

Original Research Article

Phytochemical profiling and identification of bioactive compounds in the leaf extract of *Syzygium malaccense* using Gas Chromatography–Mass Spectrometry

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Abstract

Purpose: To determine the phytochemical composition of methanol extract of *Syzygium malaccense* leaves using Gas Chromatography–Mass Spectrometry (GC–MS).

Methods: Fresh leaves of *Syzygium malaccense* were air-dried, powdered and extracted with methanol using cold maceration. Following filtration and concentration under reduced pressure, the extract was freeze-dried and subjected to GC–MS to identify the phytochemicals present.

Results: The analysis revealed the presence of thirty bioactive compounds with known medicinal and pharmacological properties. The identified compounds included phytol, oleic acid, copaene, caryophyllene and phenyltricyclo derivatives, all of which exhibit antioxidant, anti-inflammatory, antimicrobial, and anticancer properties.

Conclusion: These results provide scientific support for the traditional uses of *Syzygium malaccense* and indicate the potential of the plant as a useful source of natural therapeutic agents.

Keywords: Bioactive compounds, GC–MS, Pharmacological properties, Phytochemicals, *Syzygium malaccense*

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INTRODUCTION

Plants have long served as rich sources of bioactive compounds for pharmaceutical and nutraceutical development. Secondary metabolites like terpenoids, fatty acids, and phenolic compounds play crucial roles in human health due to the exhibition of a wide spectrum of biological activities [1]. The identification and characterization of these phytochemicals through modern analytical techniques such as GC–MS are vital for validating the traditional medicinal uses of plants [2].

Syzygium malaccense, popularly called Malaysian apple, belongs to the family Myrtaceae. In Southeast Asia and the Caribbean, the plant has been traditionally used for the treatment of vaginal infections, itching, dysentery, and as a diuretic [2,3]. In some communities, *S. malaccense* is used for the management of diabetes and constipation. Although *S. malaccense* has high nutritional value as a rich source of fiber, reducing sugars, minerals, and vitamins, as well as good fruit qualities, the plant remains underutilized despite having significant pharmaceutical potential [2].

The red, pink, and purple colors of *S. malaccense* fruits arise from anthocyanins, which are sensitive to pH, heat, light, oxygen, and interaction with metals or other food components. However, these sensitivities are mostly related to stability, processing and sensory qualities rather than toxicity or health risks [4].

Despite the ethnomedicinal importance of *S. malaccense*, only a few studies have characterized the chemical constituents of the plant. Therefore, this study was carried out to identify and profile the phytochemical compounds present in the leaves of *S. malaccense*, using GC–MS analysis.

EXPERIMENTAL

Plant collection and preparation

Fresh leaves of *Syzygium malaccense* were collected from Isefun in Lagos State, Nigeria (6°34'40.8"N and 3°12'01.3"E) in January, 2020. The leaves were authenticated by Dr. B. Ade-Ademilua in the Department of Botany, University of Lagos, Lagos State, and assigned voucher specimen number LUH 7646. The sample was washed, air-dried in the shade, and ground into fine powder using a mechanical grinder.

Extraction procedure

Approximately 5 g of the powdered leaves of *S. malaccense* was extracted with 100 mL of methanol for 3 days using cold maceration. The extract was filtered and concentrated under reduced pressure using a rotary evaporator to obtain a crude extract, which was then freeze-dried and preserved at 4 °C before analysis.

GC–MS analysis

The sample was analyzed on a Shimadzu GC–MS system model QP2010, with mid-polarity capillary SLB-5 MS Supelco column of dimensions 30.0 m x 0.20 mm x 0.20 mm. Helium was used as carrier gas. The column oven temperature was kept at 50 °C for 1 min, and increased at a rate of 5 °C/min to a final temperature of 150 °C. The injector and detector temperatures were set at 200 and 250 °C, respectively, with splitless injection mode. The volume of sample injected was 0.2 µL. The instrumental analysis conditions were as follows: temperature was programmed to 50 - 200 °C and was increased at the rate of 5 °C/min, with isothermal temperature fixed at 200 °C and injector temperature at 250 °C. The flow rate of the carrier gas was 30 cm³/sec. The ion source temperature was 200 °C, and ionization voltage

was 70 eV, while electron multiplier voltage was 2600 V. The total run time was 18 min. The compounds were identified by comparing the resultant mass spectra with standard mass spectra in the NIST library.

RESULTS

The GC–MS chromatogram of *S. malaccense* leaf extract (Figure 1) revealed 30 peaks corresponding to the various phytochemicals identified (Table 1). The major compounds identified were derivatives of benzopyran, which were the most abundant (24.05 %), as well as benzimidazole (15.00 %), 2-propen-1-one (9.52 %), and phenyltricyclo derivative (6.64%).

