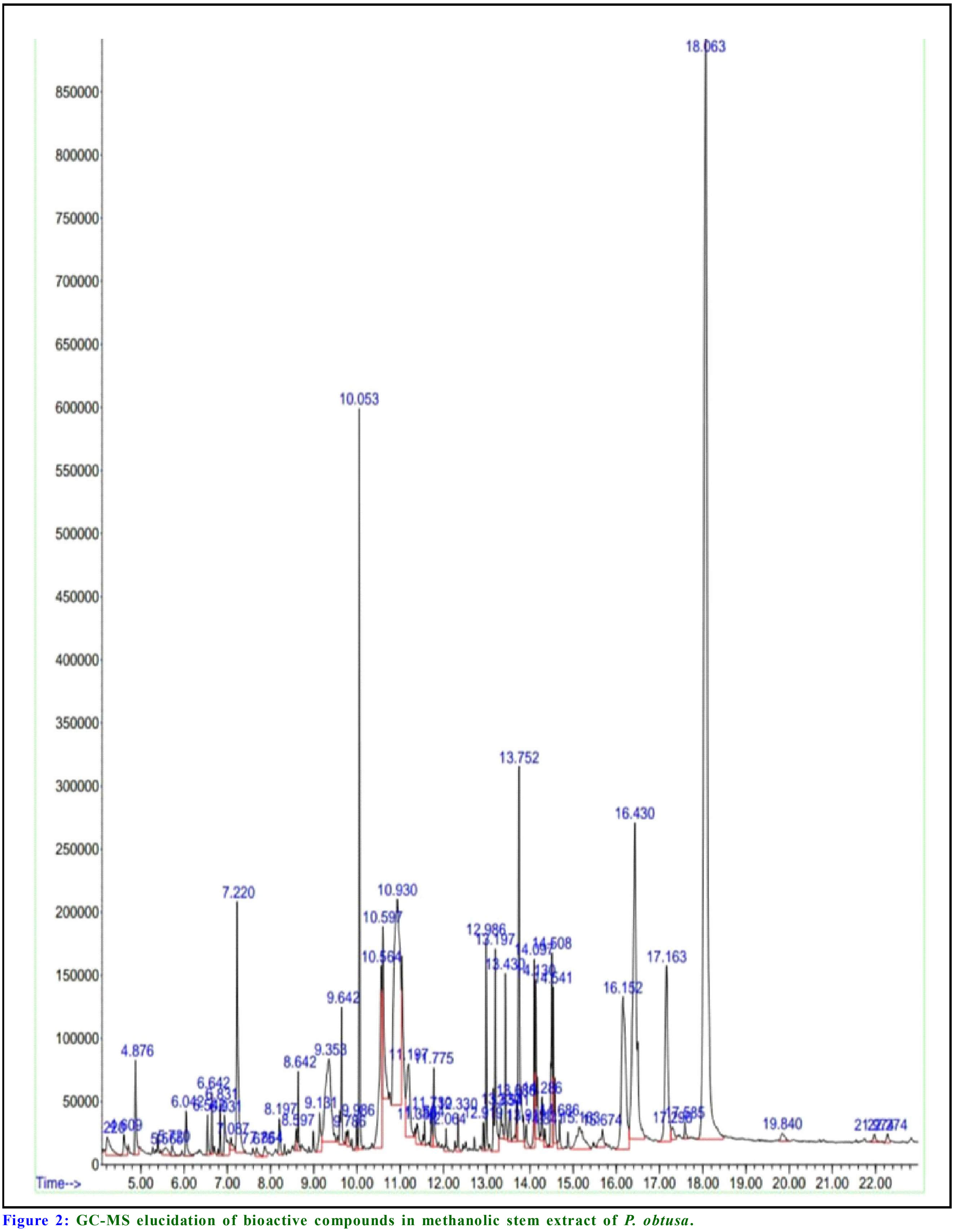

Figure 2: GC-MS elucidation of bioactive compounds in methanolic stem extract of *P. obtusa*.

