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GENUS *OCIMUM* IN TERMS OF MINERAL, NUTRIENT, CHEMICAL CONTENTS AND BIOLOGICAL ACTIVITY

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ABSTRACT

In many regions, plants are the sole source of natural medicines. The numerous bioactive substances they contain have significant advantages in the prevention and treatment of many ailments. Determining the therapeutic characteristics of plants requires knowledge about their biological activity and essential oil contents. The mineral, nutritional, essential oil, and biological activity data for the genus *Ocimum* was gathered in this research. Several members of the genus *Ocimum* were found to engage in a wide variety of biological processes, as shown by the research findings. It has been discovered that this source may be very useful, particularly for its antioxidant and antibacterial properties. It's also said to contain naturally occurring minerals, nutrients, and essential oils. For this reason, plants belonging to the genus *Ocimum* are being considered as a potential valuable resource for use in the development of pharmaceuticals.

Keywords: Basil, Complemantary medicine, Medicinal Plants, *Ocimum*

INTRODUCTION

Nature has evolved with humans to become a valuable tool in the battle against sickness. From the earliest Homo sapiens to the present, numerous illnesses have been fought with just instinct, observation, and trial and error (**Korkmaz *et al.*, 2021; Unal *et al.*, 2022**). By studying natural organisms, humans have devised strategies for preventing and treating illness. As a result of these investigations, natural compounds that may be utilised to treat human ailments were discovered (**Mohammed *et al*., 2021a; Bal *et al.*, 2023**). Everything we need to survive has been discovered in nature. Humans have found great success in treating illness using a wide variety of natural compounds derived from plants, animals, and fungus (**Mohammed *et al.*, 2018; Krupodorova and Sevindik, 2020**). Traditional medicine is now the first line of defence against illness and the primary method of therapy in many underdeveloped countries (**Mohammed *et al.*, 2020a**). Herbal remedies and other medicines derived from plants play a significant role in the practise of traditional medicine. Antioxidant, anticancer, antiaging, antiinflammatory, antiproliferative, hepatoprotective, anti-allergic, antibacterial, and DNA protective are only some of the biological actions that have been linked to plants (**Sevindik *et al.*, 2017; Miastkowska and Sikora, 2018; Showkat *et al.*, 2019; Mohammed *et al.*, 2019; Hernández *et al.*, 2021; Mohammed *et al.*, 2021b; Ng *et al.*, 2021; Shen *et al.*, 2022; Uysal *et al.*, 2023**). It is crucial in this setting to identify plants with potential therapeutic benefits for use in the treatment of illness. Data on the nutritional value, mineral content, essential oil composition, and biological activity of *Ocimum* species were gathered for this research.

GENUS *OCIMUM* AND USAGE AREAS

The Lamiaceae family includes the genus *Ocimum*. It's most often known as basil. The *Ocimum* genus is native to sub-Saharan Africa and Southeast Asia. There are probably about 64 different kinds of annual and perennial herbs there. Both tropical Asia and the New World have examples of secondary and tertiary hybrids. While *Ocimum* species do vary somewhat in appearance depending on latitude, in the grand scheme of things; Flowers are tiny and clustered on vertical branches; stem is straight and branched; height is 50-100 cm; leaf colour is generally diverse but typically green and purple; leaves are normally smooth or wavy; flower colour is usually white, lilac, or scarlet; (**Simon *et al.*, 1984; Paton *et al.*, 1999; Vieira *et al.*, 2003; May *et al.*, 2007; Wyenandt *et al.*, 2015**).
The essential oils and secondary metabolites found in the *Ocimum* genus have attracted the interest of the pharmacological and medicinal communities. One of the most noticeable is the medical field, with conditions like bronchitis, coughing, sore throats, bronchial asthma, chronic fever, colds, malaria, dysentery, convulsions, diabetes, diarrhoea, arthritis, emetic syndrome, skin diseases, insect bites, etc., as well as stomach upset, liver disease, cardiovascular and immunological disorders. Its applications extend beyond medicine and into the beauty, fragrance, and food industries. (**Batta and Santhakumari, 1971; Sen, 1993; Vieira and Simon, 2000; Khalil, 2013**).

NUTRITIONAL AND MINERAL CONTENTS

Many nutritional items provide the vitamins and minerals that the human body need. When dietary deficiencies arise, it is crucial that they seek out helpful foods. In Table 1 below, we compare the nutritional and mineral content of *Ocimum* species from the literature.

Table 1 Nutritional and mineral contents of *Ocimum*

Nutritional Composition	Values (%)
Protein	1.21-40.60 %
Lipids	0.02-13.51 %
Carbohydrate	5.85-75.87 %
Ash	1.0-25.56 %
Mouisture	8.99-86.90 %
Caloric energy (kcal/100 g)	43.9-373.26
Mg	0.11-88.26 mg/100g
K	4.530-396.94 mg/100g
Na	9.58-90.32 mg/100g
Fe	0.20-16.18 mg/100g
Ca	3.594-195.02 mg/100g
Zn	0.01-20.00 mg/100g
Mn	0.11-5.41 mg/100g
P	10.5-287.00 mg/100g

Protein (1.21%-40.60), lipids (0.02%-13.51), carbohydrates (5.85%-75.87), ash (1.0%-25.56), mouisture (8.99%-86.9%) and caloric energy (43.90-373.26 kcal/100 g) values of Genus *Ocimum* members have been reported in literature research (**Edeoga *et al.*, 2006; Thomas and Oyediran, 2008; Oboh *et al.*, 2009; Igbinosa *et al.*, 2013; Ikpeazu *et al.* 2019; Siddique *et al.* 2021**). In addition, Mg (0.11-88.26 mg/100g), K (4.530-396.94 mg/100g), Na (9.58-90.32 mg/100g), Fe (0.20-16.18 mg/100g), Ca (3,594-195.02 mg/100g) , Zn (0.01-20.0 mg/100g), Mn (0.11-5.41 mg/100g), and P (10.5-287.0 mg/100g) values have been reported (**Thomas and Oyediran, 2008; Pachkore and Dhale, 2012; Igbinosa *et al.*, 2013; Ikpeazu *et al.*, 2019; Siddique *et al.*, 2021**).

