

# Phytotherapeutic and Therapeutic Applications of *Ocimum gratissimum*: Insights from 2020 to 2024, An Integrative Literature Review

## ABSTRACT

**Aims:** This article examines the medicinal and therapeutic applications of *Ocimum gratissimum*, focusing on studies conducted between 2020 and 2024. The review aims to highlight the plant's therapeutic properties, potential applications, and future prospects for the development of new drugs.

**Study design:** Integrative literature review of recent scientific publications on *O. gratissimum*.

**Place and Duration of Study:** The study covers research conducted worldwide, with a particular focus on studies published between 2020 and 2024.

**Methodology:** Relevant literature was collected from scientific databases, analyzing studies that investigated the bioactive compounds, medicinal properties, and therapeutic applications of *O. gratissimum*. The review included in vitro, in vivo, and in silico studies.

**Results:** *O. gratissimum*, a bushy and highly aromatic plant from the Lamiaceae family, is rich in bioactive compounds such as eugenol and thymol. The plant has demonstrated efficacy in treating bacterial, fungal, and parasitic infections. Its applications include use as a bronchodilator, antiseptic, analgesic, anti-inflammatory, and healing agent. The evidence also highlights its accessibility and low cost, particularly in tropical regions where natural remedies are widely employed.

**Conclusion:** The findings indicate that *O. gratissimum* offers effective and safe alternatives for contemporary medicine. Its therapeutic potential and bioactive compounds support its use in combating infectious and pathogenic diseases, providing a basis for the development of novel pharmacological treatments.

**Keywords:** *Ocimum gratissimum*; Traditional medicines; Bioactive properties; Alternative treatments.

## 1. INTRODUCTION

The use of medicinal plants in human health is a widely recognized practice, both in traditional medicine systems and in scientific research. This approach has gained increasing relevance due to the growing resistance of pathogenic microorganisms to conventional drugs, as well as the search for natural and economically viable therapeutic alternatives for the population. Tropical regions, in particular, exhibit rich biodiversity that provides a wide variety of species with medicinal potential, establishing medicinal plants as essential resources for the development of new treatments [1].

Among medicinal plants, *Ocimum gratissimum* Linnaeus stands out, popularly known as clove basil, African basil, or simply basil. Belonging to the Lamiaceae family, this species is widely used in traditional practices across Africa, Asia, and Latin America. Recognized for its aromatic and medicinal properties, *O. gratissimum* plays a significant role in human health and is used as a natural flavoring agent, condiment, or vegetable in the preparation of fish, meat, soups, and stews [2].

The therapeutic properties of *O. gratissimum* are associated with its chemical composition, which is rich in bioactive compounds such as eugenol, thymol, geraniol, and

other monoterpenes. These compounds, present in its essential oils and extracts, exhibit a wide range of bioactivities useful for the treatment of various diseases, including cough, pneumonia, fever, inflammation, anemia, diarrhea, pain, and fungal and bacterial infections [3].

Essential oils are complex and volatile mixtures of natural compounds, generally obtained by steam distillation or solvent extraction from the aromatic parts of plants, such as leaves, flowers, bark, roots, or fruits. These oils are responsible for the characteristic aroma of plant species and play important ecological roles, such as defense against herbivores and microorganisms, as well as the attraction of pollinators [4].

Chemically, the major constituents of essential oils primarily belong to the classes of terpenoids and phenylpropanoids. Terpenoids, such as thymol and geraniol, are derived from the isoprene pathway ( $C_5H_8$ ) and are formed by the condensation of isoprene units, giving rise to structures such as monoterpenes ( $C_{10}H_{16}$ ) and sesquiterpenes ( $C_{15}H_{24}$ ). Phenylpropanoids, such as eugenol, are derived from the shikimic acid pathway, originating from the amino acid phenylalanine, and feature an aromatic ring attached to a three-carbon side chain [5].

Between 2020 and 2024, studies have advanced in identifying its immunomodulatory properties, its efficacy in treating infectious diseases, and its relevance as an alternative to conventional drugs. These findings reinforce the importance of this plant as an accessible and low-cost therapeutic resource. The growing preference for using herbal medicines over conventional drugs can be attributed to the effectiveness of the active ingredients present in phytotherapy as natural healing agents, as well as their availability, accessibility, and widely recognized lower or non-toxic effects [6].

The clinical applicability of *O. gratissimum* and its future prospects have generated significant interest in academic and pharmacological fields. In addition to its efficacy against resistant pathogens, studies highlight its potential as a phytotherapeutic agent for the treatment of neglected diseases. Moreover, over the past decade, medicinal plants and their bioactive compounds have attracted the attention of numerous researchers due to their usefulness in the management and prevention of chronic and life-threatening diseases [7,8]. Thus, this article aims to analyze the medicinal use of *O. gratissimum* between 2020 and 2024, with an emphasis on its therapeutic properties and clinical applications. It intends to highlight the main scientific findings on this plant, its relevance in combating antimicrobial and antiparasitic resistance, as well as the prospects for the development of innovative drugs based on its bioactive compounds.

## **2. METHODOLOGY**

### **2.1 Type of Research**

This study is an integrative literature review, serving as a tool for obtaining, identifying, analyzing, and synthesizing publications.