Table 3: Compounds identified in the methanolic stem extract of *P. obtusa*

S.No.	Compound	Molecular formula	Molecular weight (g/mol)	Area%	Retention time
1.	Urs-12-en-24-oic acid 3-oxo- methyl ester	$C_{31}H_{48}O_3$	468.7	27.43	18.063
2.	alpha-d-glucopyranoside,	$C_7H_{14}O_6$	194.18	9.29	10.930
3.	alpha-amyrin	$C_{30}H_{50}O$	426.7	8.41	16.430
4.	9,19-Cyclolanost-24-en-3-ol	$C_{32}H_{52}O_2$	468.8	4.66	16.152
5.	4'-methoxybiphenyl-3-carboxylic acid	$C_{14}H_{12}O_3$	228.24	4.14	13.752
6.	Benzoic acid, 4-ethoxy- ethyl ester	$C_{11}H_{14}O_3$	194.23	3.93	10.053
7.	12-Oleanen-3-yl acetate (3 alpha)	$C_{32}H_{52}O_2$	468.8	3.70	17.163
8.	Methylbeta-d-glucopyranoside	$C_7H_{14}O_6$	194.18	3.67	10.564
9.	2-(2-butoxyethoxy) ethyl thiocyanate	$C_9H_{17}NO_2S$	203.30	3.39	9.353
10.	2,3-Dihydrobenzofuran	C_8H_8O	120.15	2.72	7.220
11.	n-hexadecanoic acid	$C_{16}H_{32}O_2$	256.42	2.06	13.197
12.	alpha-d-galactopyranoside methyl	$C_7H_{14}O_6$	194.18	1.91	10.597
13.	Linoleic acid ethyl ester	$C_{20}H_{36}O_2$	308.5	1.86	14.508
14.	4-O-methylmannose	$C_7H_{14}O_6$	194.18	1.82	11.197
15.	9-Octadecenoic acid (Z)- methyl ester	$C_{19}H_{36}O_2$	296.5	1.46	14.130
16.	9,12-Octadecadienoic acid (Z,Z)- methyl ester	$C_{18}H_{32}O_2$	280.4	1.30	14.097
17.	Beta-amyrin	$C_{30}H_{50}O$	426.7	1.17	15.163
18.	Ethyl oleate	$C_{20}H_{38}O_2$	310.5	1.12	14.541
19.	Hexadecanoic acid methyl ester	$C_{17}H_{34}O_2$	270.45	1.12	12.986
20.	Hexadecanoic acid ethyl ester	$C_{18}H_{36}O_2$	284.5	1.08	13.430

Table 4: Phytochemical compounds with their biological activity in *P. obtusa* stem extract

S.No.	Chemical compound	Nature of the compound	Biological activity	Reference
1.	Alpha-d-glucopyranoside	Glycosides	Pharmaceuticals and food industries	González *et al.*, 2014
2.	Methylbeta-d-glucopyranoside		Antimicrobial glycoside	Olawumi *et al.*, 2020
3.	Alpha-d-galactopyranoside methyl		Skin moisturizing agent, antitu-berculous, antioxidant, alpha amylase inhibitory, hypolipi-demic, anticonvulsant	Sonia and Singh, 2019
4.	4-O-methylmannose		Antiviral, antimicrobial activity	Ololade Zacchaeus *et al.*, 2021
5.	n-hexadecanoic acid	Fatty acids	Antioxidant and hypocholestrol agent, in addition for use in soap and lubricant industry	Singh *et al.*, 2024
6.	Linoleic acid ethyl ester		Antiarrithritic, antihistaminic and anti-inflammatory agents	Kolar *et al.*, 2019
7.	9-Octadecenoic acid (Z)- methyl ester		Anti-inflammatory, anticancer activity	Mohamad *et al.*, 2020
8.	9,12-Octadecadienoic acid (Z,Z)-methyl ester		Analgesic, anticancer, anti-inflammatory agent	Mohamad *et al.*, 2020
9.	Ethyl oleate		Antibacterial activity	Ankita *et al.*, 2015
10.	Hexadecanoic acid, methyl ester		Acidifier, arachidonic acid inhibitor, inhibits production of uricacid, urine acidifier	Perumal *et al.*, 2021

