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Research Article

Chemical characterization and antioxidant activities of essential oil of *Ficus elastica* Roxb. ex Hornem. leaves

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Abstract: The present study investigates the chemical constituents and antioxidant potential of essential oils extracted from *Ficus elastica*. The essential oils were obtained through steam distillation and were subjected to gas chromatography-mass spectrometry (GC-MS) analysis to determine their constituents representing 100% of the total peak areas. The analysis revealed the presence of 34 compounds. Among these compounds, Caryophyllene was found to be the major constituent, accounting for 50.57% of the total percentage area. Among other identified major compounds include γ-Muurolene (8.19%), camphene (5.69%), Heptacosane (2.61%), and Heneicosane (2.60%). Furthermore, the antioxidant potential of *Ficus elastica* essential oil was evaluated using 2,2-diphenyl-1-picrylhydrazyl (DPPH) and hydrogen peroxide radical scavenging methods. The results indicated that *F. elastica*'s essential oil exhibited significant radical scavenging activity when compared to the standard antioxidant, Ascorbic acid. For the highest concentration tested (10 µL/mL), the DPPH scavenging inhibition percentage was 45.26% for *F. elastica* and 90.40% for Ascorbic acid. Similarly, the hydrogen peroxide scavenging activity at 10 µL/mL was found to be 74.90% for *F. elastica* and 90.12% for Ascorbic acid. Additionally, the essential oils demonstrated high radical scavenging and chelating activity. The quantitative DPPH and hydrogen peroxide assays indicate the potent antioxidant activity of *F. elastica* essential oil, making it a promising candidate for further biological and chemical analysis. The isolation of therapeutically active compounds from these essential oils can be pursued, considering their potential role in the management and treatment of various diseases.

1. INTRODUCTION

A nexus between humans, ill-health, and folk medicine cannot be traced from recent times because man has been battling with various forms of diseases and illnesses since his origin (Danjuma & Darda'u, 2013). As generations pass and humans suffer from illnesses, the search for remedies to these diseases propels the development of traditional knowledge of medicines, remedies, and norms that are cheaper and have lesser side effects, hence popular among the people (Zain *et al*., 2013). Resources from plants have gained a wide range of applications in various industrial setups for the production of several useful products for the benefit of

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humankind such as perfume, food and dietary supplements, cosmetics, pharmaceutical drugs, etc. (Chika *et al*., 2022). Essential oils (EOs) and bioactive compounds from plants, herbs, fruit waste, and enzymes of fruits or biomaterials are potential crop protection agents. They are largely composed of bioactive secondary metabolites like monoterpenes, esters, sesquiterpenes, phenols, aldehydes, oxides, and ketones that are synthesized both internally and externally by plants (Dassanayake *et al*., 2021). Essential oils, also called volatile odoriferous oils, are aromatic oily liquids extracted from different parts of plants such as leaves, peels, barks, flowers, buds, seeds, etc. (Lubna *et al*., 2020). Among all methods of producing essential oils, the steam distillation method has been widely used, especially for commercial-scale production (Burt, 2004). EOs have been widely used as food flavors because of their antibacterial, antifungal, antioxidant, antiseptic, anti-inflammatory, anti-carcinogenic, and antimutagenic properties (Basavegowda & Baek, 2021). Essential oils found in many different plants, especially aromatic plants, vary in odor and flavor, which are governed by the types and amount of constituents present in oils (Phakawat & Soottawat, 2014). Numerous essential oils with antioxidant properties must be mentioned here since their use as natural antioxidants is a field of real interest, especially in food science and medicine (Tit & Bungau, 2023). Although many antioxidants are available, most antioxidant formulations contain as BHA (Butylated hydroxyanisole) and BHT (Butylated hydroxytoluene), which are synthetic in nature. In recent years, consumers and food manufacturers have opted for products with "all-natural" labels. The area of natural antioxidants developed enormously in the past decade mainly because of the increasing limitations on the use of synthetic antioxidants and enhanced public awareness of health issues (Nanditha & Prabhasankar, 2009). The addition of EOs to edible products, either by direct mixing or in active packaging and edible coatings, may represent a valid alternative to prevent autooxidation and prolong the shelf life of food (Amorati *et al*., 2013; Alparslan, 2018).

