"*In Vitro*Antioxidant and Anti-Inflammatory Potential of Essential Oils of *Ocimum tenuiflorum* And *Ocimum kilimandscharicum*"

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Anti-inflammatory, Antioxidant, Essential oil, *Ocimum tenuiflorum*, *Ocimum kilimandscharicum*

Deeply ingrained in traditional Indian medical systems such as Ayurveda, Siddha and Unani along with Tibetan and Chinese medicine, medicinal plants are extremely valuable in both conventional and contemporary pharmaceuticals. For the millions of people who depend on them, they offer substantial health advantages and have a variety of therapeutic uses. Essential oils are volatile substances that are taken from aromatic and therapeutic plants. Because of their intricate chemical makeup, essential oils have been shown to have anti-inflammatory and antioxidant prospective. Their major component's activities or interactions with one another, which are crucial in expressing their bioactive qualities, provide the basis of these activities. Analyzing antioxidant along with anti-inflammatory activities from essential oils derived out of *Ocimum tenuiflorum* as well as *Ocimum kilimandscharicum* was the aim of the present research. Using the DPPH, ABTS along with FRAP techniques, *O. tenuiflorum* essential oil's IC_{50} was 30.94±0.10µgml^{-1}, 33.13±0.06µgml^{-1} and 84.51±0.86µgml^{-1}, whereas IC_{50} of *O. kilimandscharicum* essential oil was 28.76±0.05µgml^{-1}, 31.05±0.16µgml^{-1} and 68.57±0.95µgml^{-1}, respectively. *O. tenuiflorum* essential oil IC_{50} was determined as 31.32±0.18µg ml^{-1} and 30.98±0.07µg ml^{-1} with egg albumin denaturation and proteinase inhibitory activity respectively. In contrast, the egg albumin denaturation procedure yielded IC_{50} 27.63±0.54µg ml^{-1} for essential oil of *O. kilimandscharicum* and 26.10±0.16µg ml^{-1} as assessed by proteinase inhibitory activity. *O. kilimandscharicum* essential oil showed slightly higher anti-inflammatory and antioxidant potential as compared to *O. tenuiflorum.* The present investigation's conclusion is that *O. tenuiflorum* as well *O. kilimandscharicum* essential oils can be employed as sources of antioxidants and non-toxic anti-inflammatory drugs.

Abbreviations:
DMSO- Dimethyl sulfoxide
PBS - Phosphate buffered saline

1. Introduction

Synthetic materials are employed in the food along with cosmetics industries to prevent oxidation of their goods. Synthetic antioxidants, on the other hand, have been shown to have detrimental impacts on human health, including gastrointestinal issues, skin allergies and in certain situations, an elevated threat to cancer. Immoderate quantity of chemically synthesized antioxidants has prospective to damage DNA as well as accelerate aging. Carcinogenesis and detrimental effects on the liver have already been linked to BHA (butylated hydroxyanisole) and BHT (butylated hydroxytoluene). There has been a growing trend to replace natural antioxidants for these. Current decades possess surge of interest in creating medicinal plants based antioxidants. Since the beginning of time, human beings have utilized medicinal floras as food and medicine. The majority of therapeutic drugs are derived from natural plant ingredients, albeit to varying degrees [1,2]. Herbal medicines continue to be extensively employed as primary protection in developing countries. Conventional medication widely utilized to prevent as well as cure broad span of ailments along with to increase energy plus strengthen immune system [3,4]. The scientific community has recently become interested in plant's antioxidant capability, which also shields living cells from oxidative destruction brought on through production of free radicals together with reactive oxygen species during metabolic processes [5]. Flora-based natural antioxidants have a few advantages over synthetic ones, including being less expensive, easier to use and having few to no side effects [6].

Globally *Ocimum* spp. (Lamiaceae family) is among the most prominent fragrant curative flora. It is an abundant source of essential oil and has latent uses in food, pharmaceutical and many other sectors. Linnaeus in 1753 reported five spp. of genus *Ocimum*. These days, nevertheless, over 50 species have been shown to

offer potential medical and financial value [7, 8]. *Ocimum* spp. are formed throughout tropical inclusive of subtropical regions [9]. Two most significant species among them are *O. tenuiflorum* and *O. kilimandscharicum*.

O. tenuiflorum, a branched perennial herb with some woody tissue at the stem bases, is often referred to as Tulasi or Tulsi in Hindi and Holy Basil in English [10]. This pleasant aromatic flora can reach a height of 1 m. The leaves have glabrous surfaces and a broad elliptical form, linear measuring 3–6 cm as well as 1–2.5 cm wideness. Terminal blooms develop into thin racemes or panicles. Stems of the flora are four-angled, hairy and purple [8].

Additionally, *O. kilimandscharicum* Guerke, a perennial undershrub native to Kenya, was brought to India for the large-scale manufacturing of camphor during World War II and is also named Kapoori Tulsi in Hindi as well Camphor Basil in English [11]. With oppositely arranged, pubescent leaves that are thin at the base and deeply serrated, this evergreen shrub has oblong, ovate, green leaves that range in length from 0.5-5 m. Clusters of hermaphrodite blooms, deep, soft-wooded tap roots and one-seeded, indehiscent fruits are all present [12].