BIOLOGICAL ACTIVITY

Plants are valuable resources because of the wide variety of biological functions they provide. Many investigations have shown that medications may be derived from plants (**Mohammed *et al.* 2020b**). It is crucial for the development of novel medicines that the potential biological activities of plants with these characteristics be identified. Biological activity investigations on *Ocimum* species performed in vitro and in vivo were gathered for this research. Alcohol, hydroalcoholic, essential oil, methanol, ethyl acetate, water, chloroform, petroleum ether, acetone, hexane, and dichloromethane are only some of the solvents that have been used to extract *Ocimum* species. The studies that were found during the literature review are included in Table 2.

Table 2 Biological activity of genus *Ocimum*

Plant species	Biological activity	Extraction	References
Ocimum africanum Lour.	Antimicrobial, gastroprotective, anticholinesterase, antioxidant	Ethanol, hydroalcoholic, essential oil, methanol	(**Tadros *et al.*, 2014; Bunwijit *et al.*, 2017; Kusuma and Ningrum, 2021; Limanan *et al.*, 2021**)
O. basilicum L.	Antioxidant, antimicrobial, anticholinesterase, larvicidal, antiviral, antiproliferative	Essential oil, methanol, cloroform, acetone ethanol, hexan, dichloromethane	(**Adıgüzel *et al.*, 2005; Kaya *et al.*, 2008; Ahonkhai *et al.*, 2009; Amir *et al.*, 2011; Shafique *et al.*, 2011; Yucharoen *et al.*, 2011; Ouibrahim *et al.*, 2013; Joshi, 2014b; Beatovic *et al.*, 2015; Gaio *et al.*, 2015; Gebrehiwot *et al.*, 2015; Mith *et al.*, 2016; Stanojevic *et al.*, 2017; Tenore *et al.*, 2017; Sundararajan *et al.*, 2018; Falowo *et al.*, 2019; Mohammed *et al.*, 2020; Złotek *et al.*, 2020; Gürgan and Adiloğlu, 2021; Rubab *et al.*, 2021; Chu *et al.*, 2022**)
O. campechianum Mill.	Larvicidal, cytotoxic	Essential oil	(**Ricarte *et al.*, 2020**)
O. canum Sims	Antimicrobial	Essential oil	(**Mith *et al.*, 2016**)
O. carnosum (Spreng.) Link & Otto ex Benth.	Larvicidal, cytotoxic	Essential oil	(**Ricarte *et al.*, 2020**)
O. forskolei Benth.	Antiinflammatory, antimicrobial, antioxidant, antiülcer, ameliorative effect	Ethanol, essential oil, petroleum ether, dichloromethane, ethyl acetate, aqueous, methanol	(**Ali *et al.*, 2017; Zahran *et al.*, 2019a; Zahran *et al.*, 2021b; Khalil *et al.*, 2022**)
O.gratissimum L.	Antimicrobial, antioxidant	Essential oil, ethanol, methanol	(**Nakamura *et al.*, 1999; Adebolu and Oladimeji, 2005; Mbata and Saikia, 2005; Matasyoh *et al.*, 2007; Ahonkhai *et al.*, 2009; Silva *et al.*, 2010; Alo *et al.*, 2012; Koche *et al.*, 2012; Joshi, 2013a; Omodamiro and Jimoh, 2015; *Mith et al.*, 2016; Melo *et al.*, 2019; Onaebi *et al.*, 2020**)
O. kenyense Ayob. ex A.J.Paton	antinosiseptif,	Ethanol	(**Mwangi *et al.*, 2012**)
O. kilimandscharicum Gürke	antinosiseptif, analgesic, anti-inflammatory, antimicrobial, antidiarrhoeal, antioxidant, antidepressant, larvicidal	Ethanol, essential oil, aqueous	(**Mwangi *et al.*, 2012; Sarin *et al.*, 2013; Lawal *et al.*, 2014; Tewari *et al.*, 2015; Chaturved *et al.*, 2018; Dos Santos *et al.*, 2021; Ochola *et al.*, 2022**)
O. minimum L.	cytotoxic, apoptotic, antiproliferative,	Essential oil	(**Jovankić *et al.*, 2022**)
O. obovatum E.Mey. ex Benth.	antimicrobial	Essential oil	(**Naidoo *et al.*, 2014**)