Oxidative stress is a problem in human beings since it not only makes our body cells age but also causes diseases such as cancer that are difficult to treat. One of the ways to make the body healthier is to stop the aging process. This can be done using certain chemicals and metals to prevent oxidation or mop up free radicals from the body, known as antioxidants (Musa, 2008). Reactive oxygen species (ROS) are highly reactive molecules that may lead to tissue damage via several different cellular molecular pathways (Ginting *et al*., 2020). Globally, the use of antioxidants as preservatives has been instrumental in improving the quality and extending the shelf life of muscle foods, especially during processing and storage. A low dietary intake of antioxidant, vitamins, and minerals is responsible for the rise in the incidence of cardiovascular diseases and cancer cases (Salehi *et al*., 2018).

Plants are a rich source of phytochemicals with medicinal properties, rendering them useful for the industrial production of pharmaceuticals and nutraceuticals (Hasnain *et al*., 2022). Many supplements, nutricosmetics, and cosmetics are based on botanical ingredients, many of which have a long history of use in traditional or folk medicine (Michalak, 2022). Increasing the antioxidant intake can prevent diseases and lower health problems (Saikat *et al*., 2010). Research is increasingly showing that antioxidant-rich foods and herbs reap health benefits (Saikat *et al*., 2010, Mayo Clinic, 2023).

F. elastica, commonly known as the rubber tree, is an important medicinal plant belonging to the *Moraceae* family. *F. elastica* plants have been widely planted throughout Asia and possess pharmacological properties such as antioxidant, anti-inflammatory, and anticancer. *Ficus* species are reported to be very rich in flavonoids, essential oils, anthocyanins, tannins, and other phenolic constituents (Ginting *et al*., 2020). *F. elastica* (*Moraceae*) is a widely spread evergreen tree up to 30 m tall. The leaves are 7-20 cm long, with smooth edges and blunt pointed tips. The leaves are about a foot long and are thick with a deep green color. The plant is known locally as the "India rubber tree" (Hari *et al*., 2011). Three species (*F. religiosa*, *F. elastica*, *F. benjamina*) display multiple common attributes: high distribution and abundance in local forests, relevant roles in forest ecology, high tolerance and adaptability to stress conditions,

growth in several types of environments (Solis *et al*., 2015). Nigeria's forests are replete with over 45 different species of *Ficus.* Some of them are *Ficus goliath*, *Ficus capensis*, *Ficus ingens, Ficus glomosa, Ficus lecardi*, and *Ficus elastica*. They can be found in the savanna, rainforest, rivers, and streams (Odunbaku *et al*., 2008). Some *Ficus* species are cultivated for their edible fruits (*Ficus sycomorus* Linn.), while others provide shade and function as ornamental plants (Amgad *et al*., 2015).

Ficus elastica is used to cure skin infections, allergies, anemia, neurodegenerative disorders and hepatic problems, and also used as a diuretic agent (Iqbal *et al*., 2018). This research investigation aims to study the chemical composition and antioxidant potential of essential oils extracted from the leaves of *Ficus elastica*. This involves analyzing the constituents of the essential oils using gas chromatography-mass spectrometry (GC-MS) and evaluating their antioxidant activity using DPPH and hydrogen peroxide radical scavenging methods to determine the potential therapeutic benefits of the essential oils and assess their suitability for further biological and chemical analysis for the management and treatment of various diseases.

2. MATERIAL and METHODS

2.1. Sample Collection

Ficus elastica belongs to the family *Moraceae* and was collected from the bush area of Sukur Settlement, Madagali Local Government Area of Adamawa State, Nigeria. Random leaf samples were collected from different trees in the same location into the sack with appropriate labeling and stored in an ice cooler until being transported to the laboratory for extraction and further analysis (Biswas *et al.*, 2013).

2.2. Sample Preparation

The sample of the Plant was properly washed and allowed to dry for 30 minutes in the laboratory. The leaves were then cut into tiny slices to increase the surface area for contact with solvent during extraction process (Ibrahim *et al.,* 2021).