Both of these *Ocimum* spp. leaves contain fragrant oils that are a representation of the plant's true nature. The antioxidant and anti-inflammatory perspectives of *O. tenuiflorum* inclusive of *O. kilimandscharicum* essential oils *in vitro* are thus main focus of the current investigation.

2. Materials and Methodology

2.1 Chemicals and Solvents

We bought solvents from Loba Chemie Private Limited in Mumbai, India, including methanol and DMSO (dimethyl sulphoxide). We bought chemicals from Sigma-Aldrich Co. LLC, Mumbai, including DPPH and ABTS. In Mohali, India, we obtained ibuprofen from Ranbaxy Laboratories. In the current study, only chemicals of analytical quality were used. Fresh egg albumin was bought from local market.

2.2 Gathering of flora specimens together with extrication of essential oil from O. tenuiflorum as well O. kilimandscharicum

O. tenuiflorum was gathered from Gurukula Kangri (Deemed to be) University, Haridwar campus in Uttarakhand where as *O. kilimandscharicum* was gathered from Palampur region of Himachal Pradesh, India's North-West Himalayan area. Both *Ocimum* spp. leaves were collected, identified at Botanical Survey of India Dehradun, Uttarakhand and extraction of their essential oil was done by using hydrodistillation method [13].

2.3 In vitro Antioxidant potential of O. tenuiflorum as well O. kilimandscharicum essential oil

To ascertain antioxidant potential in regard to both *Ocimum* spp. essential oils, the current study combines FRAP, DPPH and ABTS methodologies [14,15]. Ascorbic acid was employed as the reference antioxidant component for all assays and various oil concentrations (10–40 µg/ml) were produced for each antioxidant experiment [16]. The antioxidant capacity was demonstrated using the IC_{50} value. Antioxidant perspective was elevated as the IC_{50} worth was demote.

In the DPPH radical scavenging method, the essential oil's capacity to scavenge DPPH radicals was assessed using the procedure described by Barros *et al*. (2007) [17]. There were three assay runs. The essential oil's reduction power for the FRAP assay was determined using Benzie and Strain's (1996) methodology [18]. The antioxidant perspective of essential oil was examined to lessen iron (III) ions. A rise in absorbance following blank subtraction was used to characterize the reducing power. We used the Re *et al*. (1999) method for ABTS scavenging activity [19].

2.4 In vitro Anti-inflammatory potential based on O. tenuiflorum as well O. kilimandscharicum essential oil

***Egg albumin denaturation*:** Anti-inflammatory perspective as regard to essential oils from both selected *Ocimum* spp. were assessed utilizing egg albumin denaturation method recounted by Chandra *et al*. (2012) [20] and Gogoi *et al*. (2018) [21]. 2.8 ml of PBS (pH 6.4), 200µl of naturally extricated egg albumin and 2 ml of both *Ocimum* spp. essential oil at concentrations ranging from 10-40 µg/ml were adjoined. Following fifteen minute incubation (37±2ºC), mixture was made hot for five minute to 70ºC. Following chilling, absorbance at 660 nm was measured and contrasted with a blank. An equivalent amount of distilled water was utilized as a

control. The final amounts of ibuprofen, a conventional anti-inflammatory medication, ranged from 50-400 µg/ml. The % inhibition in regard to protein denaturation was measured as:
%age inhibition = $[1-A_T/A_C]*100$
Where A_T: test specimen's absorbance and A_C**:** control specimen's absorbance. Experiment was performed three times and the average was calculated.

***Proteinase inhibitory activity*:** With a few minute alterations, the test was conducted in accordance with Daniel, 2016 [22]. 0.06mg trypsin, 20mM Tris HCl buffer having pH 7.4 along with 1ml essential oil with varying quantities was present in the reaction mixture. 2ml 70% perchloric acid was put on for stopping process after 20 minute incubation. After centrifuging the hazy suspension, absorbance of supernatant was noted at 210nm with buffer as blank. Three replicas of study were conducted.

Percentage inhibition = (Abs control − Abs sample) × 100/Abs control.

