



Ethnobotanical Survey and Antibacterial Activity of Selected *Ocimum gratissimum* used in New Bussa, Niger State, Nigeria

Ibrahim Sani ^{1*}, Fatima Bello ², Ebirinwa Samuel Chibike ³

¹⁻³ Department of Biochemistry, Faculty of Life Sciences, Abdullahi Fodio University of Science and Technology, Aliero, Nigeria

* Corresponding Author: Ibrahim Sani

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Abstract

The use of medicinal plants in the treatment of diseases has been in practice since ancient times in different parts of the world. Plants have the major advantage of still being the most effective and cheaper alternative sources of drugs among which *Ocimum gratissimum* is one of such plants. This study was aimed at conducting ethnobotanical survey and evaluating the antibacterial activity of a selected medicinal plant (*Ocimum gratissimum*) in New Bussa. Oral interview was used to obtain information from herbalist and traditional medicine practitioners for the ethnobotanical survey while standard laboratory procedures were used to conduct qualitative phytochemical analysis. Agar well diffusion and dilution methods were used to determine zones of inhibition and minimum inhibitory concentration respectively. Eight (8) medicinal plants (*Cucumis melo*, *Citrus limonum*, *Adansonia digitata*, *Hibiscus sabdariffa*, *Ocimum gratissimum*, *Zingiber officinalis*, *Carica papaya*, and *Moringa oleifera*) were documented from the ethnobotanical survey. *Ocimum gratissimum* hydro-methanol extract revealed the presence of tannins, phenols, sterols, saponnins, alkaloids, terpenoids, glycosides and phlobatannins while flavonoids were not detected. A significant increase in antibacterial activity against *Streptococcus pneumonia* and *Klebsiella pneumonia* was observed in 50, 100 and 150mg/ml extract concentration. The activity of *Ocimum gratissimum* extract against the test organisms revealed significant increases at all concentrations (50, 100 and 150mg/ml) compared to the standard drug (Ampiclox 30µg and ciproflaxin 10µg). *Ocimum gratissimum* hydro-methanol extract revealed MIC against *Streptococcus pneumonia* and *Klebsiella pneumonia* of 10⁻³ and 10⁻⁴ mg/ml respectively. The potency of these plant extract against certain bacteria supports its traditional usage, furthermore it may contain their potential to be used as an alternative synthetic antibiotic.

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Keywords: New Bussa, Ethnobotanical survey, Antibacterial activity, *Ocimum gratissimum* Medicinal plants

1. Introduction

Ocimum gratissimum, popularly known as scent leaf, is one of the discovered medicinal plants with the potential to serve as an alternative therapy for the treatment of various ailments or as a source of a new drug. It is a widespread and commercially viable perennial herbaceous plant with a very strong aromatic smell. It belongs to the family of Lamiaceae and is found in Africa, Asia, and South America (Tanko *et al.*, 2008; Akara *et al.*, 2021) [56, 6].

In Nigeria the plant is called “Effirin-na” by the Yoruba speaking tribe, “Alumokho” in Esan, “Nchanwu” in Igbo, “Aramogbo” in Edo, and in the Northern part, the Hausa call it “Daidoya”.

It is used as a natural flavoring agent, condiment, or vegetable in the preparation of fish, meat, soup, and stew. It is also used in

traditional medicine for the treatment of several ailments such as cough, pneumonia, fever, inflammation, anaemia, diarrhoea, pains, and fungal and bacterial infections (Akara *et al.*, 2021) ^[6]. billion people ^[2]. Scientific reports have shown that *Ocimum gratissimum* has a wide range of bioactive compounds such as flavonoids and polyphenols (Venuprasad *et al.*, 2014; Ironi *et al.*, 2016) ^[58, 29]. and essential oils with several beneficial effects (Benitez *et al.*, 2009; Melo *et al.*, 2019) ^[14, 40]. Furthermore, several studies have shown this plant possesses numerous pharmacological

properties such as anti-hyperglycaemic (Aguayi *et al.*, 2000; Casanova *et al.*, 2014) ^[3, 15], hypoglycaemic (Shittu *et al.*, 2019) ^[54], anti-inflammatory (Ajayi *et al.*, 2019) ^[5], antidiarrheal (Offiah and Chikwendu, 1999) ^[45], anti-anaemic, hepatoprotective (Akara *et al.*, 2021) ^[6], anti-hypertensive (Shaw *et al.*, 2017) ^[53], antibacterial (Melo *et al.*, 2019) ^[40], antifungal (Mohr *et al.*, 2017) ^[41], and anti-oxidative properties (Joshi, 2013; Mahapatra and Roy, 2014) ^[30, 38]. as well as exhibits many other pharmacological activities.