### **2.2 Research Setting**

The databases used for the selection of texts were accessed through virtual platforms such as ScienceDirect, SciELO, PubMed, Google Scholar, Litmaps, and Science.gov, using the following descriptors: "*Ocimum gratissimum*", "*O. gratissimum*", "Medicinal properties of *Ocimum gratissimum*" and "Therapeutic applications of *O. gratissimum*". Accordingly, the

selected studies were carefully read and chosen to support the scientific construction of this study.

### **2.3 Inclusion Criteria**

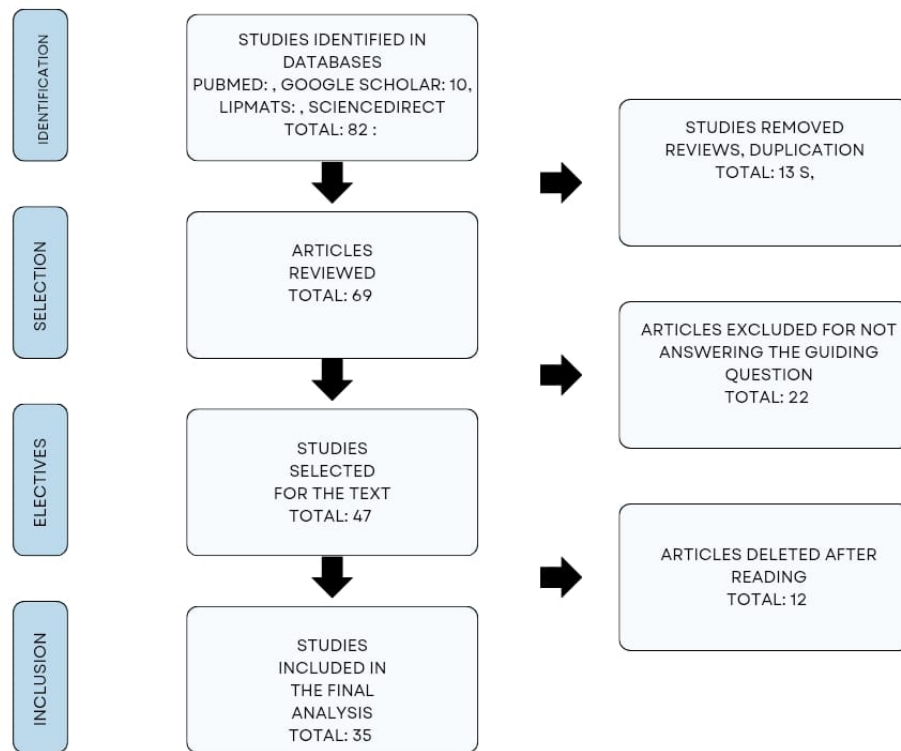
The selection of articles for this integrative review followed specific criteria to ensure the relevance and quality of the sources analyzed. Studies published between 2020 and 2024 were included, reflecting recent innovations and emerging discoveries about *O. gratissimum*. Only articles reporting clinical, laboratory, and experimental studies were considered, as these types of research provide a solid scientific evidence base with well-defined methodology and comparable results. The choice of articles addressing the bioactive properties of *O. gratissimum* and its medicinal applications for diseases caused by pathogens is essential to understand the therapeutic potential of the plant in combating infectious diseases.

### **2.4 Exclusion Criteria**

Initially, a strict filter was applied to exclude articles that, despite meeting the publication year criteria, were literature reviews. Another important exclusion criterion was the presence of articles with insufficient or inconsistent data. Studies that did not provide adequate information about the plant's medicinal properties or presented data inconsistencies were discarded. This step is crucial to maintain the integrity of the research and ensure that the conclusions drawn are based on solid and relevant data. Thus, the careful exclusion of articles guaranteed the quality and accuracy of the integrative review, focusing only on the most robust scientific evidence pertinent to the proposed topic.

### **2.5 Data Collection and Analysis**

Data collection followed established academic norms, and the selected articles were properly referenced, covering the period from 2020 to 2024. The analysis of the collected materials was based on identifying sufficient elements to achieve the study's objectives. The research utilized the databases SciELO, PubMed, Google Scholar, Science.gov, and Litmaps. A total of 82 articles were analyzed, and 47 were excluded for not addressing the guiding research question or failing to meet the inclusion criteria.



**Figure 1.** Flowchart of the stages of the article selection process

### 3. RESULTS AND DISCUSSION

The table 1 presents a selection of scientific articles addressing the medicinal and therapeutic applications of *O. gratissimum* as a basis for the treatment of various pathologies, analyzing publications from 2020 to 2024. The studies include different methodologies, such as *in vitro*, *in vivo*, and *in silico* approaches. A variety of organisms were studied, including parasites, fungi, bacteria, and other models used for clinical and pharmacological testing, such as rats and mice. The research identified several ways of applying *O. gratissimum*, either through leaf extracts or essential oil, for the treatment of pathologies, as well as its use in managing diseases such as cancer and diabetes.

**Table 1.** Distribution of the selected articles according to authors, year of publication, research location, use of *O. gratissimum*, therapeutic properties and applicability, type of study, and the organism, cell, or molecule investigated.