Antioxidant Activity

There can be severe consequences for living things when free radical levels go too high. When it comes to preventing and lessening these consequences, endogenous antioxidants play a vital role. When the body's antioxidant defences are weak, oxidative stress can set in (**Bal *et al.*, 2019; Baba *et al.*, 2020; Selamoglu *et al.*, 2020**). Cancer, heart disease, Parkinson's, and Alzheimer's are just some of the debilitating illnesses that might develop as a result of oxidative stress in humans (**Mohammed *et al.*, 2021c**). Antioxidant supplementation can mitigate the harmful effects of oxidative stress, which plays a role in the development of many illnesses. Identifying the role plants play as complementary antioxidants is crucial in this setting. In this study, we gathered data from previous research on the antioxidant properties of *Ocimum* species (Table 2). In this context, the DPPH test was used for the antioxidant activity of *O. africanum* reported from Indonesia. It has been reported that the IC50 values are 0.03 µg/mL and 174.04 µg/mL, respectively (**Limanan *et al.*, 2021**). It has been reported that the inhibition percentages of DPPH activity of essential oils of *O. basilicum* collected from Pakistan vary between 90.04 and 96.16 (**Shafique *et al.*, 2011**). The IC50 value of the DPPH activity of essential oils of *O. basilicum* collected from Serbia has been reported as 0.03 µg/mL (**Beatovic *et al.*, 2015**). The EC50 value of DPPH activity of essential oils of *O. basilicum* collected from Bosnia and Herzegovina has been reported to be 2.38 mg/mL (**Stanojevic *et al.*, 2017**). In a study reported from Italy, it was determined that the DPPH activity of *O. basilicum* had values between 580-1288 µmol L^{-1}. In addition, it has been reported that FRAP values vary between 1159-1195 µmol L^{-1} (**Tenore *et al.* 2017**). In another study reported from South Africa, it was reported that compounds obtained from *O. basilicum* had antioxidant activity between 5.32-41.40% (**Falowo *et al.*, 2019**). It has been reported that essential oils of *O. basilicum* collected from Sudan show high antioxidant activity **(Mohammed *et al.*, 2020**). The IC50 value of the DPPH activity of O. forskolei collected from Yemen has been reported as 31.55 µL/mL (**Ali *et al.*, 2017**). DPPH free radical scavenging test, anti-lipid peroxidation test and nitric oxide scavenging test were used to determine the antioxidant potential of *O. gratissimum* collected from Nigeria. As a result of the study, it was reported that the IC50 value at 800 g/mL for nitric oxide was 56.91±0.33, the IC50 value at 400 g/mL for anti-lipid peroxidation was 54.76±1.35, and the IC50 value at 400 g/mL for DPPH was 25.43±1.83 (**Omodamiro and Jimoh, 2015**). In another study reported from India, the antioxidant activities of essential oils of *O. gratissimum* and *O. sanctum* were determined by DPPH and ABTS tests. According to the data obtained, it was reported that the IC50 values in the DPPH test were 23.66 and 219.16, respectively, and 23.91 and 241.50 µg/mL in the ABTS test (**Joshi, 2013**). In another study reported from India, antioxidant activity of *O. kilimandscharicum* was reported to have significant antioxidant activity using the FRAP test (Chaturved et al., 2018). In another study, DPPH free radical scavenging activities of water extracts of *O.kilimandscharicum, O. tenuiflorum* and *O. basilicum* were reported to be 95.88, 93.13 and 95.09, respectively (**Tewari *et al.*, 2015**). In this context, it is seen that genus *Ocimum* species show significant antioxidant activity based on literature data. As a result, it is thought that genus *Ocimum* species may be a natural antioxidant source.