2.5 Characterization of O. kilimandscharicum as well O. tenuiflorum essential oil employing GC-MS

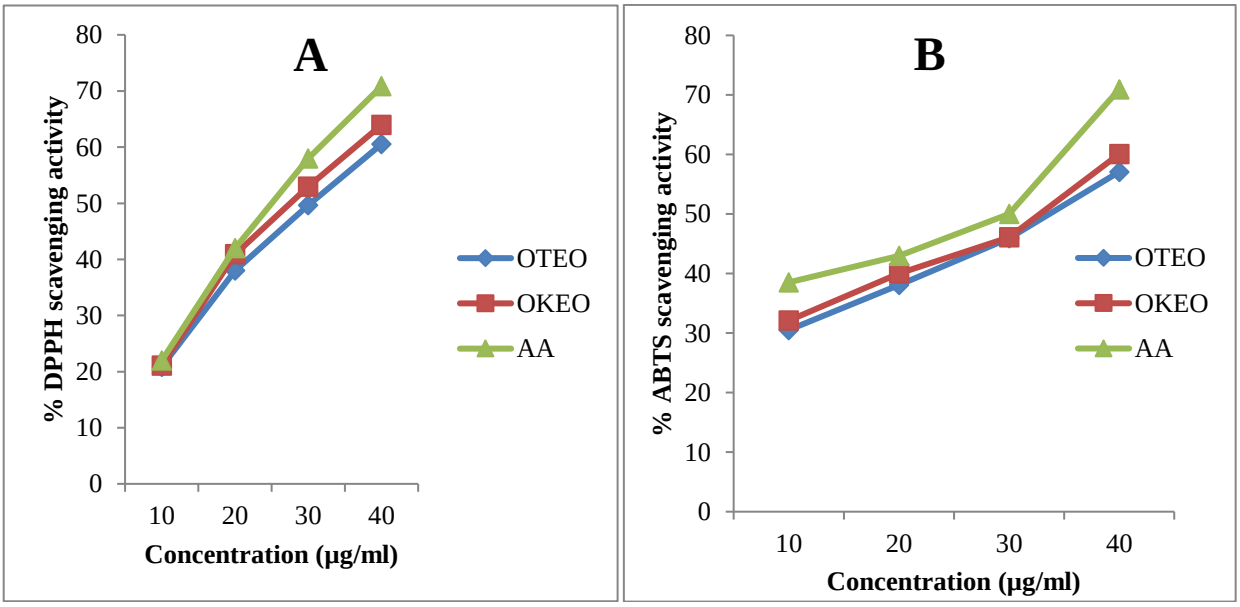
A Hewlett Packard GC HP 6890 connected along Hewlett Packard 5973 MS, fitted along DB-5 column was used to analyze the essential oils of both *Ocimum* spp. Following a five-minute hold at 40ºC, the oven programme increased the temperature by 8ºC per minute until it reached 280ºC, where it was eventually maintained isothermally for two minutes. The ion source was put at electron ionization 70eV. The carrier gas, helium was employed at a flow rate of 1 milliliter per minute. The range of the scan was 35-425 amu. A 1.0 µl injection of diluted oil in n-hexane was made into the GC-MS.

According to their retention time (Rt), the components of the essential oils were determined in relation to the reference. The unspecified peaks in the MS-data bank (NIST 2.0 electronic Library) were matched to identify the chemicals with those standards, Wiley, the GC-MS system's 275 library mass spectra database and published data.

3. Results

3.1 In vitro Antioxidant activity of O. tenuiflorum and O. kilimandscharicum essential oil

Using the DPPH, ABTS as well FRAP methods, *O. tenuiflorum* essential oil's IC_{50} was 30.94±0.10µgml^{-1}, 33.13±0.06µgml^{-1} and 30.22±0.86µgml^{-1}, respectively. Using the DPPH, ABTS and FRAP methods, the IC_{50} of *O. kilimandscharicum* essential oil was 28.76±0.05µgml^{-1}, 31.05±0.16µgml^{-1} and 26.29±0.95µgml^{-1}, respectively. In the DPPH, ABTS and FRAP assays, ascorbic acid showed IC_{50} values of 26.13±0.05 µgml^{-1}, 24.42±0.12µgml^{-1} and 23.99±0.08µgml^{-1}, respectively (Fig. 1 and Table 1).