ARTICLES / CRITERIA	Reference	Country of publication	Study material	Therapeutic properties/Applicability	Type of Study	Organism/Cell/Molecule studied
Effect of extraction temperature and solvent type on the bioactive potential of <i>Ocimum gratissimum</i> L. extracts	[9]	Türkiye	Leaf extract	Antibacterial Activity	<i>In vitro</i>	<i>S. typhimurium</i> and two strains of gram-positive bacteria, <i>B. cereus</i>
Essential oil of <i>Ocimum gratissimum</i> (Linnaeus, 1753): efficacy for anesthesia and transport of <i>Oreochromis niloticus</i>	[10]	Brazil	Essential oil	Anesthetic	<i>In vitro</i>	<i>Oreochromis niloticus</i>
<i>In vitro</i> and <i>in vivo</i> efficacy of poly (lactic acid) nanofiber packaging containing essential oils from <i>Ocimum basilicum</i> L. and <i>Ocimum gratissimum</i> L. against <i>aspergillus carbonarius</i> and	[11]	Brazil	Essential oil	Antifungal and antiochratoxic activity	<i>In vitro</i> and <i>in vivo</i>	<i>Aspergillus carbonarius</i> and <i>Aspergillus niger</i>

*Aspergillus niger* in table grapes

The use of *Ocimum gratissimum* L. essential oil during the transport of *Lophiosilurus alexandri*: water quality, hematology, blood biochemistry and oxidative stress

[12] Brazil Essential oil Anesthetic and antioxidant used for animal transport *In vivo* *Lophiosilurus alexandri*

Essential oil of *Ocimum gratissimum* (Linnaeus, 1753) as anesthetic for *Lophiosilurus alexandri*: Induction, recovery, hematology, biochemistry and oxidative stress

[13] Brazil Essential oil Anesthetic *In vivo* *Lophiosilurus alexandri*

The effects of aqueous extract of *Ocimum gratissimum* on the cerebellum of male Wistar rats challenged by lead acetate

[14] Nigeria Aqueous extract of leaves Treatment of neurodegenerative diseases *In vivo* Wistar rat

*Ocimum gratissimum* leaf extract

[3] Nigeria Leaf extract Restorative effect on metabolic distortions *In vivo* Wistar rat

ameliorates phenylhydrazine-induced anaemia and toxicity in Wistar rats

*Ocimum gratissimum* enhances insulin sensitivity in male Wistar rats with dexamethasone-induced insulin resistance

Reversal of mitochondrial permeability transition pore and pancreas degeneration by chloroform fraction of *Ocimum gratissimum* (L.) leaf extract in type 2 diabetic rat model

Aqueous *Ocimum gratissimum* extract induces cell apoptosis in human hepatocellular carcinoma cells

Aqueous extracts of *Ocimum gratissimum* sensitize

[15]

Nigeria

Leaf extract

Reduces the accumulation of liver fat

*In vivo*

Wistar rat

[16]

Nigeria

Chlorophoric extract of leaves

Antidiabetic and tissue regeneration potentials

*In vivo*

Wistar rat

[17]

Taiwan

Aqueous leaf extract

Antitumor activity

*In vitro*

Hepatocellular carcinoma cells

[18]

China

Aqueous leaf extract

Antitumor activity

*In vitro*

Hepatocellular carcinoma cells

hepatocellular carcinoma cells to cisplatin through brca1 inhibition

Network pharmacology based anti-diabetic attributes of bioactive compounds from *Ocimum gratissimum* L. through computational approach

Anti-schistosoma efficacy of *Ocimum gratissimum* (scent leaf) and *andrographis paniculata* (king of bitters) against *Schistosoma haematobium* cercaria

*Ocimum gratissimum* L. leaf flavonoid-rich extracts reduced the expression of p53 and vcam in streptozotocin-induced cardiomyopathy rats

[19]

India

Main compounds present in the plant

Anti-diabetic

*In silico*

Diabetes Mellitus Protein Molecules

[20]

Nigeria

Aqueous leaf extract

Anti-schistosomiasis

*In vivo*

*Schistosoma haematobium*

[21]

Nigeria

Flavonoid-rich extracts from leaves

Treatment of diabetes-induced cardiomyopathy

*In vivo*

Wistar rats

Antimicrobial Effect of *Ocimum gratissimum* L. Essential Oil on *Shewanella putrefaciens*: Insights Based on the Cell Membrane and External Structure

[22]

China

Essential oil

Disrupts membrane integrity

*In vivo*

*Shewanella putrefaciens*

Investigating the antibacterial, antioxidant, and anti-inflammatory activities of aqueous and hydroethanolic extracts of *Ocimum basilicum* and *Ocimum gratissimum* on some germs responsible for aerobic vaginitis

[23]

Cameroon

Aqueous and hydroethanolic extracts of leaves

Antibacterial, antioxidant and anti-inflammatory

*In vivo*

*Aerobic vaginitis*

Anaesthetic effect of clove basil (*Ocimum gratissimum* L.) essential oil on the giant river prawn (*Macrobrachium rosenbergii*, De Man 1879) exposed to different water pHs

[24]

Brazil

Essential oil

Sedatives and anesthetics

*In vivo*

*Macrobrachium rosenbergii*

Inhibition of anthracnose symptoms in common bean by treatment of seeds with essential oils of *Ocimum gratissimum* and *Syzygium aromaticum* and eugenol

[25]

Brazil

Essential oil

Antifungal

*In vivo*

*C. lindemuthianum*

Molecular docking, MM GBSA, and ADMET studies of phytoconstituents of *Ocimum gratissimum* on multiple breast cancer targets

[26]

Nigeria

Phytochemicals present in the plant

Antitumor activity

*In silico*

Breast cancer cells

Mitigation of arsenic poisoning induced oxidative stress and genotoxicity by *Ocimum gratissimum* L.