Antimicrobial activity

Humans have always been vulnerable to illnesses caused by microorganisms. Microorganisms have emerged as the root cause of a wide range of ailments in recent decades (**Saridogan *et al.*, 2021; Mohammed *et al.*, 2023**). We fight them with synthetic antibacterial medications. Due to the rise in germ resistance and the potential adverse effects of synthetic antimicrobials, more and more people, especially in recent years, are seeking treatment with antimicrobials derived from natural sources (**Eraslan *et al.*, 2021; Islek *et al.*, 2021**). In this regard, investigating plants for the development of natural antibacterial medicines is of paramount importance (**Sevindik *et al.*, 2023)**. In our study, antimicrobial activity studies of species belonging to the genus *Ocimum* reported in the literature were compiled (Table 2). In this context, inhibition zone data of *O. africanum* against *Staphylococcus epidermidis* at different concentrations (3, 5 and 7%) were reported to be 0.88 mm, 14.81 mm and 16.83 mm, respectively (Kusuma and Ningrum, 2021). Antimicrobial activity of *O. basilicum* against *E. coli, L.monocytogenes, S.almonella enterica, S. aureus, P. aeruginosa* and *B. cereus* was determined. It has been reported that the highest effect occurred against *S. aureus* (**Stanojevic *et al.*, 2017**). In another study, it was reported that essential oils of *O. basilicum* leaves were effective against *S. aureus, B. cereus, E. coli and P. aeruginosa* at 9-18 µg/mL concentrations (Amir et al., 2011). In another study, it was reported that the essential oil of *O. basilicum* showed significant antimicrobial activity against *S. aureus, S. epidermidis, S. faecalis, M. flavus, M. luteus, B. subtilis, E.coli, E.aerogenes, K. pneumoniae, P. aeruginosa, P. vulgaris, P. luteus* and *P. chrysogenum* (**Joshi, 2014b**). In a different study, the antimicrobial activity of essential oil of *O. basilicum* against *B. cereus, M.s flavus, S. aureus, E. faecalis, E. coli, P. aeruginosa, S.typhimurium, L. monocytogenes, A.fumigatus, A.niger, A.versicolor, A.versicium penicillium, P.penicinus* and *T. viride* was investigated. At the end of the study, it was determined that the plant essential oils showed different concentrations against bacteria and fungus strains. It has also been reported that the highest effect against bacteria is 0.009 µg/mL against *M. flavus*, and antifungal effect is between 0.08-1.07 µg/mL (**Beatovic *et al.* 2015**). In a different study reported from Turkey, antimicrobial activity of *O. basilicum* was determined against 55 bacterial and 5 fungal species. In the study, it was reported that the methanol extract of the plant was effective between 125-250 µL/mL, the ethanol extract 62.50-500 µL/mL and the hexane extract between 125-250 µL/mL (**Adıgüzel *et al.*, 2005**). In a different study reported from Turkey, the effects of chloroform, acetone and methanol extracts of *O. basilicum* against *E.gallinarum, E. faecalis, B. subtilis, E. coli, Shigella sp. E. coli, S.pyogenes, S. aureus, L. monocytogenes, P. aeruginosa, S.cerevisiae, C.albicans* and *C. crusei* were investigated. According to the findings, it was reported that it showed the highest effects against *P. aeruginosa, Shigella* sp., *L. monocytogenes, S. aureus* and *E. coli* (**Kaya *et al.*, 2008**). In a study reported from Algeria, the effects of essential oils of *O. basilicum* against *E. faecalis, S. aureus, S. epidermidis, E. avium, E. coli, P. aeruginosa, K. oxytoca, K.pneumoniae, P. mirabilis, Enterobacter* sp, *C. freundii, A. baumannices* and *P. alcalifaciens* were investigated. At the end of the study, it was reported that it showed the highest activity against *P. aeruginosa* (**Ouibrahim *et al.*, 2013**). Another study reported from Brazil investigated the antimicrobial activity of essential oils of *O. basilicum* against *E. faecalis, M.luteus, Sarcina* sp., *S. aureus, S. epidermidis, S.s mutans, Acinetobacter* sp., *Aeromonas* sp., *C.freundii, E.coli, K.pneumoniae, P.mirabilis, P. vulgaris, P. aeruginosa, S. choleraesuis, S. marcescens, S. flexneri,* and *Y. enterocolitica*. As a result of the study, it was reported that the highest activity was exhibited against Staphylococcus aureus (**Gaio *et al.*, 2015**). It has been reported that essential oils of *O. basilicum* reported from Ethiopia have antimicrobial activity against *E. coli, S. aureus, A. niger* and *R. bataticola* (**Gebrehiwot *et al.*, 2015**). It has been reported that essential oils of *O. basilicum* reported from Italy are effective against *B. cereus, S. aureus, E. faecalis, L. monocytogenes, E. coli, P. mirabilis, P. vulgaris, P.aeruginosa, S. typhi, E.cloaceae, E. aerogenes, Y. enterocolitica, K. pneumoniae, C. albicosacnica* and *A. flavus* (**Tenore *et al.