Values are presented as mean $\pm$ SD (n = 3) Values having same superscript down the column are not significantly different at (P>0.05) analysed using One-Way ANOVA, followed by Duncan multiple comparison test with SPSS version 20.0

Fig 1: *Ocimum gratissimum*

2. Materials and Methods

2.1 Study Area

This study was conducted in Niger state, a state in the north central region of Nigeria. Niger state covers 76,363 square kilometers. It lies a latitude 10°00' north and a longitude 63°00' east. It has a population of 3,954,773 (2006 census) 5,556,247 (2016 forecast) and a population density of 51. Niger state accounts for 2.8% of Nigeria's total population.

2.2 Ethnobotanical Survey

The Ethnobotanical survey of medicinal plants used in traditional health care delivery system in New Bussa, Borgu Local Gov. Niger State, were carried out to obtain useful information on their uses and potentials. The Ethnobotanical data were collected by oral interviews to 12 respondents made up of traditional medical practitioners (TMPs), herbalists and herb sellers. A total of 9 plant species belonging to different families were found to be useful in the treatment of various ailments such as asthma, cough, yellow fever, tuberculosis, measles, malaria, ringworm, boil,

eczema, typhoid and diabetes. Recipes used in the treatment of these ailments were documented. Herbal remedies were either prepared from dry or freshly collected plants while the traditional solvent of choice included water, pure honey, and lime. The main methods of preparation are decoction and infusion while method of administration ranges from 3 to 5 cl of drinking cup, 2 to 3 times daily. The survey revealed that the leaves component accounted for the majority of the part used for herbal preparations. Residents in the study areas find the traditional medicine cheaper as compared to orthodox medicine.

2.3 Collections and Identification of Plant Sample

The plant sample was collected in March 2023 from New Bussa local government Niger state. The plant was authenticated by a taxonomist from the Department of Plant Science and Biotechnology, Kebbi State University Science and Technology Aliero and a voucher specimen number (KSUSTS/PSB/H/VOUCHER307) was assigned and the plant was deposited in the herbarium of the same Department.

2.4 Preparation and Extraction of the Plant Sample

The leaves were obtained from a garden in New Bussa, Niger state, Nigeria. Leaves were sorted and gently rinsed. The leaves were then spread on paper inside a room for 5 days to dry and then ground using a mortar and pestle into a powdered form. Fifty grams of the ground sample was soaked with 250 mL of hydromethanolic solvent for 48hrs. The mixture was filtered with Whatman No 1 filter paper. The filtrate was concentrated to 1/10 of its original volume using a rotary evaporator. The influence of using hydromethanolic solvent as medium for extraction on the antimicrobial property of the leaf extract was also investigated. The same procedure as the aqueous extraction was used for the hydromethanolic extract, but 50% ethanol was used instead of water.

$$\% \text{ Yield} = \frac{\text{Weight of extract removed}}{\text{weight o dried powder}} \times 100$$

2.5 Qualitative Phytochemical Screening on the Plant Extract

• Test for Alkaloids

To 2 ml of plant extract, 2 ml of concentrated Hydrochloric acid was added, and then 3 drops of Mayer's reagents. Presence of green color or white precipitate indicates the presence of alkaloids.

• Test of Saponin

To 1 ml of plant extracts, 5-10 ml of distilled water was added and shaken in a graduated cylinder for 15 minutes. Formation of a 1cm layer of foam was an indication of the presence of saponins

• Test for Phenols

The plant extract (0.5 g) was separately stirred with 10 ml of distilled water and then filtered. Few drops of 5 % FeCl₃ reagent was added to the filtrate. Blue-black or blue-green coloration or precipitation was an indication of the presence of phenols.

• Test for Tannins

To 1 ml of plant extract, 2 ml of 5 % ferric chloride (FeCl₃) was added. Formation of dark blue or greenish-black indicated the presence of tannins.