2.3. Extraction of The Essential Oil

1 kg of leaves of *Ficus elastica* sample collected were washed with distilled water and subjected to extraction to avoid loss of some essential oils as a result of the drying process, and using a modified type of steam distillation apparatus (in which the receiver end of the condenser pass-through another vessel containing ice). The time taken for the isolation of the oil is 2½ hours (Runde *et al.,* 2015). The process was repeated for each plant's batch until a total mass of 2.6 kg was used for extraction. The sample collected was subjected to steam distillation using the Clevenger-like apparatus according to the British Pharmacopoeia (BP) method (British Pharmacopoeia, 2020). The time taken for the isolation of the essential oil is 2½ hours.

2.4. GC-MS Analysis of Essential Oil

Essential oil extracted from the leaves of *Ficus elastica* was analyzed for its chemical constituents by gas chromatography coupled with mass spectrometry (GC-MS). Agilent 19091S-433 Gas Chromatography-Mass Spectrometry System, operating at a pressure of 11.649 psi equipped with a split-splitless injector, was used. Helium was used as a carrier gas at the flow rate of 1 mL/min. The columns used were HP-5MS, capillary column (30 m × 250 µm × 0.25 µm), stationary phase: 5% phenyl methyl silox. The initial temperature was programmed at 60°C for 0.5 min then 10°C/min to 300°C for 3 min followed by a constant temperature at 310°C for 22.5 min. Sample (0.2 µL) was injected into the column programmed at 310°C and the resolution of components was attained. Identification of components was performed by matching their retention indices and mass spectra with those obtained from the NIST library (Iqbal *et al.,* 2018). The spectrum from the GC-MS is shown in Figure 1.