*, 2017**). In a study reported from Turkey, essential oils of *O. basilicum* were reported to have a significant effect against *E. coli* and *S.aureus* (**Gürgan and Adiloğlu, 2021**). It has been reported that the methanol extract of *O. basilicum* reported from Pakistan is significantly effective against *C. defficile, B. subtilis, S. aureus, E. coli, S. typhi, K.pneumoniae, A. flavus, A.niger* and *C.albicans* (**Rubab *et al.*, 2021**). It has been reported that essential oils of *O. basilicum* collected from Vietnam have a low effect against *S. aureus, B. subtilis, L. fermentum, S. enterica, E. coli, P. aeruginosa* and *C.albicans* (**Chu *et al.*, 2022**). It has been reported that the antimicrobial activity of *O. forskolei* collected from Yemen was 4.3 mg/mL, 4.3 mg/mL and 8.6 mg/mL against *B. subtilis, S. aureus* and *C. albicans*, respectively (**Ali *et al.*, 2017**). It has been reported that essential oils of *O. gratissimum* collected from Brazil are effective against *S. aureus, S. flexineri, S. enteritidis, E. coli, Klebsiella sp., P. mirabilis* and *P. aeruginosa* (**Nakamura *et al.* 1999**). In a study reported from Nigeria, water extract of *O. gratissimum* was reported to be effective against *S.typhi* (0.001%), *S. typhimurium* (0.01%), *S. aureus* (0.1%) and *E.coli* (0.01%) **(Adebolu and Oladimeji, 2005)**. In a different study reported from Nigeria, essential oils of *O. gratissimum* were reported to be effective against *L.monocytogenes* at concentrations of 20-250 µg/ml (**Mbata and Saikia, 2005**). In a different study reported from Kenya, essential oils of *O. gratissimum* were reported to be effective at different concentrations against *E. coli, S. typhimurium, K. pneumoniae, P. mirabilis, P. aeruginosae, S. aureus* and *Bacillus* spp (**Matasyoh *et al.*, 2007**). In a different study reported from Nigeria, it was reported that essential oils of *O. gratissimum* and *O. bacilicum* showed 0.51-10% inhibition against *K. pneumonia, S. viridians, S. albus, P. aeruginosa* and *P. vulgaris* (**Ahonkhai *et al.*, 2009**). In a different study reported from Brazil, essential oils of *O. gratissimum* were reported to have significant effects against *E. faecalis, S.aureus* and *E. coli* (**Silva *et al.*, 2010**). In a different study reported from Nigeria, ethanol, methanol and water extracts of *O. gratissimum* were reported to be effective against *E.coli, S. typhi* and *K. pneumonia* (**Alo *et al.*, 2012**). In a study reported from India, it was reported to be effective against *E. coli* and *L.monocytogenes* at concentrations of 50-250 µg/ml (**Koche *et al.*, 2012**). In another study reported from India, essential oils of *O. gratissimum* and *O. sanctum* were reported to be effective at different concentrations against *S.aureus, S. epidermidis, S. faecalis, M. flavus, M. luteus, B. subtilis, E. coli, K.pneumoniae, S. marcescens, P. vulgaris, P. mirabilis, P. typhus, A. typhus* and *P.chrysogenum* (**Joshi, 2013**). In a study reported from Nigeria, *O. gratissimum* was reported to be effective against *P.mirabilis, S. pneumonia, S. aureus, P.aeruginosa, E.coli* and *Salmonella* species (**Omodamiro and Jimoh, 2015**). In a study reported from Benin, essential oils of *O. basilicum, O. canum* and *O. gratissimum* were reported to have significant effects against *L. monocytogenes* and *S. typhimurium* (**Mith *et al.*, 2016**). In a study reported from Brazil, essential oils of *O. gratissimum* were reported to be effective against *S. aureus* and *E.coli* (**Melo *et al.*, 2019**). In a study reported from Nigeria, it was reported that the ethanol extract of *O. gratissimum* had significant effects against *A. niger, A. flavus, G. candidum, T. viride, R. delemar* and *L. pseudotheobromae* at concentrations of 20, 40, 60, 80 and 100 mg/ml. (**Onaebi *et al.*, 2020**). In another study reported from Nigeria, it was reported that the essential oil of *O. kilimandscharicum* was effective against *B. subtilis, S. aureus, C. youagae, E. coli, Klebsiella* spp., *Micrococcus* spp., *Proteus* spp., *Pseudomonas* spp., *Salmonella* spp., *M. mucedo* and *R. stolonifer* at different concentrations (**Lawal *et al.*, 2014**). In a study reported from South Africa, it was reported that essential oils of *O. obovatum* had significant effects at different concentrations against *E. coli, S. aureus, K. pneumoniae, P. aeruginosa* and *P. mirabilis* (**Naidoo *et al.*, 2014**). According to the literature data, it is seen that Genus *Ocimum* species have significant effects against different microorganisms. In this context, it is thought that genus *Ocimum* species may be an important antimicrobial source.