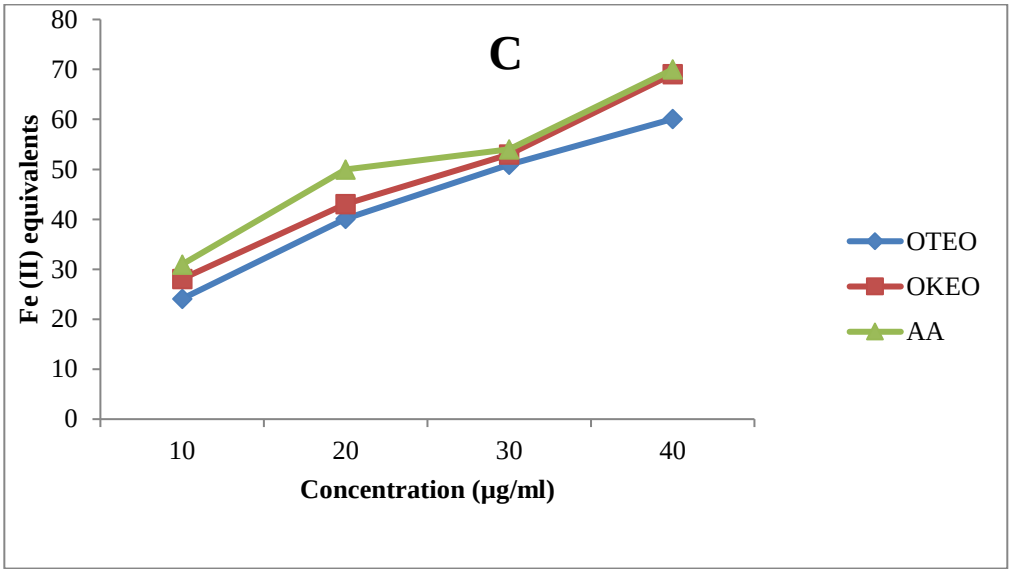


Fig. 1 Antioxidant perspective of *O. tenuiflorum* and *O. kilimandscharicum* essential oil A:DPPH; **B:** ABTS and **C:** FRAP assay. AA: Ascorbic acid (positive control); OTEO: *O. tenuiflorum* essential oil; OKEO: *O. kilimandscharicum* essential oil. The mean ± standard deviation of three separate tests was used to represent the analysis.

Table 1 Antioxidant property of essential oil of *O. tenuiflorum* and *O. kilimandscharicum*. Ascorbic acid served as a positive control and the antioxidant property assessed was reported in terms of half maximum inhibitory concentration (IC_{50}).

Antioxidant assays	**IC_{50} value (µg ml^{-1})**		
	Ascorbic acid	***O. tenuiflorum***	***O. kilimandscharicum***
DPPH	26.13 ± 0.05	30.94± 0.10	**28.76 ± 0.05**
ABTS	24.42 ± 0.12	33.13± 0.06	**31.05 ± 0.16**
FRAP	23.99± 0.08	30.22±0.86	**26.29±0.95**

In comparison to *O. tenuiflorum* essential oil, *O. kilimandscharicum* essential oil demonstrated slightly highest antioxidant capacity, according to the aforementioned studies. Nonetheless, the current study's findings support the use of *O. tenuiflorum* as well *O. kilimandscharicum* essential oils as antioxidants. Additionally, they could lead to the development of innovative drugs for a range of oxidation disorders.

3.2 Anti-inflammatory activity based on O. tenuiflorum as well O. kilimandscharicum essential oil In vitro

IC_{50} value was used to measure the anti-inflammatory activity. The anti-inflammatory potential is higher when the IC_{50} value is lower.

Egg albumin denaturation: *O. tenuiflorum* essential oil IC_{50} was determined as 31.32±0.18µg ml^{-1}. In contrast, the egg albumin denaturation procedure yielded IC_{50} 27.63±0.54µg ml^{-1} for essential oil of *O. kilimandscharicum*. The IC_{50} value of ibuprofen was 26.36±0.06 µg ml^{-1} (Fig. 2 and Table 2).

Proteinase inhibitory activity: The IC_{50} attributed to essential oil from *O. tenuiflorum* was turn out 30.98±0.07µg ml^{-1}. On the other hand, the essential oil of *O. kilimandscharicum* had an IC_{50} value of 26.10±0.16µg ml^{-1} as assessed by proteinase inhibitory activity. Ibuprofen had IC_{50}22.91±0.06 µg ml^{-1} (Fig. 2 and Table 2).

Ibuprofen was used as a positive control in both anti-inflammatory assays and the half maximum inhibitory concentration (IC_{50}) of the anti-inflammatory action determined in both methods.