[27]

India

Leaf extract

Treatment of chronic diseases

*In vivo*

*Oryctolagus cuniculus*

Essential oils of *Ocimum gratissimum*, *Lippia grata* and *Lippia origanoides* are effective in the control of the acanthocephalan *Neoechinorhynchus*

[28]

Brazil

Essential oil

Antiparasitic

*In vivo*

*Neoechinorhynchus buttnerae*

*buttnerae* in  
*Colossoma*  
*macropomum*

Identification of  
neurotherapeutic  
constituents in  
*Ocimum gratissimum*  
with cholinesterase  
and monoamine  
oxidase inhibitory  
activities, using gc-  
ms analysis, *in vitro*,  
and *in silico*  
approaches

[29]

Nigeria

Methanolic  
extract of  
leaves

Neurotherapeutic activity

*In vitro*

Cholinesterase and  
monoamine oxidase

Effects of co-  
treatment of  
plasmodium berghei-  
infected mice with  
aqueous extract of  
*Ocimum gratissimum*  
leaves and  
primaquine on  
glucose-6-phosphate  
dehydrogenase  
activity,  
hematological, and  
antioxidant  
parameters

[30]

Nigeria

Aqueous leaf  
extract

Antiparasitic

*In vivo*

*Plasmodium berghei*

UNDER PEER REVIEW

Essential oils of *Ocimum gratissimum* and *Zingiber officinale* as anesthetics for the South American catfish *Pseudoplatystoma reticulatum*

[25]

Brazil

Essential oil

Anesthetic

*In vivo*

*Pseudoplatystoma reticulatum*

*In vitro* antibacterial and antifungal potentials of *Ocimum tenuiflorum* and *Ocimum gratissimum* essential oil

[31]

India

Essential oil

Antibacterial

*In vitro*

*E. coli*, *K. pneumonia*, *S. aureus* and *C. albicans*

Evaluation of Antibacterial Effects of an Oral Rinse Containing *Ocimum tenuiflorum* and *Ocimum gratissimum* on *Streptococcus mutans* and *Lactobacillus Species*

[32]

India

Aqueous leaf extract

Antibacterial

*In vitro*

*Streptococcus mutans* e *Lactobacillus Species*

Green Synthesis of Silver Nanoparticles Using Zingiber officinale and *Ocimum gratissimum* Formulation for Its Anti-inflammatory and Antidiabetic Activity: An *In Vitro* Study

[33]

India

Herbal formulations

Anti-inflammatory and anti-diabetic

*In vitro*

Bovine serum albumin (BSA) denaturation assay and egg albumin (EA) denaturation assay

Amoebicidal activity of essential oils and essential oil-based microemulsions of *Aloysia citrodora* Ortega ex Pers., *Cymbopogon winterianus* Jowitt ex Bor, and *Ocimum gratissimum* L. against *Acanthamoeba polyphaga* trophozoites

[34]

Brazil

Essential oil

Antiparasitic

*In vitro*

*Acanthamoeba polyphaga* trophozoites

Polyphenol-rich extract of *Ocimum gratissimum* leaves prevented toxic effects of cyclophosphamide on the kidney function of Wistar rat

[35]

Nigeria

Leaf extract

Prevented kidney injury and improved kidney function

*In vivo*

Rato *Wistar*

*In Vitro* Tests for a Rapid Evaluation of Antidiabetic Potential of Plant Species Containing Caffeic Acid Derivatives: A Validation by Two Well-Known Antidiabetic Plants, *Ocimum gratissimum* L. Leaf and *Musanga cecropioides* R. Br. ex Tedlie (Mu) Stem Bark

[36] France Leaf extract Increased insulin secretion and insulin sensitivity *In vitro* INS-1 cells

Dietary supplementation of *Ocimum gratissimum* improves growth performance and immune response in broilers under high ambient temperature

[37] Taiwan Leaf extract Improved development of digestive organs and increased carcass mass and average weight gain of birds *In vivo* Poultry

Aqueous extracts of *Ocimum gratissimum* mitigate colitis and protect against AOM/DSS-induced colorectal cancer in mice

[38] Taiwan Aqueous leaf extract Antitumor activity *In vivo* Mice

UNDER PEER REVIEW

Optimization of microwave-assisted extraction of phenolic compounds from *Ocimum gratissimum* leaves and its LC-ESI-MS/MS profiling, antioxidant and antimicrobial activities

[39]

Nigeria

Leaf extract

Antioxidant and antibacterial

*In vitro*

Bacteria

Antifungal Activity of *Ocimum tenuiflorum* and *Ocimum gratissimum* Herbal Formulation-Based Oral Rinse Against *Candida albicans*

[40]

India

Herbal formulations

Antifungal

*In vitro*

*Candida albicans*

Polymyxin combined with *Ocimum gratissimum* essential oil: one alternative strategy for combating polymyxin-resistant *Klebsiella pneumoniae*

[41]

Brazil

Essential oil

Antibacterial

*In vivo*

*Caenorhabditis elegans*

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Of the 35 selected articles, studies were conducted in various countries, including Turkey, Taiwan, Brazil, India, Nigeria, China, Cameroon, and France, with Nigeria accounting for the highest number of publications at 31.43%. Table 1 provides a detailed overview of the authors, year of publication, research location, use of *O. gratissimum*, therapeutic properties and medicinal applications, type of study, and the organism, cell, or molecule investigated.