Other activities

Apart from antioxidant and antimicrobial activity, it has been determined that genus *Ocimum* species have different activities in the literature. In these studies, it was reported that the ethanol extract of *O. africanum* collected from Thailand prevented gastric damage in a dose-dependent manner **(Bunwijit *et al.*, 2017**). For the anticholinesterase effect of *O. africanum* collected from Egypt, camphor was isolated from the essential oil of the plant. It has been reported that the obtained compound significantly reduces scopolamine-induced cognitive dysfunction (**Tadros *et al.*, 2014**). In a study reported from Poland, it was reported that the jasmonic acid component isolated from its essential oil of *O. basilicum* had a significant effect on the determination of the anticholinesterase activity (**Złotek *et al.*, 2020**). It has been reported that the species of *O. basilicum* collected from India has a larvicidal effect on *Culex quinquefasciatus* (**Sundararajan *et al.*, 2018**). In another study reported from Taylan, *Ocimum sanctum*, *O. basilicum* and *O. americanum* were reported to be effective against dichloromethane and methanol Herpes simplex virus-1 (HSV-2) and HSV-2 (**Yucharoen *et al.*, 2011**). It has been reported that essential oils of *O. basilicum* collected from North Sudan have antiproliferative effects on human breast carcinoma (MCF7) and human colon adenocarcinoma (HT29 and HCT116) cell lines (**Mohammed *et al.*, 2020**). In a study reported from Brazil, the larvicidal effects of essential oils of *O. campechianum* and *O. carnosum* on *Aedes aegypti* were reported to have LC50 values of 81.45±0.35 and 109.49 ± 0.35 µg/mL, respectively. Again in the same study, it was reported that *O. campechianum* and *O. carnosum* essential oils have cytotoxic effects on cervical adenocarcinoma (HEP-2) human cell lines, breast adenocarcinoma (MCF-7), lung carcinoma (NCI-H292) and pro-myelocytic leukemia (HL-60) (**Ricarte *et al.*, 2020**). In a study conducted in Saudi Arabia, it was reported that *O. forskolei* reduced paw edema status (40.77%) in rats in the anti-inflammatory effect of ethanolic extract (TEE). In addition, it has been reported that O. forskolei has an ulcer inhibition effect of 97% in different extract fractions in its antiulcer activity (**Zahran *et al.*, 2019; Zahran *et al.*, 2021**). In another study reported from Saudi Arabia, it was reported that *O. forskolei* showed a positive effect in the case of Diabetes mellitus (DM) in terms of ameliorative effect in methanol extract (**Khalil *et al.*, 2022**). In a study reported from Kenya, it was reported that *O. kenyense* and *O. kilimandscharicum* had antinociceptive effects in mice at doses of 100, 200, 400 and 800 (mg/kg Bwt) using the radiant tail-flick test (**Mwangi *et al.*, 2012**). In a study reported from Brazil, it was reported that *O. kilimandscharicum* has analgesic and anti-inflammatory effects in the paw edema model caused by carrageenan and joint inflammation (including knee edema, leukocyte infiltration, mechanical) caused by zymosan (**Dos Santos *et al.*, 2021**). In a study reported from India, it was reported that the aquatic extract of *O. kilimandscharicum* had antidiarrhoeal effects (**Sarin *et al.*, 2013**). In another study reported from India, it was reported that water extracts of *Ocimum kilimandscharicum*, *O. tenuiflorum* and *O. basilicum* had antidepressant effects (**Tewari *et al.*, 2015**). In a study reported from Kenya, it was reported that the essential oils of the leaves, flowers, or whole aerial parts of *O. kilimandscharicum* had larvicidal activity against Anopheles gambiae (**Ochola *et al.*, 2022**). In a study reported from Serbia, it was reported that the methanol extract of *O. minimum* had cytotoxic, apoptotic and antiproliferative effects on HCT116 colorectal carcinoma cells (**Jovankić *et al.*, 2022**). According to the literature data, it is seen that the biological activities of Genus *Ocimum* species are high. In this context, it is thought that it can be used as a natural product in different biological activities.