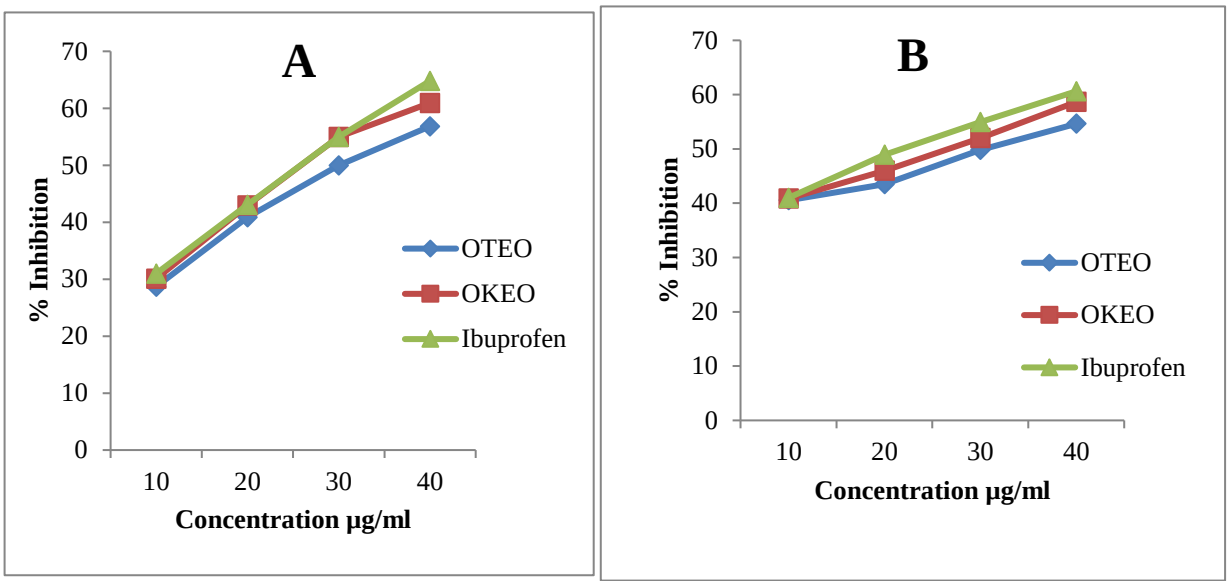


Fig. 2 Anti-inflammatory potential based on *O. tenuiflorum* as well *O. kilimandscharicum* essential oil a) by egg albumin method B) by proteinase inhibitory activity OTEO: *O. tenuiflorum* essential oil; OKEO: *O. kilimandscharicum* essential oil. Ibuprofen: standard. The mean ± standard deviation of three separate tests was used to represent the analysis.

Table 2 Anti-inflammatory activity attributed to*O. tenuiflorum* and *O. kilimandscharicum* essential oil

Anti-inflammatory assays	**IC_{50} value (µg ml^{-1})**		
	Ibuprofen	***O. tenuiflorum***	***O. kilimandscharicum***
Egg albumin Denaturation	26.36±0.06	31.32± 0.18	**27.63±0.54**
Proteinase inhibitory activity	22.91±0.06	30.98±0.07	**26.10±0.16**

According to the aforementioned results, *O. kilimandscharicum* exhibits stronger anti-inflammatory efficacy than *O. tenuiflorum*. Nonetheless, the analysis's findings suggest using the essential oils of both *Ocimum* species as anti-inflammatory agents and boosting the production of new medications for a range of inflammatory conditions.

3.3 Characterization of O. kilimandscharicum as well O. tenuiflorum essential oil employing GC-MS

O. kilimandscharicum as well *O. tenuiflorum* essential oils were subjected to their phytochemical characterization by GC-MS method. The phytocompounds were identified based on their retention time, while abundance of identified compounds was determined on the basis of area % of the corresponding peak.

Table 3 and table 4outlined the phytoconstituents revealed by contrasting the component spectra utilizing the mass spectral library at NIST (https://chemdata.nist.gov/), their PubChem CID, retention time (minute), area percentage, molecular formula and molecular weight. Gas Chromatography-MS spectra of essential oil of *O. kilimandscharicum* demonstrated the presence of total 26 phytocompounds (Fig 3), out of which 13 have percentage area more than 2. Epi-Bicyclosesquiphellandrene (10.74%), Dihydrocarvone (11.44%) and D-camphor (14.12%) are the chief phytocompounds turn out in the essential oil of *O. kilimandscharicum*. Gas chromatography-mass spectrometry spectra of essential oil of *O. tenuiflorum* revealed the occurrence of overall 24 phytoconstituents out of which 14 having percentage area more than 2. Copaene (9.56%), Beta-Elemene (12.85%) and Eugenol (21.13%) are chief phytoconstituents turn out in it (Fig. 4).

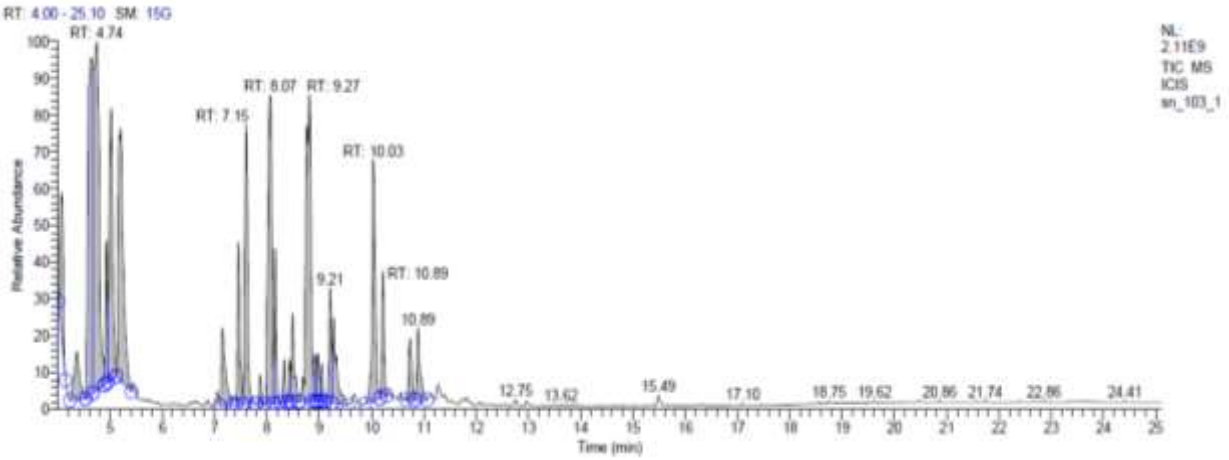


Fig. 3: GC-MS spectrum of essential oil of *O. kilimandscharicum* showing time (minute) at X-axis and relative abundance at Y-axis. Phytoconstituents are identified through different time interval and recorded in terms of retention time (RT)