Smaller amounts of other compounds were present viz: phytol (0.70 %), oleic acid (1.02 %), alpha-guaiene (1.55 %), gamma-murolene (0.46 %), caryophyllene (1.78 %), copaene (0.49 %), dimethyl sulphoxide (0.49 %), epiglobulol (1.43 %), octadecanoic acid (0.32 %), hexadecanoic acid (3.47 %), and benzaldehyde (4.37 %).

DISCUSSION

The identification of compounds such as phytol, caryophyllene, and oleic acid underscores the pharmacological potential of *S. malaccense*. The diverse chemical composition of the leaf extract supports the traditional medicinal uses of the plant and also suggests that its bioactivity may result from synergistic effects among the various components identified.

The most abundant group of compounds identified in *S. malaccense* leaf extract was the benzopyran derivatives. Benzopyran, benzimidazole, and their derivatives have attracted enormous attention in drug development as a result of possessing diverse pharmacological properties such as antibacterial, antiviral, antifungal, antitumor, antioxidant, and anti-inflammatory potential [5,6]. Phenyltricyclohexadecanoic acid is a phenolic compound with excellent antioxidant properties. Phytol, a component of chlorophyll, has anti-inflammatory effects [7]. Oleic acid, a monounsaturated fatty acid, improves cardiovascular health by balancing cholesterol levels and enhancing weight management. Moreover, oleic acid regulates blood sugar levels and reduces inflammation. Alpha-guaiene is useful in the management of tumors, allergy and inflammation. Gamma-murolene possesses antioxidant, antibacterial and anti-inflammatory activities [8].

Table 1: Phytochemical constituents identified in the leaf extract of *Syzygium malaccense*

Peak no.	Retention time (sec)	Area (cm ²)	Area (%)	Height (cm)	Height (%)	Area/Height	Name of compound
1	4.574	813320	0.49	460941	0.55	1.76	Dimethyl sulfoxide
2	10.507	820234	0.49	521096	0.62	1.57	Copaene
3	11.031	2967459	1.78	1808566	2.16	1.64	Caryophyllene
4	11.789	2395604	1.44	1393559	1.67	1.72	Bicyclo[5.3.0]decane, 2-methylene-5-(1-methylethenyl)
5	11.890	2578095	1.55	1484538	1.78	1.74	α-Guaiene
6	12.035	762165	0.46	286595	0.34	2.66	γ-Murolene
7	12.101	1013380	0.61	657790	0.79	1.54	Naphthalene, 1,2,3,5,6,8a-hexahydro-1.7-dimethyl-
8	12.241	633093	0.38	393543	0.47	1.61	Dodecanoic acid
9	12.449	2547724	1.53	792551	0.95	3.21	Diethyl Phthalate
10	13.573	2386922	1.43	1071943	1.28	2.23	Epiglobulol
11	15.430	734734	0.44	504020	0.60	1.46	1,2-Benzenedicarboxylic acid, bis(2-methylpropyl) ester
12	15.733	1126315	0.68	538980	0.64	2.09	E, E, Z-1,3,12-Nonadecatriene-5,14-diol
13	16.441	5786026	3.47	3115983	3.73	1.86	n-Hexadecanoic acid
14	17.535	575234	0.34	379484	0.45	1.52	n-Nonadecanol -1
15	17.811	1166341	0.70	739554	0.88	1.58	Phytol
16	17.911	1707871	1.02	765312	0.92	2.23	Oleic acid
17	18.103	539507	0.32	325225	0.39	1.66	Octadecanoic acid
18	19.649	1058408	0.63	722358	0.86	1.47	2-Propen-1-one, 1-(2,6-dihydroxy-4-methoxyphenyl)
19	20.136	10907654	6.54	6083870	7.28	1.79	4H-I-Benzopyran-4-one, 2,3-dihydro-5,7-dihydroxy-
20	20.323	431931	0.26	296491	0.35	1.46	2,3-Dihydro-5-hydroxy-6,8,8-trimethyl-2-phenyl-
21	20.416	2788179	1.67	1764204	2.11	1.58	Hexadecenoic acid, 2-hydroxy-i-(hydroxymethyl-)
22	20.485	11066560	6.64	5637747	6.74	1.96	15-Phenyltricyclo[8,2,2,2(4,7)]hexadecadecanoic acid (13),
23	20.549	15880983	9.52	7750876	9.27	2.05	2-Propen-1-one, 1-(2,6-dihydroxy-4-methoxypl)
24	20.687	1213760	0.73	830049	0.99	1.46	Di(2-ethylHexyl) Phthalate (DEHP)
25	20.783	40106835	24.05	17906561	21.42	2.24	4H-I-Benzopyran-4-one,2,3-dihtydro-5,7-dihydroxy-2-phenyl-
26	21.187	25004945	15.00	11900393	14.23	2.10	1H-Benzimidazole, 5-ethoxy-2-phenethylsulfanyl
27	21.409	3223772	1.93	1659020	1.98	1.94	3-Acetyl-2,4,4-trimethycyclohex-2-en-1-one
28	21.753	18314396	10.98	9365324	11.20	1.96	2,3-Dihydro-5-hydroxy-6,8,8-trimethyl-2-phenyl-
29	21.807	922441	0.55	517553	0.62	1.78	Octadecanoic acid,23-dihydroxypropyl ester
30	21.995	7279893	4.37	3932172	4.70	1.85	Benzaldehyde, (diphenylmethylidene)hydrazone
		166753781	100.00	83606298	100.00		