• Test for Terpenoids

About 2 ml of the organic extract was dissolved in 2 ml of chloroform and evaporated to dryness. 2 ml of concentrated Sulphuric acid was then added and heated for about 2 mins. A greyish colour indicated the presence of terpenoids

• Test for Steroids

One (1) ml of extract was treated with drops of chloroform, acetic anhydride and concentrated H₂SO₄ and observed for the formation of dark pink or red color.

• Test for Cardiac Glycosides

2 ml of each extract was dissolved in 2 ml of chloroform. About 2 ml of sulphuric acid was added carefully and shaken gently. A reddish-brown colour indicated the presence of a steroidal ring "that is aglycone portion of glycoside".

• Test for Flavonoids

To 2 ml of plant extract, 4 drops of concentrated Sulphuric acid was added. The formation of orange color indicates the presence of flavonoids.

• Test for Phlobatannins

About 2 ml of the extract was boiled with 1 ml of 1 %

aqueous hydrochloric acid deposition of a red precipitate was taken as evidence for the presence of phlobatannins.

2.6 Preparation and Sterilization of Media

The nutrient agar 7g were dissolved in 250ml of distilled water, shaken and put on a hot plate for 2 minutes and then sterilized in an autoclave in the microbiology laboratory for 15 minutes at 121°C. 20cm of the mixture was then poured into petri-dishes with the help of heat in order to prevent other species of microorganisms from contaminating it. The sample plates were allowed to set and later incubated aerobically at 37°C which was then turned upside down in the ovum for them to dry. Inoculation of the test organisms on nutrient agar prepared plate was reported by (Fatope *et al*, 2001) [22]. was achieved by flaming a wire loop on a spirit lamp (air cooling) and fetching the test organisms. Prepared discs containing the fractions at different concentrations (1.0x 10⁴µl, 1.5x10⁴µl, and 2.0x10⁴µl) were placed on the incubated plate using sterile forceps in each case. (Fatope *et al.*, 2001) [22]; the plates were then turned upside down and incubated at 37°C for 24 hours in an incubator. The result was taking by considering the zone of growth and inhibition of test organisms by various concentrations. Activity and inactivity were observed with standard and acceptable method.

2.7 Antibacterial Screening of the Bacterial

Agar well diffusion method and broth dilution technique was used to test for anti-bacterial activity in accordance with the method described by (Trobi *et al.*, 1994). The anti-bacterial activity of the plant was tested on *Stresptococcus aureus* and *Klebiella pneumonia*. Isolates were first grown in a nutrient broth for 18 h before use and standardized to 0.5 mcfarland standards (106) cfu/ml). Two hundred micro liters of the standardized cell suspensions was spread on a mueller-hintonn agar (oxid). Wells were then bored into the agar using a sterile 6mm diameter cork borer Approximately 100µl of the crude extract a was then introduced into the wells at concentration of 150mg/ml, 100mg/ml, 50mg/ml and was allowed to stand at room temperature for about 2 h and then incubated at 37°C. Ciprofloxacin 10µg activity was used as the positive control. The plates were observable for zones of inhibition 24 (Michel, 2002).

2.8 Determination of the Minimum Inhibitor Concentration of the Extract

Full of each test organisms were inoculated into each of the test tubes and incubated at 37°C for 24 hours. The MIC was the lowest concentration of the leaf extracts that inhibited growth.

The broth dilution method of Bailey and Elvyn (1970) was employed in the determination of the minimum inhibitory concentration (MIC) of the leaf extracts of *Ocimum gratissimum* against the test organisms. To each 5ml of the various extracts in different test tubes was added 5ml of nutrient broth each and serially diluted out to various concentrations ranging from 70 – 25mg/ml. A loop.

2.9 Statistical Analysis

The data generated from the study are presented as mean ± Standard error of means (SEM) and subjected to one-way analysis of variance (ANOVA) and statistical difference between the means were separated using New Duncan's multiple comparison test using statistical package for social science (SPSS) version 20. Values are considered statistically significant at P<0.05.

3. Results

3.1 Ethno Botanical Survey on Medicinal Plants used for Management Disease

Table 1 below, describe and characterized some

Ethnobotanical Medicinal plants used for the treatment of diseases or bacterial infections which were mentioned from the Ethnobotanical Survey conducted in New Bussa, Borgu Local Gov. Niger State, during the course of this research.