Table 3 Phytoconstituents recognized in *O. kilimandscharicum* essential oil **through Gas Chrmatography-Mass Specrometery**

S. No.	Compound Name	PubChem CID	RT (minute)	Area (%)	Molecular Formula	M.W. g/mol
1.	Beta-Terpineol	8748	4.08	2.93	$C_{10}H_{18}O$	154.25
2.	(+)-Trans-Limonene Oxide	449290	4.36	1.84	$C_{10}H_{16}O$	152.23
3.	**Dihydrocarvone**	**24473**	**4.64**	**11.44**	**$C_{10}H_{16}O$**	**152.23**
4.	**D-Camphor**	**159055**	**4.74**	**14.12**	**$C_{10}H_{16}O$**	**152.23**
5.	Isoborneol	64685	4.93	1.97	$C_{10}H_{18}O$	154.25
6.	3-Cyclohexen-1-Ol	5325830	5.02	6.85	$C_{10}H_{18}O$	154.25
7.	(-)-Myrtenol	88301	5.20	8.84	$C_{10}H_{16}O$	152.23
8.	Eugenol	3314	7.15	2.28	$C_{10}H_{12}O_2$	164.2
9.	Alpha-Cubebene	442359	7.45	2.53	$C_{15}H_{24}$	204.35
10.	Beta-Elemene	6918391	7.61	5.69	$C_{15}H_{24}$	204.35
11.	(-)-Alpha-Gurjunene	16213731	7.87	0.43	$C_{15}H_{24}$	204.35
12.	Beta-Caryophyllene	5281515	8.07	8.67	$C_{15}H_{24}$	204.35
13.	Beta-Cubebene	93081	8.16	2.10	$C_{15}H_{24}$	204.35
14.	(-)-Germacrene D	5317570	8.32	0.56	$C_{15}H_{24}$	204.35
15.	.Gamma.-Muurolene	6432308	8.43	0.50	$C_{15}H_{24}$	204.35
16.	Humulene	5281520	8.49	1.61	$C_{15}H_{24}$	204.35
17.	**Epi-Bicyclosesquiphellandrene**	**10976597**	**8.81**	**10.74**	**$C_{15}H_{24}$**	**204.35**
18.	(-)-Alloaromadendrene	10899740	8.93	0.76	$C_{15}H_{24}$	204.35
19.	A-Muuroladiene	12306049	8.98	0.75	$C_{15}H_{24}$	204.35
20.	Ylangene	20055075	9.04	0.55	$C_{15}H_{24}$	204.35
21.	(+)-Delta-Cadinene	441005	9.21	1.87	$C_{15}H_{24}$	204.35
22.	2,7-Cyclodecadien-1-Ol	522445	9.27	2.36	$C_{15}H_{26}O$	222.37
23.	Alpha-Farnesene	5281516	10.03	5.63	$C_{15}H_{24}$	204.35
24.	(-)-Globulol	12304985	10.22	1.97	$C_{15}H_{26}O$	222.37
25.	Cedrelanol	160799	10.74	1.38	$C_{15}H_{26}O$	222.37
26.	Alpha-Cadinol	10398656	10.89	1.63	$C_{15}H_{26}O$	222.37

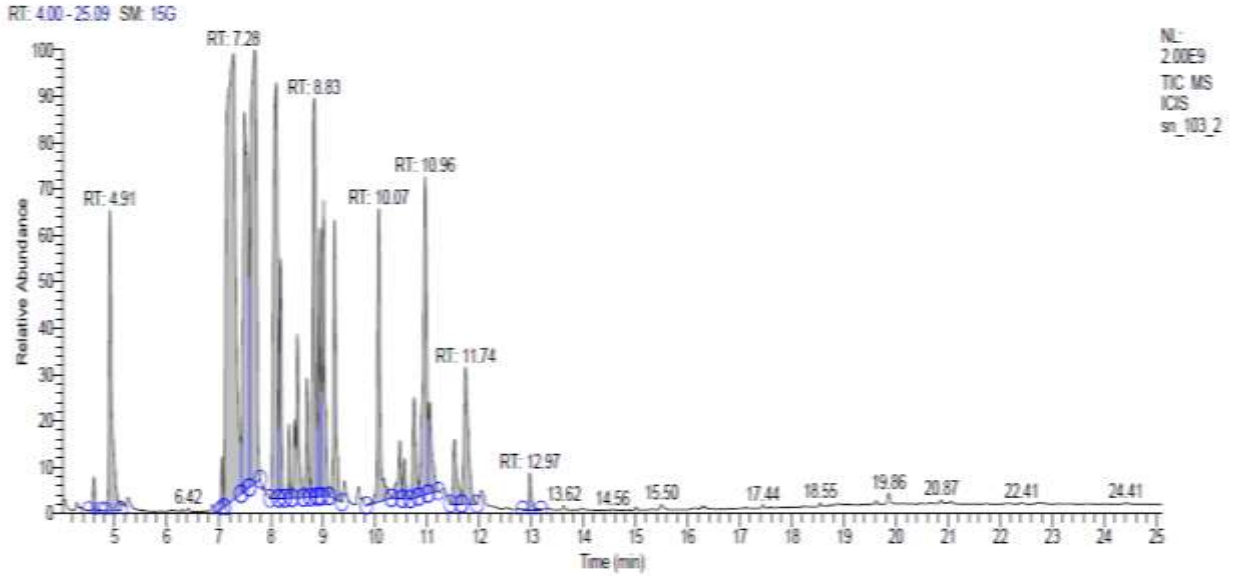


Fig. 4: Gas chromatography-mass spectrometry spectra of *O. tenuiflorum* essential oil displaying relative abundance and time (minute).