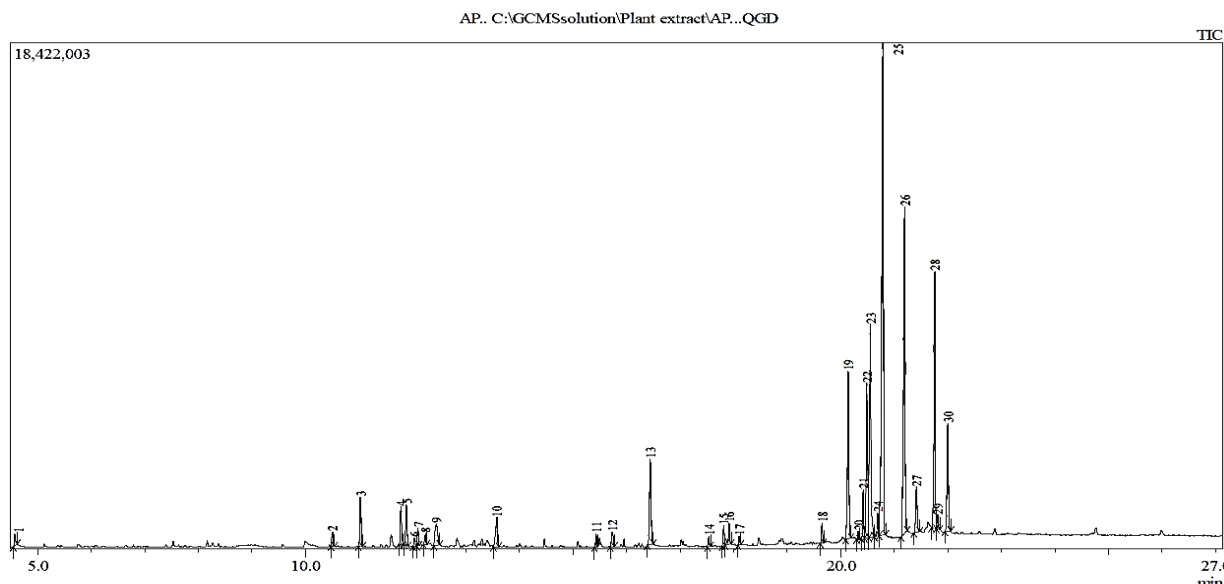


Figure 1: Chromatogram showing data, retention times, and percentage peak areas of phytochemicals present in *Syzygium malaccense* leaf extract

Recent studies have demonstrated that murolene exerts inhibitory effects on protein targets involved in cancer cell proliferation [9]. Caryophyllene, unlike most terpenes, binds to the G-protein-coupled receptors (CB2) found on immune cells (peripheral endocannabinoid system), and is useful in reducing inflammation and pain without the euphoric feeling associated with cannabis [10]. Copaene, a widely recognized component of essential oils, is a naturally occurring sesquiterpene with antibacterial properties and which exerts a calming effect, with potential to foster mental clarity and emotional balance, thereby making it an excellent agent in aromatherapy [11]. Epiglobulol exhibits antibacterial, anti-inflammatory and antitumor activities [12]. Thus, the leaves of *Syzygium malaccense* are a rich source of pharmacologically useful compounds with health-enhancing potential.

CONCLUSION

The GC–MS analysis of *Syzygium malaccense* leaf extract revealed multiple bioactive compounds with significant medicinal properties. The presence of these phytochemicals indicates that *Syzygium malaccense* has a promising potential for application in pharmaceutical and nutraceutical formulations.

DECLARATIONS

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Ethical approval

Not applicable.

Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Conflict of interest

No conflict of interest is associated with this work.

Contribution of authors

We declare that this work was done by the author(s) named in this article, and all liabilities pertaining to claims relating to the content of this article will be borne by the authors.

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