In terms of temporality, the analyzed articles were published between 2020 and 2024. The year 2024 recorded the highest number of publications, totaling 12 studies, followed by 2023 with 8, 2020 with 6, 2021 with 5, and 2022 with 4 articles.

The results highlight the importance of discussing the various factors influencing the use of *O. gratissimum* in human and veterinary medicine, demonstrating the complexity involved in its care and application. The analyzed themes allowed the integration of the obtained data with existing literature, deepening the understanding of the medicinal use of *O. gratissimum*.

The studies reported several therapeutic activities, including: potential to combat infections caused by multidrug-resistant bacteria, strong antifungal activity against *Candida albicans*, antiparasitic effects, anti-ochratoxigenic activity, reduction of oxidative stress and DNA polymorphism, significant decrease in tumor burden and number of tumors, notable anticancer properties against breast cancer cells, potential antidiabetic effects, and tissue regeneration capabilities.

Regarding the forms of plant use, most studies (51.43%) focused on extracts, while essential oils were used in 34.29% of the studies. Among the extracts, leaf extract was the most employed, reported in five studies. Other extracts, including aqueous, methanolic, hydroethanolic, crude aqueous, chloroform leaf extracts, or flavonoid- and phytochemical-rich extracts, were cited in only one study each. Additionally, other methods of use accounted for 14.29% of the publications, including powdered dried leaves (1 study), fresh leaves (1 study), main chemical compounds of the plant (1 study), and herbal formulations (2 studies). This diversity of approaches highlights the wide range of therapeutic and medicinal possibilities offered by *O. gratissimum*.

#### 4. CONCLUSION

In light of the increasing use of herbal medicines and the search for new therapies to alleviate and treat symptoms, knowledge of the medicinal properties of *O. gratissimum* becomes highly relevant. The research and compilation of information conducted in this study indicate that this species has a wide range of well-documented medicinal uses, supported by reliable evidence.

Literature analysis revealed that the secondary metabolites of basil (*O. gratissimum*) are primarily responsible for the reported therapeutic effects, highlighting its potential in pharmacological and alternative treatments, particularly for inflammatory, infectious, and wound-healing processes. Despite the evidence presented, further studies both clinical and bibliographic are necessary to strengthen ethnobotanical and phytotherapeutic research in Brazil.

Therefore, it is essential to promote research that quantifies and systematizes the use of this plant in both human and veterinary clinical contexts, demonstrating the vast therapeutic potential of *O. gratissimum* and supporting its safe and effective application in medical practice.