Table 4 Outline of phytoconstituents recognized in *O. tenuiflorum* essential oil

S. No.	Constituent Name	PubChem CID	Retention time (minute)	Area %age	Molecular Formula	M.W. (g/mol)
1.	(-)-Camphor	444294	4.60	0.35	$C_{10}H_{16}O$	152.23
2.	Borneol	64685	4.91	4.48	$C_{10}H_{18}O$	154.25
3.	Alpha-Cubebene	442359	7.06	0.44	$C_{15}H_{24}$	204.35
4.	**Eugenol**	**3314**	**7.28**	**21.13**	**$C_{10}H_{12}O_2$**	**164.2**
5.	**Copaene**	**12303902**	**7.49**	**9.56**	**$C_{15}H_{24}$**	**204.35**
6.	**Beta-Elemene**	**6918391**	**7.69**	**12.85**	**$C_{15}H_{24}$**	**204.35**
7.	Beta-Caryophyllene	5281515	8.10	8.67	$C_{15}H_{24}$	204.35
8.	Beta-Cubebene	93081	8.18	2.18	$C_{15}H_{24}$	204.35
9.	(-)-Germacrene D	5317570	8.35	0.69	$C_{15}H_{24}$	204.35
10.	Humulene	5281520	8.51	2.49	$C_{15}H_{24}$	204.35
11.	Gamma-Maaliene	21775138	8.69	1.37	$C_{15}H_{24}$	204.35
12.	Epi-Bicyclosesquiphellandrene	10976597	8.83	6.35	$C_{15}H_{24}$	204.35
13.	(-)-Beta-Selinene	28237	8.93	2.76	$C_{15}H_{24}$	204.35
14.	Alpha-Selinene	10856614	9.01	3.96	$C_{15}H_{24}$	204.35
15.	(+)-Delta-Cadinene	441005	9.22	3.40	$C_{15}H_{24}$	204.35
16.	Caryophyllene Oxide	1742210	10.07	4.12	$C_{15}H_{24}O$	220.35
17.	Juniper Camphor	521214	10.47	0.93	$C_{15}H_{26}O$	222.37
18.	(-)-Cubenol	11770062	10.56	0.48	$C_{15}H_{26}O$	222.37
19.	Cedrelanol	160799	10.75	1.63	$C_{15}H_{26}O$	222.37
20.	(-)-Globulol	12304985	10.96	5.70	$C_{15}H_{26}O$	222.37
21.	Ent-Spathulenol	13854255	11.05	1.60	$C_{15}H_{24}O$	220.35
22.	Ledene Oxide-(II)	534497	11.52	1.30	$C_{15}H_{24}O$	220.35
23.	Longipinocarveol, Trans-	534645	11.74	3.04	$C_{15}H_{24}O$	220.35
24.	Dibutyl Phthalate	3026	12.97	0.51	$C_{16}H_{22}O_4$	278.34

4. Discussion

Literature from several thousand years ago has recorded the use of medicinal herbs in traditional medicine [23]. During the Vedic period (3500–1600 B.C.), literature on Ayurvedic medication detail the techniques, such as the utilization of medicinal herbs, which served as basis of every branch of medicine developed in the Indian subcontinent. The primary source of treatments in modern harmonious as well substitute medication is floras. Furthermore, all flora fragments hold biologically active compounds. The usage of medicinal plants has various benefits, but the two primary ones are their affordability and accessibility worldwide. Other obvious benefits include their safety in comparison to other medications and the absence of significant adverse effects [24]. The worldwide market for medicinal plants is currently worth over $60 billion annually and is expanding at a 6.4% yearly rate [25].

During the current investigation, literature survey attributed to specified aromatic curative plants along with present concerns regarding efficacy of chemically synthesized medications were taken into consideration in order to ascertain the anti-inflammatory as well as antioxidant qualities based on two *Ocimum* spp. essential oils mentioned above.