11.	Hexadecanoic acid, ethyl ester		Antioxidant activity	Mohamad *et al.*, 2020
12.	Urs-12-en-24-oic acid, 3-oxo-methyl ester	Triterpenoids	Anti-inflammatory,anticancer, antioxidant activity	Rai *et al.*, 2019
13.	alpha-amyrin		Anti-inflammatory, anticancer, antioxidantactivity	Okoye *et al.*, 2014
14.	Beta-amyrin		Anti-inflammatoryactivity	Okoye *et al.*, 2014
15.	12-Oleanen-3-yl acetate (3 alpha)		Antioxidant, antibacterial, anti-inflammatory, antitumor activities	Fabiyi *et al.*, 2012
16.	2,3-Dihydrobenzofuran	Bicyclic derivative	Anticancer, antifungal, antibac-terial activity	Mohamad *et al.*, 2020
17.	4'-methoxybiphenyl-3-carboxylic acid	Biphenyl derivative	Antibacterialactivity	Kuppusamy *et al.*, 2018
18.	Benzoic acid, 4-ethoxy-ethyl ester	Ester	Antimicrobial activity	Sheela and Uthayakumari, 2013
19.	2-(2-butoxyethoxy) ethyl thiocyanate	Alcohol	Insecticide	Hideo and Casida, 1971
20.	9,19-Cyclolanost-24-en-3-ol	Steroid derivative	Antioxidant and pharmaceutical properties	Sawale *et al.*, 2019

Differentiation and overlapping of the compounds are tabulated in (Table 5) and the interactions among them are represented by Venn diagram (Figure 3). A total of eight compounds were identified in common to both root and stem extracts. The root and stem extracts of *P. obtusa* are rich in bioactive compounds, making them a valuable source for pharmaceuticaland industrial applications, warranting further investigation and development.

Table 5 : Comparision of compounds in root and stem extracts of *P. obtusa*

Common compounds in both rootand stem extracts	8	Linoleic acid ethyl ester, ethyl oleate, 9,12-octadecadienoic acid (Z,Z)- methyl ester, hexadecanoic acid ethyl ester, methylbeta-d-glucopyranoside, 2,3-dihydrobenzofuran, 4'-methoxybiphenyl-3-carboxylic acid, 2-(2-butoxyethoxy) ethyl thiocyanate
Compounds in root extract	12	Ethylalpha-d-glucopyranoside,n-decanoic acid,7-octadecenoic acid methyl ester, methylbeta-d-galactopyranoside, 2,2-diethoxytetrahydrofuran, methyl palmitate, ethyl 4-ethoxybenzoate, 2,6-dimethylbenzoquinone-4-oxime, diborane(6), plumericin, 7-hydroxy -6-methoxy-2H-1-benzopyran-2-one, 2,6,10,14,18,22-tetracosahexaene
Compounds in stem extract	12	Urs-12-en-24-oic acid3-oxo- methyl ester, alpha-d-glucopyranoside methyl ester, alpha-amyrin,9,19-cyclolanost-24-en-3-ol,benzoic acid 4-ethoxy- ethyl ester,12-oleanen-3-yl acetate(3alpha), n-Hexadecanoic acid,alpha-d-galactopyranoside, methyl, 4-O-methylmannose,9-Octadecenoic acid (Z)- methyl ester,beta-amyrin, hexadecanoic acid methyl ester