## REFERENCES

1. Stehmann JR, Sobral M. Pharmacognosy: from natural product to medicine. Biodiversity in Brazil. 2017.
2. Dos Santos JPC, Rodrigues H de CM, Resende HE, Barbosa BB, Rosa LP de A, Nominato LT. *Ocimum gratissimum* Lineu: A review of its pharmacological effects and medicinal uses. *Brazilian J Heal Rev* [Internet]. 2021 Dec 22;4(6):28716–32. Available from: <https://brazilianjournals.com/ojs/index.php/BJHR/article/view/41743>
3. Akara EU, Emmanuel O, Ude VC, Uche-Ikonne C, Eke G, Ugbogu EA. *Ocimum gratissimum* leaf extract ameliorates phenylhydrazine-induced anemia and toxicity in Wistar rats. *Drug Metab Pers Ther* [Internet]. 2021 Apr 9; Available from: <https://www.degruyter.com/document/doi/10.1515/dmdi-2020-0185/html>
4. Souza EM de, Santos PHC, Peixoto AR, Coccozza FDM, Carneiro Neto TF de S. ESSENTIAL OILS FROM MEDICINAL PLANTS: *Rev Bras Agroecol* [Internet]. 2020 Nov 27;15(4):13. Available from: <https://periodicos.unb.br/index.php/rbagroecologia/article/view/50147>
5. Masyita A, Mustika Sari R, Dwi Astuti A, Yasir B, Rahma Rumata N, Emran T Bin, et al. Terpenes and terpenoids as main bioactive compounds of essential oils, their roles in human health and potential application as natural food preservatives. *Food Chem X* [Internet]. 2022 Mar;13:100217. Available from: <https://linkinghub.elsevier.com/retrieve/pii/S2590157522000153>
6. Ikpeazu VO, Ugbogu EA, Emmanuel O, Uche-Ikonne C, Okoro B, Nnaemeka J. Evaluation of the safety of oral intake of aqueous extract of *Stigma maydis* (corn silk) in rats. *Acta Sci Pol Technol Aliment* [Internet]. 2018 Dec 30;17(4):387–97. Available from: <http://www.food.actapol.net/volume17/issue4/abstract-9.html>
7. Sofowora A, Ogunbodede E, Onayade A. The role and place of medicinal plants in the strategies for disease prevention. *African J Tradit Complement Altern Med* [Internet]. 2013 Aug 14;10(5). Available from: <http://www.ajol.info/index.php/ajtcam/article/view/92333>
8. WHO. WHO global report on traditional and complementary medicine 2019 [Internet]. World Health Organization, editor. 2019. 226 p. Available from: <https://www.who.int/publications/i/item/978924151536>
9. Onyebuchi C, Kavaz D. Effect of extraction temperature and solvent type on the bioactive potential of *Ocimum gratissimum* L. extracts. *Sci Rep* [Internet]. 2020 Dec 10;10(1):21760. Available from: <https://www.nature.com/articles/s41598-020-78847-5>
10. Ferreira AL, Favero GC, Boaventura TP, de Freitas Souza C, Ferreira NS, Descovi SN, et al. Essential oil of *Ocimum gratissimum* (Linnaeus, 1753): efficacy for anesthesia and transport of *Oreochromis niloticus*. *Fish Physiol Biochem* [Internet]. 2021 Feb 16;47(1):135–52. Available from: <http://link.springer.com/10.1007/s10695-020-00900-x>
11. Magalhães Brandão R, Roberto Batista L, Elvis de Oliveira J, Bispo Barbosa R, Lee Nelson D, Graças Cardoso M. In vitro and in vivo efficacy of poly(lactic acid) nanofiber packaging containing essential oils from *Ocimum basilicum* L. and *Ocimum gratissimum* L. against *Aspergillus carbonarius* and *Aspergillus niger* in table grapes. *Food Chem* [Internet]. 2023 Jan;400:134087. Available from: <https://linkinghub.elsevier.com/retrieve/pii/S0308814622020490>
12. Boaventura TP, Souza CF, Ferreira AL, Favero GC, Baldissera MD, Heinzmann BM, et al. The use of *Ocimum gratissimum* L. essential oil during the transport of *Lophiosilurus alexandri*: Water quality, hematology, blood biochemistry and oxidative stress. *Aquaculture* [Internet]. 2021 Jan;531:735964. Available from: <https://linkinghub.elsevier.com/retrieve/pii/S0044848620319979>
13. Boaventura TP, Souza CF, Ferreira AL, Favero GC, Baldissera MD, Heinzmann BM, et

- al. Essential oil of *Ocimum gratissimum* (Linnaeus, 1753) as anesthetic for *Lophiosilurus alexandri*: Induction, recovery, hematology, biochemistry and oxidative stress. *Aquaculture* [Internet]. 2020 Dec;529:735676. Available from: <https://linkinghub.elsevier.com/retrieve/pii/S0044848620312011>
14. Udi OA, Oyem JC, Ebeye OA, Chris-Ozoko LE, Igbigbi PS, Olannye DU. The effects of aqueous extract of *ocimum gratissimum* on the cerebellum of male Wistar rats challenged by lead acetate. *Clin Nutr Open Sci* [Internet]. 2022 Aug;44:28–41. Available from: <https://linkinghub.elsevier.com/retrieve/pii/S2667268522000304>
  15. Shittu STT, Lasisi TJ, Shittu SAS, Adeyemi A, Adeoye TJ, Alada AA. *Ocimum gratissimum* enhances insulin sensitivity in male Wistar rats with dexamethasone-induced insulin resistance. *J Diabetes Metab Disord* [Internet]. 2021 Jul 13;20(2):1257–67. Available from: <https://link.springer.com/10.1007/s40200-021-00850-y>
  16. Salemcity AJ, Olanlokun JO, Olowofolahan AO, Olojo FO, Adegoke AM, Olorunsogo OO. Reversal of mitochondrial permeability transition pore and pancreas degeneration by chloroform fraction of *Ocimum gratissimum* (L.) leaf extract in type 2 diabetic rat model. *Front Pharmacol* [Internet]. 2023 Nov 14;14. Available from: <https://www.frontiersin.org/articles/10.3389/fphar.2023.1231826/full>
  17. Huang CC, Hwang JM, Tsai JH, Chen JH, Lin H, Lin GJ, et al. Aqueous *Ocimum gratissimum* extract induces cell apoptosis in human hepatocellular carcinoma cells. *Int J Med Sci* [Internet]. 2020;17(3):338–46. Available from: <http://www.medsci.org/v17p0338.htm>
  18. Chen JH, Lin TH, Chien YC, Chen CY, Lin CT, Kuo WW, et al. Aqueous Extracts of *Ocimum gratissimum* Sensitize Hepatocellular Carcinoma Cells to Cisplatin through BRCA1 Inhibition. *Int J Mol Sci* [Internet]. 2024 Aug 1;25(15):8424. Available from: <https://www.mdpi.com/1422-0067/25/15/8424>
  19. Halayal RY, Bagewadi ZK, Maliger RB, Al Jadidi S, Deshpande SH. Network pharmacology based anti-diabetic attributes of bioactive compounds from *Ocimum gratissimum* L. through computational approach. *Saudi J Biol Sci* [Internet]. 2023 Sep;30(9):103766. Available from: <https://linkinghub.elsevier.com/retrieve/pii/S1319562X23002115>
  20. ITO EE, UTEBOR EK. ANTI-SCHISTOSOMA EFFICACY OF *Occimum gratissimum* (SCENT LEAF) AND *Andrographis paniculata* (KING OF BITTERS) AGAINST *Schistosoma haematobium* CERCARIA. *Sci African* [Internet]. 2023 Sep;21:e01839. Available from: <https://linkinghub.elsevier.com/retrieve/pii/S2468227623002958>
  21. Ajiboye BO, Famusiwa CD, Falode JA, Ojelabi AO, Mistura AN, Ogunbiyi DO, et al. *Ocimum gratissimum* L. leaf flavonoid-rich extracts reduced the expression of p53 and VCAM in streptozotocin-induced cardiomyopathy rats. *Phytomedicine Plus* [Internet]. 2024 May;4(2):100548. Available from: <https://linkinghub.elsevier.com/retrieve/pii/S2667031324000265>
  22. Xie Y, Zhang C, Mei J, Xie J. Antimicrobial Effect of *Ocimum gratissimum* L. Essential Oil on *Shewanella putrefaciens*: Insights Based on the Cell Membrane and External Structure. *Int J Mol Sci* [Internet]. 2023 Jul 4;24(13):11066. Available from: <https://www.mdpi.com/1422-0067/24/13/11066>
  23. VALDI DS, FLORENTINE NF, ARLETTE DZ, LANDRY KG, ROSETTE N, DIMITRI NT, et al. INVESTIGATING THE ANTIBACTERIAL, ANTIOXIDANT, AND ANTI-INFLAMMATORY ACTIVITIES OF AQUEOUS AND HYDROETHANOLIC EXTRACTS OF *OCIMUM BASILICUM* AND *OCIMUM GRATISSIMUM* ON SOME GERMS RESPONSIBLE FOR AEROBIC VAGINITIS. *Int J Pharm Pharm Sci* [Internet]. 2023 Mar 1;21–8. Available from: <https://innovareacademics.in/journals/index.php/ijpps/article/view/47116>
  24. de Souza Valente C, dos Santos G, Becker AG, Heinzmann BM, Caron BO, Baldisserotto B, et al. Anaesthetic effect of clove basil (*Ocimum gratissimum* L.)