The antioxidant as well anti-inflammatory potentials of *Ocimum* spp. essential oils were covered in earlier studies and are relevant to the current investigation. Salles *et al*., 2006 represented best antioxidant potential (IC_{50}=0.46 µL/mL) of essential oil from *O. tenuiflorum* among other five species of the genus *Ocimum* using DPPH assay[26].HA *et al*., 2024 reported antioxidant activity IC_{50} 0.165 µg/mL for *O. tenuiflorum* essential oil [27]. Luong *et al*., 2024 also described *O. tenuiflorum* leaves essential oil as high radical scavengers with IC_{50} values of 53.5 and 55.1 µg/ml with DPPH and ABTS respectively, compared with 67.2 and 63.2 µg/ml, respectively, for the positive control [28]. Whereas, Tewari *et al*., 2015 represented high antioxidant potential of *O. kilimandscharicum* with DPPH assay [29]. Chaturvedi *et al*., 2018 represented good radical scavenging potential (0.15–0.93%) of the essential oil by ferric reducing antioxidant power (FRAP) assay [30]. De lima *et al*., 2014 proclaimed firstly that essential oil of *O. kilimandscharicum* have potent anti-inflammatory as well antioxidant potential assessed with DPPH (IC_{50}8.21 g/ml) [31]. Singh *et al*., 2011 reported *in vivo* antioxidant activity of *O. kilimandscharicum* [32].

15-45 chemical components are often found in essential oil of *O. kilimandscharicum* [11, 12, 31, 33-35]. The oil content of aerial parts was comparable, with linalool being the majority of the composition (leaves: 41.94%, flowers: 58.85%). Other significant components were 1,8-cineole (leaves (10.18%), flowers (6.38%)) and camphor (leaves (17.02%), flowers (15.82%)). Ntezurubanza *et al*., in 1984 revealed the presence of a 1.8-cineole (62%) for the first time [35]. Limonene (5.5% in winter, 5.6% in summer), 1,8-cineole (22.2% in winter, 14.8% in summer) and camphor (48.9% in winter, 58.9% in summer) were found abundantly in this chemotype. Linalool, eugenol, myrtenol, lupeol, stigmasterol, turkesterone, camphene, α-pinene, quercetin, fisetin, apigenin, chrysin, friedelin, α-amyrin acetate, apigenin-7-O-neohesperidoside and n-octacosonoic acid are among the other compounds found in *O. kilimandscharicum* [30,36,37]. Presence of camphor as a major phytocompound in our research was similar with the research of De Lima *et al*., (2014) [31]; Verma *et al*., (2011) [36], Pragadheesh *et al*., (2013) [38] and Anand *et al*., (2020) [39]. The primary constituents of *O. tenuiflorum*'s essential oil were reported as eugenol (9.0–44.0%), methyl eugenol (46.07-84.7%), methyl chavicol (87%), trans-β-elemene (4.333–37.1%),caryophyllene (15.65%), caryophyllene oxide (3.18%), (E)-β-caryophyllene (27.8–49.0%), β-caryophyllene (5-7.4%), β-copaene (4.18%), α-copaene (1.95%) and lower levels of camphor (4%), [28, 40-42]. Several other researches confirmed that eugenol was a significant phytocompound in our investigation.

5. Conclusion

Ocimum (Tulsi), one of the many herbal floras found globally, is regarded as the "queen of herbs" because of its many therapeutic applications. Tulsi's many therapeutic benefits are well-documented in Hindu mythology. Our Indian elders insisted on planting a Tulsi sapling in every home because of its many health benefits. According to the written literature, essential oils of gathered *Ocimum* species from various geographic locations contained a range of chemical ingredients and the researchers discovered numerous and diverse uses in the conventional healthcare system. Due to their numerous biological activities, essential oils derived from *Ocimum* plants have garnered a lot of respect among food scientists and researchers. The examined findings were intended to draw the interest of scientists and researchers studying the pharmacological diversity of essential oils as well as those searching for novel medications made from natural sources. Therefore, it is hoped

that essential oils of *Ocimum* species will be taken into consideration for additional clinical trials and uses in the future, as well as potential adjuvant to existing drugs. Two important medicinal plants that significantly affect human health are *O. kilimandscharicum* and *O. tenuiflorum*. In present research, *O. tenuiflorum* as well *O. kilimandscharicum* essential oils were examined for antioxidant and anti-inflammatory properties to bolster their purported health benefits. The essential oil of *O. kilimandscharicum* exhibited strong anti-inflammatory and antioxidant qualities in contrast to *O. tenuiflorum*. As possible therapeutic candidates, they can be utilized to create broad-spectrum anti-inflammatory and antioxidant medications. In conclusion, the present study offers fresh prospects for the safe and less hazardous application of *O. tenuiflorum* and *O. kilimandscharicum* as remedies for problems caused by inflammation and oxidative stress; hence, these essential oils may be advantageous to the food and cosmetics sectors.

6. Limitations of the study: The present study solely examined *in vitro* antioxidant and anti-inflammatory properties. We will do additional research to determine the pathogenecity of essential oils *in vitro* and *in vivo*.

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Conflict of interest
The authors state that they have neither monetary nor communal conflicts which might be revealed as well as could have an impact on the findings of this study.
Author's contribution: Each of the tests was performed by **Ms. Shagun Sharma** inclusive of manuscript. **Dr. Ramesh Chandra Dubey** gave scientific inputs to carry out tests and data analysis.
Data Availability: No data was utilized for experimentation reported in paper.

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