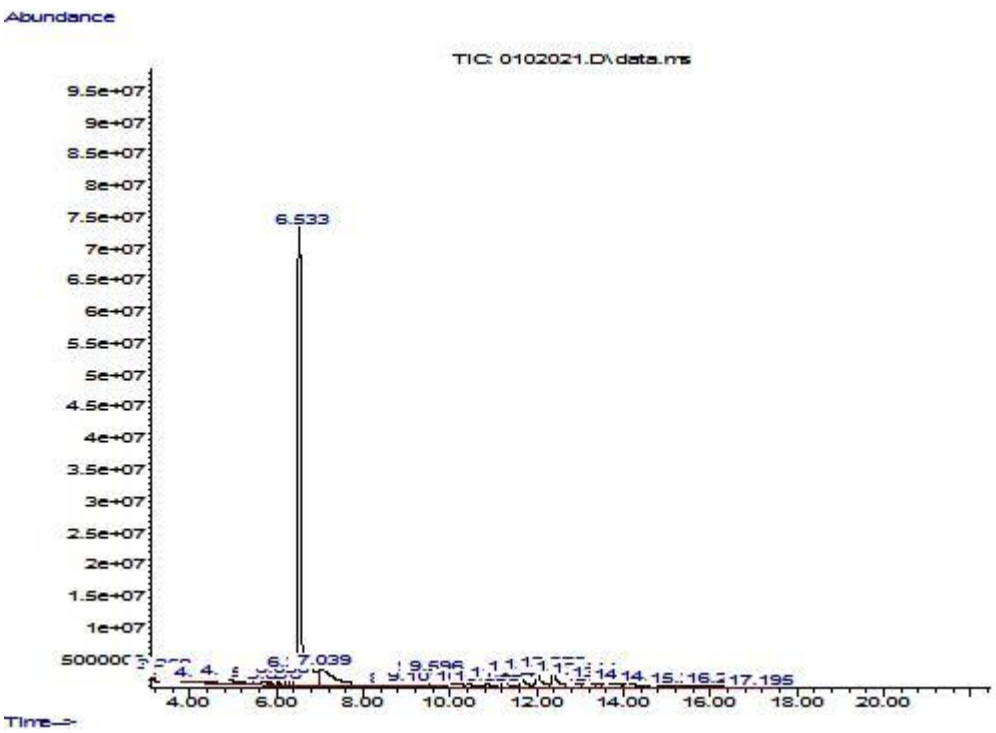

Figure 1. GC-MS Spectrum of essential oil extracted from *Ficus elastica.*

2.5. Determination of Antioxidant Activity of Essential Oils

2.5.1. *Free radical scavenging activity*

DPPH has been widely used for the measurement of the free radical scavenging ability of antioxidants. This method is based on the reduction of an alcoholic DPPH solution in the presence of a hydrogen-donating antioxidant (Fatiha & Abdelkader, 2019). The DPPH assay was performed using a standard method with minor modification. The hydrogen atom or electron-donating abilities of the compounds were measured from the bleaching of the purple colored methanol solution of 2,2-diphenyl-1-picryl hydrazyl (DPPH). This spectrophotometric assay uses the stable free radical, DPPH as a reagent. One thousand microliters of diverse concentrations (2.5 µL/mL) of the essential oil in ethanol were added to 4 mL of 0.004 % methanol solution of DPPH. After a 30 min incubation period at room temperature, the absorbance was read against a blank at 517 nm and compared to the standard antioxidants, Ascorbic acid (vitamin C). The DPPH radical scavenging effect was calculated as inhibition of percentage (I %) using the following formula (Burits & Bucar, 2000).

$$I\ \% = \frac{\text{absorbance of Blank} - \text{absorbance of sample}}{\text{absorbance of Blank}}\ x\ 100$$

Where, A is blank is the absorbance of the control reaction (containing all reagents except the test compound) and A (sample) is the absorbance of the test compound. The values of inhibition were calculated for various concentrations of the extract. Tests were conceded out in triplicate.

2.5.2. *Hydrogen peroxide scavenging activity*

The ability of the extract to scavenge hydrogen peroxide was determined according to the method with modification. A solution of hydrogen peroxide (40 mM) was prepared in phosphate buffer (ρH = 7.4). Extracts (2.5-25 µg/mL) in methanol were added to a H_2O_2 solution (0.6 mL, 40 mM). The absorbance value of the reaction mixture was recorded at 230 nm. The blank solution contained the phosphate buffer without H_2O_2 (Ebrahimzadeh *et al.*, 2010). The percentage of H_2O_2 scavenging was calculated as:

$$H_2O_2\text{Scavenging effect (\%)} = \frac{A_{control} - A_{sample}}{A_{control}}\ x\ 100$$

Where A (control) is the absorbance of the control, and A (sample) is the absorbance in the presence of the sample or standards.

3. RESULTS and DISCUSSION

3.1. Percentage Yield of The Essential Oil from *Ficus elastica*

2.58264 kg of *Ficus elastica* fresh leaves were subjected to steam distillation for the extraction of essential oil components from the plants. The percentage yield was obtained by using the relation

$$\%Yield = \frac{\text{Weight of ail (WO)}}{\text{Weight of plant (WP)}}\ x\ 100$$

The results obtained showed *Ficus elastica* has a percentage yield of 0.09 % as shown in Table 1.

Table 1. Percentage yield of essential oil of *Ficus elastica* (FE) leaves.

Plant	Plant Part Used	Weight of Plant	Weight of Oil	Appearance	% Yield (WO/WP) x 100
FE	Fresh leaves	2.58264 kg	2.38 g	Colorless	0.09