- essential oil on the giant river prawn (*Macrobrachium rosenbergii*, De Man 1879) exposed to different water pHs. *Aquac Int* [Internet]. 2024 Apr 7;32(2):1493–505. Available from: <https://link.springer.com/10.1007/s10499-023-01226-0>
25. Silva AA, Pereira FAC, de Souza EA, de Oliveira DF, Nobre DAC, Macedo WR, et al. Inhibition of anthracnose symptoms in common bean by treatment of seeds with essential oils of *Ocimum gratissimum* and *Syzygium aromaticum* and eugenol. *Eur J Plant Pathol* [Internet]. 2022 Aug 19;163(4):865–74. Available from: <https://link.springer.com/10.1007/s10658-022-02525-7>
  26. Ajiboye BO, Fatoki TH, Akinnusi PA, Ajuwon OR, Oyinloye BE, Jeje TO, et al. Molecular docking, MMGBSA, and ADMET studies of phytoconstituents of *Ocimum gratissimum* on multiple breast cancer targets. *Nat Prod Res* [Internet]. 2025 Aug 18;39(16):4669–77. Available from: <https://www.tandfonline.com/doi/full/10.1080/14786419.2024.2344193>
  27. Mishra N, Tripathi S, Nahar L, Sarker SD, Kumar A. Mitigation of arsenic poisoning induced oxidative stress and genotoxicity by *Ocimum gratissimum* L. *Toxicol* [Internet]. 2024 Feb;238:107603. Available from: <https://linkinghub.elsevier.com/retrieve/pii/S0041010124000096>
  28. Oliveira MIB, Brandão FR, Tavares-Dias M, Barbosa BCN, Rocha MJS, Matos LV, et al. Essential oils of *Ocimum gratissimum*, *Lippia grata* and *Lippia organoides* are effective in the control of the acanthocephalan *Neoechinorhynchus buttnerae* in *Colossoma macropomum*. *Aquaculture* [Internet]. 2024 Jan;578:740043. Available from: <https://linkinghub.elsevier.com/retrieve/pii/S0044848623008177>
  29. Njan AA, Olaleye EO, Afolabi SO, Anoka-Ayembe I, Gyebi GA, Nyamngee A, et al. Identification of neurotherapeutic constituents in *Ocimum gratissimum* with cholinesterase and mono amine oxidase inhibitory activities, using GC-MS analysis, in vitro, and in silico approaches. *Informatics Med Unlocked* [Internet]. 2023;39:101261. Available from: <https://linkinghub.elsevier.com/retrieve/pii/S235291482300103X>
  30. Kanu C S, Alope C, Elom I N, Eleazu O C. Effects of co-treatment of *Plasmodium berghei*-infected mice with aqueous extract of *Ocimum gratissimum* leaves and primaquine on glucose-6-phosphate dehydrogenase activity, hematological, and antioxidant parameters. *J Ayurveda Integr Med* [Internet]. 2022 Oct;13(4):100656. Available from: <https://linkinghub.elsevier.com/retrieve/pii/S0975947622001152>
  31. Sharma S, Rolta R, Salaria D, Dev K. In vitro antibacterial and antifungal potentials of *Ocimum tenuiflorum* and *Ocimum gratissimum* essential oil. *Pharmacol Res - Nat Prod* [Internet]. 2024 Sep;4:100065. Available from: <https://linkinghub.elsevier.com/retrieve/pii/S2950199724000533>
  32. Loganathan A, Varghese RM, Subramanian AK, Shanmugam R. Evaluation of Antibacterial Effects of an Oral Rinse Containing *Ocimum tenuiflorum* and *Ocimum gratissimum* on *Streptococcus mutans* and *Lactobacillus* Species. *Cureus* [Internet]. 2024 Aug 27; Available from: <https://www.cureus.com/articles/282503-evaluation-of-antibacterial-effects-of-an-oral-rinse-containing-ocimum-tenuiflorum-and-ocimum-gratissimum-on-streptococcus-mutans-and-lactobacillus-species>
  33. Anandachockalingam A, Shanmugam R, Rynthiang I, Dharmalingam Jothinathan MK. Green Synthesis of Silver Nanoparticles Using *Zingiber officinale* and *Ocimum gratissimum* Formulation for Its Anti-inflammatory and Antidiabetic Activity: An In Vitro Study. *Cureus* [Internet]. 2024 Apr 12; Available from: <https://www.cureus.com/articles/242314-green-synthesis-of-silver-nanoparticles-using-zingiber-officinale-and-ocimum-gratissimum-formulation-for-its-anti-inflammatory-and-antidiabetic-activity-an-in-vitro-study>
  34. Siqueira IB, de Oliveira YLM, Caron BO, Schmidt D, Silva ARST, Jain S, et al. Amoebicidal activity of essential oils and essential oil-based microemulsions of