ESSENTIAL OIL CONTENT

There are various chemicals with biological effects that plants make naturally. In spite of their lack of nutritional value, these chemicals are critically useful in medicine. Identifying the plants' essential oil levels is crucial in this context due to the wide variety of applications for these oils. Table 3 displays the essential oil concentrations in the stems and aerial parts of *Ocimum* species.

Table 3 Essential oil contents of genus *Ocimum*

Plant species	Geographic regions	Used Parts	Essential oil contents	References
O. africanum Lour.	India, Thailand	Aerial parts	Citral (55.0–76.05%), (E)-γ-bisabolene (2.6–9.5%), nerol (1.7–36.08%), geraniol (1.5–33.4%), linalool (1.1–8.9%), β-caryophyllene (0.7–3.2%), α-humulene (0.4–3.5%),6-methyl-5-hepten-2-one (≤0.03–2.1%), (E)-caryophyllene (3.5-7.7%), germacrene D (5.5%), methyl chavicol (9.4%),	(**Pisutthanan and Pisutthanan, 2013; Lal *et al.*, 2017; Padalia *et al.*, 2018**)
O. basilicum L.	Turkey, Iran, Pakistan, Brazil, Egypt, Srpska Republika, Saudi Arabia, Iran, Guinea, South Africa	Aerial parts, stem	Methyl eugenol (1.0-78.02%), α-cubebene (6.17%), nerol (0.83%), ε-muurolene (0.74%), methyl chavicol (20.34-42.8%), geranial (2.60-27.6%), neral (12.2-18.5%), caryophyllene oxide (0.98-10.69%), estragole (11.3-60.88%), limonene (1.5-19.41%), p-cymene(0.38-2.40%), apiole (9.48%), exo-fenchyle acetate (6.14%), epi-α-cadinol (8.6–11.4%), α-bergamotene (3.0–9.2%), γ-cadinene (3.2–5.4%), linalool (1.7-86.80%), 1,8-cineol (0.4-12.2%), eugenol (2.40-26.43%), methyl cinnamate (6.2%), caryophyllene (0.42-5.70%), β-ocimene (2.1%), α-farnesene (2.0%), menthone (0.4–33.1 %), phytol (0.1–6.1 %), trans-β-farnesene (1.1–3.9 %), menthol (6.1%), isoneomathol (7.5 %), menthyl acetate (5.6 %), piperitone (3.7 %), α-cadinol (2.9–21.1 %), thymol (2%), 2, 6- octadienal (3.2–11.95%), phthalic acid (1.43–47.89%), 1,6-Octadien-3-ol (29.49%), β- linalool (9.12-72.59%), β-caryophyllene (7.2%)	(**Kéita *et al.*, 2000, Özcan and Chalchat, 2002; Carvalho-Filho *et al.*, 2006; Sajjadi, 2006; Chalchat and Özcan, 2008; Hussain *et al.*, 2008; Hassanpouraghdam *et al.*, 2010; Said-Al Ahl and Mahmoud, 2010; Abou El-Soud *et al.*, 2015; Rabbani *et al.*, 2015; Farouk *et al.*, 2016; Stanojevic *et al.*, 2017; Ladwani *et al.*, 2018; Falowo *et al.*, 2019; Fattahi *et al.*, 2019; Anwar *et al.*, 2021**)
O. campechianum Mill.	Colombia, Peru, Brazil, Ecuador	Aerial parts	Methyl eugenol (12.0%), germacrene D (10.1%), eugenol (9.0-72.1%), methyl eugenol (60.6–69.5%), 1,8-cineole (0.9- 39.0%), elemicin (0.2- 65.9%), β-elemene (6.8%), (E)-caryophyllene (6.4%), bicyclogermacrene (5.2%), dillapiole (48%)	(**Zoghbi *et al.*, 2007; Benitez *et al.*, 2009; Scalvenzi *et al.*, 2019; Ricarte *et al.*, 2020; Wilson *et al,*. 2022**)
O. carnosum (Spreng.) Link & Otto ex Benth.	Brazil	Aerial parts	Linalool (79.0%), α-epi-cadinol (5.4%), terpinen-4-ol (3.2%), 1,8-cineole (2.8%)	(**Ricarte *et al.*, 2020**)
O. dhofarense (Sebald) A.J.Paton	Oman	Aerial parts, stem	Germacrene D (41%), bicyclogermacrene (16.4%), germacrene B (13.7%)	(**Al-Harrasi *et al.*, 2021**)
O. forskolei Benth.	Yemen	Aerial parts	Endo-fenchol (31.1%), fenchone (12.2%), τ-cadinol (12.2%), methyl (E)-cinnamate (5.1%)	(**Ali *et al.*, 2017**)
O. gratissimum L.	India, Kenya, Vietnam, Algeria, Turkey, Colombia, Togo, Brazil	Aerial parts	Methyl cinnamate (48.29%), γ-terpinene (26.08%), eugenol (7.87-77.389%), methyl eugenol (13.21%), cis-ocimene (7.47%), trans-ocimene (0.94%), -pinene (1.10%),camphor (0.95%), germacrene D (4.25-31.4%), trans-caryophyllene (1.69-4.10%), arnesene (0.85%), bisabolene (0.74%), ocimene <(Z) -b-> (7.20%-8.67%), caryophyllene <E-> (6.64-9.0%), β-elemene (10.9 %), 1,8 cineole (4.1 %-32.70%), α-humulene (3.8 %) linalool (2.1 %) and α-amorphene (2.1 %), thymol (31.79–58.2%), β-selinene (4.0-9.0%), α-copaene (8.48 %), caryophyllene oxide (7.03 %), p-cymene (15.57 %), terpinene (12.34 %), myrcene (6.94 %), thujene (6.11 %)	(**Yusuf *et al.*, 1998; Lahlou *et al.*, 2004; Benitez *et al.*, 2009; Koba *et al.*, 2009; Brada *et al.*, 2011; Prakash *et al.*, 2011; Matasyoh *et al.*, 2007; Anh *et al.*, 2019; Bisht *et al.*, 2019; Kumar *et al.*, 2019; Dung *et al.*, 2021**)
O. kilimandscharicum Gürke	Nigeria, Kenya, India	Aerial parts	Methyl eugenol(40.4-53.9%), borneol (11.9%) ,linalool (10.6-91%), γ-cadinene (16.2%), camphor (47.1-57.2%), 1.8-cineole (14.8%-22.2%), limonene (5.5-5.6%)	(**Kumar *et al.*, 2009; Lawal *et al.*, 2014; Chaturvedi *et al.*, 2018; Essoung *et al.*, 2020**)
O. minimum L.	Turkey, Australia	Aerial parts	Eugenol (4.8-8.37%), germacrene D (3.94–6.04%), γ-cadinene (3.51–5.47%), δ-cadinene (2.39–4.48%), 1,8-cineole(13.38 -14.65%), linalool (52-54%)	(**Zabaras and Wyllie, 2001; Telci *et al.*, 2009**)
O. obovatum E.Mey. ex Benth.	South Africa	Aerial parts	Phytol (21.46 %); 2-isopropyl-5-methyl-9-methylene-bicyclo[4.4.0]dec-1-ene (8.2 %); n-hexadecanoic acid (7.4 %); 6,10,14-trimethyl 2-pentadecanone (5.2 %), phthalic acid (5.2 %); dibutyl phthalate (4.5 %); 2,6-lutidine-N-oxide(3.4 %) and 2- (1,1-dimethylethyl)-1,4-dimethoxy-benzene (3.1 %)	(**Naidoo *et al.*, 2014**)