3.2. Chemical Components of Essential Oil of The Plant

The GC-MS analysis of the essential oil of *Ficus elastica* leaves revealed the presence of 34 compounds, which constituted 100% of the total percentage composition. These compounds were listed in order of their retention indexes. The most abundant component was caryophyllene, which is a natural bicyclic sesquiterpene compound accounting for 50.57% of the essential oil. Other components of the essential oil of *Ficus elastica* were γ-Muurolene (8.18%), camphene (5.69%), and heneicosane, 11-decyl- (4.57%) as shown in Table 2. However, this result was not consistent with the outcome of Iqbal *et al*. (2018) study, which revealed that the essential oil of aerial roots of *Ficus elastica* contained compounds such as Benzene, [1-propyldecyl], benzene, benzene, [1-ethylundecyl], propanamide, N,N-dodecyl-3-phenyl, benzene, [1-methyldodecyl], diethyl phthalate, octadecane, 3-ethyl-5-[2-ethylbutyl], and cyclopropane butanoic acid. The difference in composition may be the result of various factors, including the part of the plant used, weather, vegetation, and geographical location (Battaloğlu & Yağız, 2017). Maimuna *et al*. (2016) reported that *Ficus thonningii*'s leaves' essential oil contained 2, 6, 10, 15-tetramethyl-heptadecane (42.42%), 9-methyl-nonadecane (17.62%), eicosane (16.17%), and methylsalicylate (10.58%), which is different from the essential oil composition of *Ficus elastica*. Likewise, Dangarembizi *et al*. (2014) reported that *Ficus thonningii*'s essential oil contained 18.8 % of 6, 10, 14 trimethyl-2-pentadecanone, 14.7% of phytol, 7.6% of acorenone, and 6.3% of β-gurjunene. Similarly, Emmanuel *et al*., (2016) revealed that *Ficus mucoso* contained α-phellandrene (13.0%), p-cymene (11.3%), germacrene D (10.5%), β-caryophyllene (9.7%), 1, 8-cineole (9.5%), and α-copaene (8.7%), which shared some similar composition with *Ficus elastica* in this study.

Adebayo *et al*. (2015) reported that the essential oil composition of *Ficus benghalensis* comprised sesquiterpenes such as α-cadinol (25.1%), germacrene-D-4-ol (14.9%), γ-cadinene (11.8%), and α-muurolene (9.6%), which differ from the result obtained from this research, except for α-muurolene present in *Ficus benghalensis* but was detected in *F. elastica* as γ-muurolene. Sherifat *et al*. (2007) reported that *Treculia africana*'s (Moraceae) essential oil isolated by hydrodistillation and characterized by means of GC-MS contained α-pinene, myrtenal, limonene, camphene, and n-hexanoic acid, which share some common constituents with the findings in this work.

Ogunwande *et al*. (2011) reported the major essential oil composition of *Ficus elastica* Roxb. ex Hornem as 6,10,14-trimethyl-2-pentadecanone (25.9%), geranyl acetone (9.9%), heneicosene (8.4%), 1,8-cineole (8.2%), pentadecanal (6.1%), caryophyllene-oxide (4.2%), (E)-β-ionone (3.9%), and heptadecane (3.3%), which partially agreed with the findings of this research study.

In a separate study, Radulović *et al*. (2016) reported trans-Phytol as the predominant component, constituting 71.2% and 65.4% of the essential oil in fresh and dried leaves, respectively, of *Morus nigra* (Moraceae). Within the same investigation, *Morus alba* (Moraceae) fresh leaves showed the presence of trans-Phytol (61.6%) and Pentacosane (8.2%), while the dried leaves contained nonacosane (12.4%), Hentriacontane (12.4%), Pentacosane (10.9%), and Geranyl acetone (9.8%) as the primary essential oil components. Interestingly, our research findings do not align with these results.