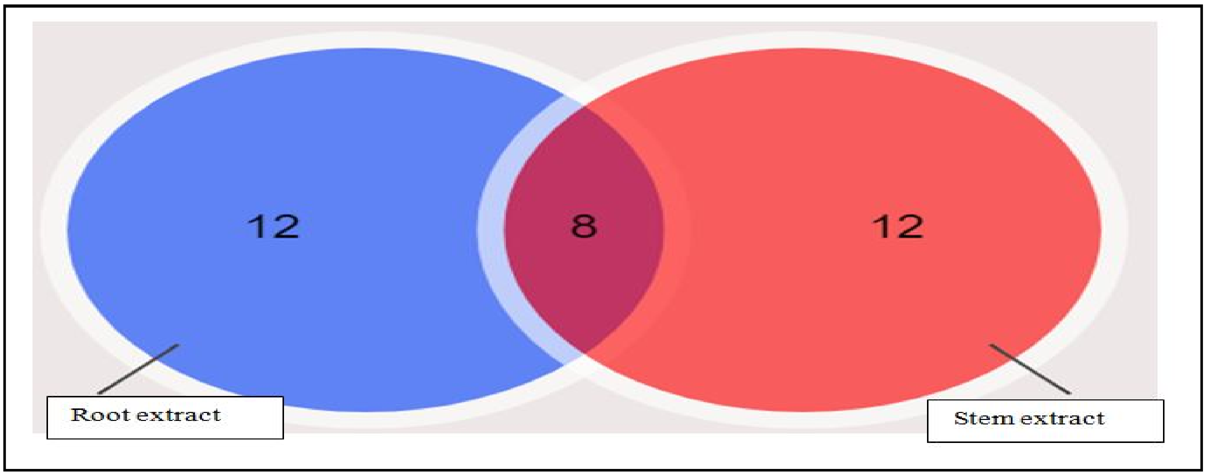

Figure 3 : Venn diagram showing significant common and different compounds of root and stem extracts of *P. obtusa*.

4. Discussion

Gas chromatography, known for its speed and precision, is ideal for analyzing and identifying volatile oils and heatsensitive compounds. It plays a crucial role in accurately determining phytoconstituents and profiling complex structures (Singh *et al.*, 2024). Phytochemical analysis was conducted in the plant extracts, revealing constituents with recognized physiological and medicinal properties in *Plumeria pudica* (Bari *et al.*, 2023). It has been reported that compounds such as terpenoids, flavonoids, iridoids, cardiac glycosides, phenolic acids, fatty acid esters, coumarins, steroids and cardenolides are responsible not only for antioxidant activity but also for exhibiting anti-inflammatory effects in *P. obtusa* (Salar *et al.*, 2022). The GC-MS analysis of *P. obtusa* root extract identified a variety of bioactive compounds with significant therapeutic potential. Ethyl alpha-d-glucopyranoside and methyl beta-d-glucopyranoside are the glycosides in which they exhibit strong antioxidant and antimicrobial properties, aligning with their potential in skin care and pharmaceuticals (Olawumi *et al.*, 2020; Sonia and Singh, 2019). 2,3-dihydrobenzofuran have demonstrated notable anti-allergy, antioxidant, anti-inflammatory and antimalarial properties, as well as effective in treating skin conditions (O Moustafa, 2021).Anticancer and antibacterial activities were noted in 4'-methoxybiphenyl-3-carboxylic acid, indicating their relevance in cancer and infection treatments (Kuppusamy *et al.*, 2018; Mohamad *et al.*, 2020). Compounds like n-decanoic acid and linoleic acid ethyl ester demonstrate anti-inflammatory and antihistaminic effects, supporting their use in treating inflammatory conditions. Plumericin, an iriod with its broad spectrum of antibacterial, antifungal and antiviral activities, highlights the plant's extensive therapeutic potential (Coppen and Cobb, 1983).Plumericin has been reported to exhibit algicidal, antileishmanial, molluscicidal and antifungal activities (Singh *et al.*, 2011). Additionally, the presence of methyl palmitate and ethyl oleate suggests applications in food, cosmetics and antibacterial formulations (Ankita *et al.*, 2015; Pinto *et al.*, 2017). The identification of anticancer agents like 2,6-dimethylbenzoquinone-4-oxime, along with compounds such as 7-hydroxy-6-methoxy-2H-1-benzopyran-2-one and 2,6,10,14,18,22-tetracosahexaene with antioxidant and anti-inflammatory properties, underscores the plant's value in nutraceuticals and pharmaceuticals (de Siqueira Leite *et al.*, 2015; Görner, 2019; Kim and Karadeniz, 2012).