Essential oil contents of different *Ocimum* species have been reported in the literature. In this context, it has been reported that the main components in the essential oil content of *O. africanum* species are citral (55.0–76.05%), (E)-γ-bisabolene (2.6–9.5%), nerol (1.7–36.08%), geraniol (1.5–33.4%), linalool (1.1–8.9%), β-caryophyllene (0.7–3.2%), α-humulene (0.4–3.5%),6-methyl-5-hepten-2-one (≤0.03–2.1%), (E)-caryophyllene (3.5-7.7%), germacrene D (5.5%) ve methyl chavicol (9.4%) (**Pisutthanan and Pisutthanan, 2013; Lal *et al.*, 2017; Padalia *et al.*, 2018**). It has been reported that the main components in the essential oil content of *O. basilicum* species are between methyl eugenol (1.0-78.02%), α-cubebene (6.17%), nerol (0.83%), ε-muurolene (0.74%), methyl chavicol (20.34-42.8%), geranial (2.60-27.6%), neral (12.2-18.5%), caryophyllene oxide (0.98-10.69%), estragole (11.3-60.88%), limonene (1.5-19.41%), p-cymene (0.38-2.40%), apiole (9.48%), exo-fenchyle acetate (6.14%), epi-α-cadinol (8.6–11.4%), α-bergamotene (3.0–9.2%), γ-cadinene (3.2–5.4%), linalool (1.7-86.80%), 1,8-cineol (0.4-12.2%), eugenol (2.40-26.43%), methyl cinnamate (6.2%), caryophyllene (0.42-5.70%), β-ocimene (2.1%), α-farnesene (2.0%), menthone (0.4–33.1 %), phytol (0.1–6.1 %), trans-β-farnesene (1.1–3.9 %), menthol (6.1 %), isoneomathol (7.5 %), menthyl acetate (5.6 %), piperitone (3.7 %), α-cadinol (2.9–21.1 %), thymol (2%), 2, 6- octadienal (3.2–11.95%), phthalic acid (1.43–47.89%), 1,6-octadien-3-ol (29.49%), β- linalool (9.12-72.59%) and β-caryophyllene (7.2%) values and values (**Kéita *et al.*, 2000, Özcan and Chalchat, 2002; Carvalho-Filho *et al.*, 2006; Sajjadi, 2006; Chalchat and Özcan, 2008; Hussain *et al.*, 2008; Hassanpouraghdam *et al.*, 2010; Said-Al. Ahl and Mahmoud, 2010; Abou El-Soud *et al.*, 2015; Rabbani *et al.*, 2015; Farouk *et al.*, 2016; Stanojevic *et al.*, 2017; Ladwani *et al.*, 2018; Falowo *et al.*, 2019; Fattahi *et al.*, 2019; Anwar *et al.*, 2021**). It has been reported that the main components in the essential oil content of *O. campechianum* species are methyl eugenol (12.0%), germacrene D (10.1%), eugenol (9.0-72.1%), methyl eugenol (60.6–69.5%), 1,8-cineole (0.9- 39.0%), elemicin (0.2- 65.9%), β-elemene (6.8%), (E)-caryophyllene (6.4%), bicyclogermacrene (5.2%) and dillapiole (48%) (**Zoghbi *et al.*, 2007; Benitez *et al.*, 2009; Scalvenzi *et al.*, 2019; Ricarte *et al.*, 2020; Wilson *et al.*, 2022**). It has been reported that the main components in the essential oil content of *O. carnosum* species are linalool (79.0%), α-epi-cadinol (5.4%), terpinen-4-ol (3.2%) and 1,8-cineole (2.8%) (**Ricarte *et al.*, 2020**). It has been reported that the main components in the essential oil content of *O. dhofarense* species are germacrene D (41%), bicyclogermacrene (16.4%) and germacrene B (13.7%) (**Al-Harrasi *et al.*, 2021**). It has been reported that the main components of the essential oil content of *O. forskolei* species are endo-fenchol (31.1%), fenchone (12.2%), τ-cadinol (12.2%) and methyl (E)-cinnamate (5.1%) (Ali et al., 2017). It has been reported that the main components in the essential oil content of *O. gratissimum* species are between methyl cinnamate (48.29%), γ-terpinene (26.08%), eugenol (7.87-77.389%), methyl eugenol (13.21%), cis-ocimene (7.47%), trans-ocimene (0.94%), -pinene (1.10%),camphor (0.95%), germacrene D (4.25-31.4%), trans-caryophyllene (1.69-4.10%), arnesene (0.85%), bisabolene (0.74%), ocimene <(Z) -b-> (7.20-8.67%), caryophyllene <E-> (6.64-9.0%), β-elemene (10.9 %), 1,8 cineole (4.1-32.70%), α-humulene (3.8 %) linalool (2.1 %) and α-amorphene (2.1 %), thymol (31.79–58.2%), β-selinene (4.0-9.0%), α-copaene (8.48 %), caryophyllene oxide (7.03 %), p-cymene (15.57 %), terpinene (12.34 %), myrcene (6.94 %) and thujene (6.11%) (**Yusuf *et al.*, 1998; Lahlou *et al.*, 2004; Benitez *et al.*, 2009; Koba *et al.* 2009; Brada *et al.*, 2011; Prakash *et al.*, 2011; Matasyoh *et al.*, 2007; Anh *et al.*, 2019; Bisht *et al.*, 2019; Kumar *et al.*, 2019; Dung *et al.*, 2021**). The main components in the essential oil content of *O. kilimandscharicum* species are methyl eugenol (40.4-53.9%), borneol (11.9%), linalool (10.6-91%), γ-cadinene (16.2%), camphor (47.1-57.2%), 1.8 -cineole (14.8-22.2%) and limonene (5.5-5.6%) have been reported to be between values and values (**Kumar *et al.*, 2009; Lawal *et al.*, 2014; Chaturvedi *et al.*, 2018; Essoung *et al.*, 2020**). The main components of the essential oil content of *O. minimum* type; eugenol (4.8-8.37%), germacrene D (3.94–6.04%), γ-cadinene (3.51–5.47%), δ-cadinene (2.39–4.48%), 1,8-cineole (13.38-14.65%), and linalool (52-54%) values were reported (**Zabaras and Wyllie, 2001; Telci *et al.*, 2009**). It has been reported that the main components in the essential oil content of *O. obovatum* species are phytol (21.46%), 2-isopropyl-5-methyl-9-methylene- bicyclo[4.4.0]dec-1-ene (8.2 %), n-hexadecanoic acid (7.4 %), 6,10,14-trimethyl 2-pentadecanone (5.2 %), phthalic acid (5.2 %), dibutyl phthalate (4.5 %), 2,6-lutidine-N-oxide(3.4 %) and 2- (1,1-dimethylethyl)-1,4-dimethoxy-benzene (3.1%) (**Naidoo *et al.*, 2014**). According to the literature data, it is thought that the Genus *Ocimum* species may be an important natural resource in terms of the essential oil contents determined in its body.

CONCLUSION

Literature material was used to assemble this study's findings on the biological activity, nutritional, mineral, and essential oil content of species in the genus *Ocimum*. Evidence suggests that this plant might be a significant contributor to the supply of essential oils now on the market. It is also a crucial source of vitamins and minerals. As an added bonus, it has been established that genus *Ocimum* species are reliable natural sources, particularly for their antioxidant and antibacterial properties. Therefore, plants of the genus *Ocimum* have been recognised as potential medicinal resources.

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