Table 2. GC-MS essential oil analysis of leaves of *Ficus elastica.*

S/N	Constituents	Mol. Formula	RT (Min.)	Area (%)
1	α-Pinene	$C_{10}H_{16}$	3.360	0.77
2	γ-Terpinene	$C_{10}H_{16}$	3.716	0.38
3	α-Phellandrene	$C_{10}H_{16}$	3.973	0.10
4	3-Carene	$C_{10}H_{16}$	4.200	0.86
5	Cyclohexene, 1-methyl-4-(1-methylethylidene)-	$C_{10}H_{16}$	4.821	2.28
6	Cyclohexene, 4-methyl-3-(1-methylethylidene)-	$C_{10}H_{16}$	5.411	1.18
7	2-Carene	$C_{10}H_{16}$	5.525	1.51
8	Methyl m-tolyl carbinol	$C_9H_{12}O$	5.858	0.20
9	Cyclohexene, 4-ethenyl-4-methyl-3-(1-methylethenyl)-1-(1-methylethyl)-	$C_{15}H_{24}$	6.062	0.42
10	Copaene	$C_{15}H_{24}$	6.251	1.07
11	1H-Cyclopropa[a]naphthalene, 1a, 2, 3,5,6,7,7a,7b-octahydro-1,1,7,7a-tetramethyl-, [1aR-(1aα,7α,7aα,7bα)]-	$C_{15}H_{24}$	6.319	1.19
12	Caryophyllene	$C_{15}H_{24}$	6.531	50.57
13	γ-Muurolene	$C_{15}H_{24}$	7.038	8.19
14	Aromandendrene	$C_{15}H_{24}$	8.529	0.14
15	Z-8-Methyl-9-tetradecen-1-ol acetate	$C_{17}H_{32}O_2$	8.673	0.11
16	1,2-15,16-Diepoxyhexadecane	$C_{16}H_{30}O_2$	9.037	0.68
17	5β,6β-Epoxy-7α-bromocholestan-3beta-ol	$C_{27}H_{45}BrO_2$	9.097	0.19
18	1,3-Pentadiene, (E)-	C_5H_8	9.354	3.42
19	Camphene	$C_{10}H_{16}$	9.597	5.69
20	Stearic acid hydrazide	$C_{18}H_{38}N_2O$	10.437	0.52
21	Tricosane	$C_{23}H_{48}$	10.861	0.59
22	Tricosane, 2-methyl-	$C_{24}H_{50}$	11.254	1.03
23	Docosane, 5-butyl-	$C_{26}H_{54}$	11.633	1.96
24	Nonadecane	$C_{19}H_{40}$	11.633	1.97
25	Hentriacontane	$C_{31}H_{64}$	12.011	2.41
26	Heptacosane	$C_{27}H_{56}$	12.374	2.61
27	Heneicosane, 11-decyl-	$C_{31}H_{64}$	12.738	2.60
28	Batilol	$C_{21}H_{44}O_3$	13.389	0.57
29	Heptadecane	$C_{17}H_{36}$	13.601	2.21
30	Tetracosane, 3-ethyl-	$C_{26}H_{54}$	14.108	1.46
31	Eicosane	$C_{20}H_{42}$	14.698	1.61
32	Hexadecane, 1-chloro-	$C_{16}H_{33}Cl$	15.394	0.99
33	5-Octadecene, (E)-	$C_{18}H_{36}$	16.219	0.44
34	Octadecane, 1-(ethenyloxy)-	$C_{20}H_{40}O$	17.196	0.08
	Total			100

Contrary to our study, Arsyad *et al*. (2023) outlined the composition of *Ficus elastica* leaf oil, revealing the presence of 1,8-cineole (8.2%), heneicosene (8.4%), geranyl acetone (9.9%), and 6,10,14-trimethyl-2-pentadecanone (25.9%). Additionally, Orhan *et al*. (2016) highlighted the essential oil components of *Maclura pomifera* (Moraceae), noting that Phytol dominated with percentages of 61.5%, 51.4%, and 69.3% for female leaves, male leaves, and fruits, respectively. Battaloğlu & Yağız (2017) further contributed to this knowledge by reporting Dodecanal (9.05%), Eugenol (8.36%), α-humulene (7.84%), and Octadecane (5.28%) as the major components in the essential oil of *Maclura pomifera*.

In a recent study by Cipriano *et al*. (2021), the predominant essential oil compounds in *Euomgenia uniflora* L. genotypes were revealed, indicating two major groups: Sesquiterpene hydrocarbons (26.05%) and Oxygenated sesquiterpenes (40.90%).

3.3. DPPH Radical Scavenging Activity for Essential Oil of *Ficus elastica* and Ascorbic Acid

In Table 3, the essential oil of the plant's leaves demonstrated concentration dependent antioxidant potential and comparable to standard Ascorbic acid, as determined by the DPPH scavenging assay method. At the lowest concentration (2.5 µL/mL), the percentage inhibitions were 41.31% and 52.56% for *Ficus elastica* and Ascorbic acid, respectively. At the highest concentration (10 µL/mL), these values were 45.26% and 90.40%. Figure 2 illustrates the comparison of essential oil activities against the two test reagents. The plant's essential oil exhibited effective scavenging abilities against DPPH in a concentration-dependent manner.