- Aloysia citrodora Ortega ex Pers., Cymbopogon winterianus Jowitt ex Bor , and Ocimum gratissimum L. against Acanthamoeba polyphaga trophozoites. J Appl Microbiol [Internet]. 2024 Sep 2;135(9). Available from: <https://academic.oup.com/jambio/article/doi/10.1093/jambio/lxae232/7750041>
35. Alabi QK, Akomolafe RO, Omole JG, Aturamu A, Ige MS, Kayode OO, et al. Polyphenol-rich extract of Ocimum gratissimum leaves prevented toxic effects of cyclophosphamide on the kidney function of Wistar rats. BMC Complement Med Ther [Internet]. 2021 Nov 2;21(1):274. Available from: <https://bmccomplementalthermed.biomedcentral.com/articles/10.1186/s12906-021-03447-3>
  36. Awwad A, Poucheret P, Idres YA, Tshibangu DST, Servent A, Ferrare K, et al. In Vitro Tests for a Rapid Evaluation of Antidiabetic Potential of Plant Species Containing Caffeic Acid Derivatives: A Validation by Two Well-Known Antidiabetic Plants, Ocimum gratissimum L. Leaf and Musanga cecropioides R. Br. ex Tedlie (Mu) Stem Bark. Molecules [Internet]. 2021 Sep 13;26(18):5566. Available from: <https://www.mdpi.com/1420-3049/26/18/5566>
  37. Lin PH, Chen ZW, Liu JY, Ye JC. Dietary supplementation of Ocimum g ratissimum improves growth performance and immune response in broilers under high ambient temperature. J Anim Sci [Internet]. 2023 Jan 3;101. Available from: <https://academic.oup.com/jas/article/doi/10.1093/jas/skad212/7205227>
  38. Liu JY, Tsai FL, Chuang YL, Ye JC. Aqueous extracts of Ocimum gratissimum mitigate colitis and protect against AOM/DSS-induced colorectal cancer in mice. Carcinogenesis [Internet]. 2023 Dec 30;44(12):837–46. Available from: <https://academic.oup.com/carcin/article/44/12/837/7326709>
  39. Alara OR, Abdurahman NH, Ukaegbu CI, Alara JA. Optimization of microwave-assisted extraction of phenolic compounds from Ocimum gratissimum leaves and its LC–ESI–MS/MS profiling, antioxidant and antimicrobial activities. J Food Meas Charact [Internet]. 2020 Dec 14;14(6):3590–604. Available from: <https://link.springer.com/10.1007/s11694-020-00602-1>
  40. Safiya S N, Varghese RM, S AK, Shanmugam R. Antifungal Activity of Ocimum tenuiflorum and Ocimum gratissimum Herbal Formulation-Based Oral Rinse Against Candida albicans. Cureus [Internet]. 2024 Aug 18; Available from: <https://www.cureus.com/articles/282603-antifungal-activity-of-ocimum-tenuiflorum-and-ocimum-gratissimum-herbal-formulation-based-oral-rinse-against-candida-albicans>
  41. de Melo ALF, Rossato L, Velasques J, de Sousa VL, Pina Rodrigues GV, Cardoso CAL, et al. Polymyxin combined with Ocimum gratissimum essential oil: one alternative strategy for combating polymyxin-resistant Klebsiella pneumoniae. J Med Microbiol [Internet]. 2024 Sep 18;73(9). Available from: <https://www.microbiologyresearch.org/content/journal/jmm/10.1099/jmm.0.001891>