The GC-MS analysis of stem extract from *P. obtusa* identified a diverse range of bioactive compounds with significant pharmacological potential. Ursane-type pentacyclic triterpenoids, such as urs-12-en-24-oic acid 3-oxo- methyl ester, have gained attention as potential therapeutic agent due to its wide range of pharmacological properties. This compound demonstrates strong anti-inflammatory, anticancer and antioxidant activities, making it promising for usage in anticancer drug development (Sultana, 2017). Alpha-amyrin is identified for anti-inflammatory, anticancer and antioxidant activities, making it promising in therapeutic applications (Okoye *et al.*, 2014; Rai *et al.*, 2019). The presence of 9,19-Cyclolanost-24-en-3-ol, an antioxidant with pharmaceutical relevance, highlights the plant's potential in developing new drugs (Sawale *et al.*, 2019) . Additionally, compounds like 12-oleanen-3-yl acetate and 4'-methoxybiphenyl-3-carboxylic acid exhibit strong antibacterial and anti-inflammatory effects, which could be useful in treating infections and inflammatory diseases (Fabiyi *et al.*, 2012; Kuppusamy *et al.*, 2018).The antimicrobial properties of benzoic acid, 4-ethoxy-ethyl ester and beta-d-glucopyranoside methyl, further underscore the potential of these stem extract in developing antimicrobial agents (Olawumi *et al.*, 2020; Sheela and Uthayakumari, 2013). The identification of 2-(2-butoxyethoxy) ethyl thiocyanatehas been reported to possess insecticidal properties (Hideo and Casida, 1971). Bioactive compounds like the methyl ester of hexadecanoic acid have demonstrated potent antifungal properties, making them useful in combating fungal infections in plants and humans. On the other hand, n-hexadecanoic acid exhibits a broad range of health benefits, including anti-inflammatory effects that help reduce swelling and pain. Its antimicrobial properties make it effective in inhibiting the growth of harmful bacteria, while its antioxidant activity helps neutralize free radicals, protecting cells from oxidative stress. These compounds are valuable for their therapeutic potential in both agriculture and medicine (Sharma *et al.*, 2021). Moreover, linoleic acid ethyl ester and 9,12-octadecadienoic acid (Z,Z)-methyl ester are known for their anti-inflammatory and analgesic properties (Zubair *et al.*, 2024) reinforcing the therapeutic potential of *P. obtusa* .Other noteworthy compounds include beta-amyrin and ethyl oleate, both known for their anti-inflammatory and antibacterial properties, which could be harnessed in developing treatments for inflammation and infections (Ankita *et al.*, 2015; Okoye *et al.*, 2014).

5. Conclusion

Based on the GC-MS analysis, the root and stem extracts of *P. obtusa*have been identified to possess promising bioactive compounds with significant therapeutic potential. The methanolic root and stem extract contains a diverse array of compounds like irioids, fatty acids, triterpenoids which are rich in antioxidant, antimicrobial, anti-inflammatory and anticancer properties, making it suitable for pharmaceutical, cosmetic and agricultural applications. The presence of compounds like ethyl alpha-d-glucopyranoside, 23-dihydrobenzofuran and plumericin highlights its potential for further development in therapeutic products. The bioactive properties observe in these extracts exhibits the way for advancing research and applications in the health and wellness industries. Further investigation is warranted to explore and optimize their use across various fields.

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Conflict of interest

The authors declare no conflicts of interest relevant to this article.

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