The antioxidant activity of *Ficus elastica* aligns with the findings of Iqbal *et al*. (2018), indicating that the essential oil's antioxidant activity of aerial roots is concentration-dependent. The hydrogen donation removes the odd electron responsible for radical reactivity, as mentioned by Ahmed *et al*. (2017). Yong *et al*. (2019) reported the antioxidant activity (EC_{50} µg/mL) of *Maclura Tricuspidata* Fruit Steam Distilled Essential Oil, which demonstrated superior properties over synthetic antioxidants BHT and BHA in DPPH (17,065.22 ± 146.27), ABTS (1921.81 ± 49.45), and FRAP (10,638.56 ± 223.33) assays.

Eugenia uniflora L., belonging to the same phylum Tracheophyta as *Ficus elastica*, showed positive antioxidant activity (176.66 to 867.57 µM Trolox Equivalent Antioxidant Capacity) in research by Cipriano *et al*. (2021). Similarly, *Salvia officinalis* essential oil, of the same class *Magnoliopsida* as *Ficus elastica*, exhibited antioxidant capacity of 33.61 % and 84.50 % in DPPH and ABTS analyses, respectively (Mot *et al*., 2022). In a study by Ozkan *et al*. (2010) on *Salvia pisidica*, a plant sharing the same phylum and class taxonomic classification with *Ficus elastica*, essential oils from wild and cultivated forms demonstrated higher reducing power activity (EC_{50} 100.99 and 96.87 µg/mL) and β-Carotene/linoleic acid radical scavenging activity (EC_{50} 63.20 and 72.65 µg/mL) than the values of BHT and Ascorbic acid used as standards. Moreover, not much research has been conducted on the antioxidant activity of essential oil of the *Ficus elastica* specie and the *Ficus* family.

Table 3. Result for percentage inhibition of DPPH by the essential oils and ascorbic acid at 517 nm.

Concentration (µL/mL)	*Ficus elastica (%)*	Ascorbic Acid *(%)*
2.5	41.31	52.56
5.0	41.56	65.26
7.5	44.18	79.06
10.0	45.26	90.40

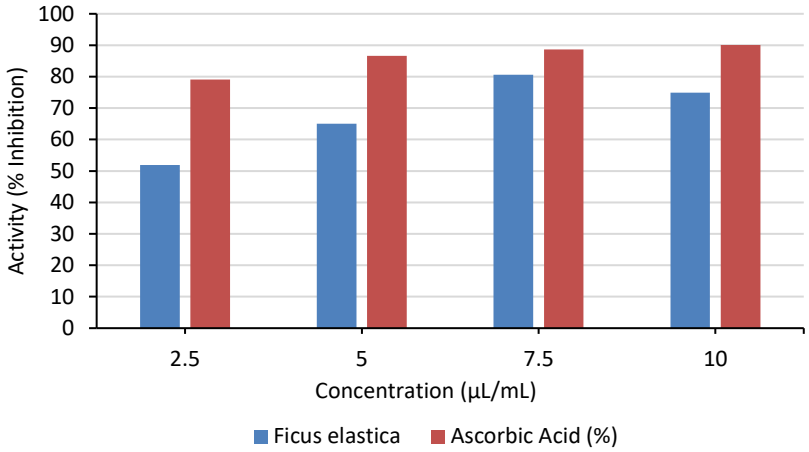

Figure 2. DPPH scavenging activity (%) of *Ficus elastica* essential oils against ascorbic acid.

3.4. Hydrogen Peroxide Radical Scavenging Activity for Essential Oil of *Ficus elastica* and Ascorbic Acid

Table 4 shows that the essential oil of the leaves of these plants demonstrates significant antioxidant potential when compared to the standard Ascorbic acid, as determined by the peroxide scavenging assay method. The percentage inhibitions were 51.92 % and 79.13 % at the lowest concentration (2.5 µL/mL) and 74.90 % and 90.12 % at the highest concentration (10 µL/mL) for *Ficus elastica* and Ascorbic acid, respectively. Figure 3 illustrates the comparison of essential oil activities against the two test reagents.

When comparing the results obtained in this study with the research conducted by Ojah *et al*. (2021) it aligns with their findings on the antioxidant activity of the essential oil of *Calophyllum inophyllum* Linn, belonging to the same class *Magnoliopsida* as *Ficus elastica*. Their study on hydrogen peroxide scavenging assay revealed a concentration-dependent percentage inhibition of the standard used in this study (Ojah *et al*., 2021).

Plumeria alba, belonging to the phylum *Tracheophyta* and class *Magnoliopsida* like *Ficus elastica*, was investigated by Mamattah *et al.* (2023), revealed that the antioxidant activities of the plant's leaves and flower essential oil against hydrogen peroxide exceeded the standard antioxidants used. The IC50 values were 370.5 and 476.0 µg/mL respectively for the flower and leaf parts against the activity of Ascorbic acid (5.30 µg/mL) and Gallic acid (9.08 µg/mL).

In comparing the antioxidant activity of the essential oil of plant leaves against the two test reagents, *Ficus elastica* demonstrated higher hydrogen peroxide radical scavenging efficiency than DPPH radicals, possibly attributed to differences in mechanisms. In both DPPH and hydrogen peroxide assays, the scavenging action may be attributed to the hydrogen-donating ability, as the role of an antioxidant is to eliminate free radicals. No prior research has explored the antioxidant activity of the essential oil of the plant against hydrogen peroxide, serving as a reference for related literature.

Table 4. Result for percentage inhibition of hydrogen peroxide by the essential oils and Ascorbic acid at 230 nm.

Concentration (µL/mL)	*Ficus elastica* (%)	Ascorbic acid (%)
2.5	51.92	79.13
5.0	65.00	86.59
7.5	80.65	88.71
10.0	74.90	90.12

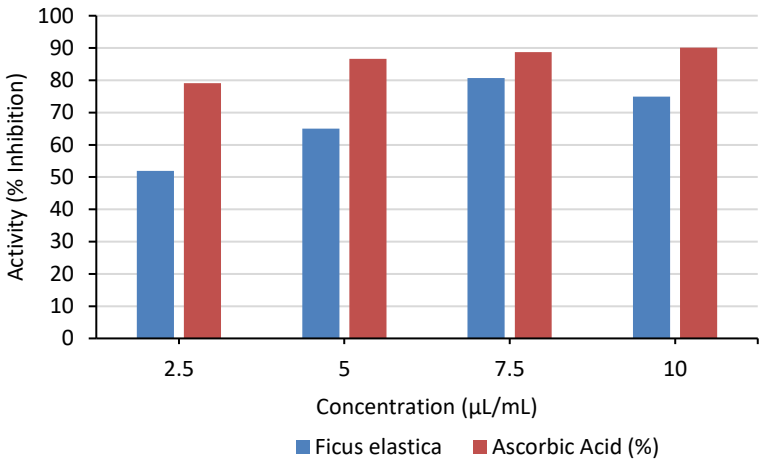

Figure 3. Hydrogen peroxide scavenging activity (%) of *Ficus elastica* essential oils against ascorbic acid.

5. CONCLUSION

Plant essential oils are increasingly utilized in the food industry as natural antioxidant and preservative agents, contributing to enhanced consumer well-being and the prolonged shelf life of consumable food products.

The antioxidant activity of *Ficus elastica* essential oil was examined through DPPH and hydrogen peroxide methods, demonstrating comparable efficacy to standard Ascorbic acid. Quantitative analysis using DPPH and hydrogen peroxide assays revealed potent antioxidant activity within the plant's essential oil, positioning it as a promising candidate for both biological and chemical analyses. Furthermore, the oil could be explored for the isolation of therapeutically active compounds. This robust antioxidant activity suggests potential applications in the management and treatment of various diseases. The findings of this study support the consideration of *Ficus elastica* essential oil as an alternative source of antioxidants.

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Declaration of Conflicting Interests and Ethics

The authors declare no conflict of interest. This research study complies with research and publishing ethics. The scientific and legal responsibility for manuscripts published in IJSM belongs to the authors.

Authorship Contribution Statement

Author 1 designed the study, performed the statistical analysis, wrote the protocol, and wrote the first draft of the manuscript. ‘Author 1, 2 and 3 managed the analyses of the study. ‘Author 1 managed the literature searches. All authors read and approved the final manuscript.

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