Table 1: Ethnobotanical data for the Plants used for the Treatment of Bacterial Infections in New Bussa, Niger State

S/No	Botanical name	English name	Local name	Mode of preparation	Mode of administration	Part used	Citations
1	<i>Moringa oleifera</i>	Drum stick tree	Zogala	Blending and cooking	Drinking and eating	leaf	5
2	<i>Carica papaya</i>	Paw paw	Ganyen gwanda	Boiling	Drinking	leaf	4
3	<i>Zingiber officinalis</i>	Ginger	Citta	Blending	Drinking extract	The bulb	3
4	<i>Ocimum gratissimum</i>	African basil	Daidoya	Boiling	Drinking	leaf	7
5	<i>Hibiscus sabdariffa</i>	Roselle plant	Zobo	Boiling	Drinking	Flowers/leaves	5
6	<i>Adansonia digitata</i>	Baobab tree	Kuka	Boiling	Drinking	Bark,leave,root	4
7	<i>Citrus limonum</i>	Lemon	Lemuntsami	Boiling	Drinking/eating	leaf	6
8	<i>Cucumis melo</i>	Muskmelon	Gurji	Boiling	Drinking	leaf	4

3.2 Percentage Yield

Extraction of 100g of *Ocimum gratissimum* leaf in 250mls of

hydromethanol yielded 10.7% and the extract is soluble in water, sticky texture and syrup brown in colour.

Table 2: Physical Characteristics of Leaf Extract *Ocimum gratissimum* (Scent Leaf)

Texture	Color	Percentage Yield	Yield
Sticky	Syrup brown	10.7%	10.694

3.3 Results of Qualitative Phytochemical Screening

The qualitative phytochemical screening of *Ocimum gratissimum* leaf hydromethanol extract is presented in Table

3.3. The result revealed the presence of phenols, alkaloids, tannins, steroids, saponin, phlobatannins, terpenoids, and glycosides while, flavonoids is not detected.

Table 3: Preliminary Phytochemical Composition of the Plant Extract.

Phytochemicals	Results
Alkaloids	+
Flavonoids	-
Tannins	+
Steroids	+
Saponin	+
Glycoside	+
Terpenoids	+
Phenols	+
Phlobatannins	+

+ = Present, - = Not detected

3.4 Antibiotic Sensitivity Profile of the *Streptococcus pneumonia* and *Klebsiella pneumonia*

Among the tested antibiotics, the isolated strains (*Streptococcus pneumonia* and *Klebsiella pneumonia*); *S. pneumonia* was resistant to chloroamphenicol, znacef, ampicillin, chloroquin, pefloxacin, amoxillin, cefoxitin and

erythromycin. On the other hand, it was sensitive to ampiclox and septrin and *Klebsiella pneumonia* was resistant to pefloxacin, septrin, znacef, ampicillin, erythromycin, amoxillin, cefoxitin and it was sensitive to ciproflaxin,, and chloroamphenicol.

Table 4: Antibiotic Sensitivity Profile of the *Streptococcus pneumonia* and *Klebsiella pneumonia*

Test Organism	CH	Z	APX	CPX	AM	E	PEF	SXT	S	CN
<i>Streptococcus pneumonia</i>	-	-	+	-	-	-	-	-	+	-
<i>Klebsiella pneumonia</i>	+	-	-	+	-	-	-	-	-	-

+ = Effective, - = Resistance, CH: chloroamphenicol, CPX: ciproflaxin, AM: ampicillin, E: erythromycin, PEF: pefloxacin CN:chloroquin, Z: znacef. APX: Ampiclox, S: Seprin

3.5 Antibacterial Activity of *Ocimum gratissimum* Leaf Hydromethanol Extract against *Streptococcus pneumonia* and *Klebsiella pneumonia*

The results revealed significant ($P < 0.05$) increase in antibacterial activity against *Klebsella pneumonia* at 50, 100 150mg/ml of *Ocimum gratissimum* leaf hydro-methanol

extract concentrations compared to standard drugs (ciproflaxin 10µg) respectively (Table 3.3). Similarly, *Streptococcus pneumonia* revealed significant ($P < 0.05$) increase only at 50, 100 and 150mg/ml extract doses compared to standard drug (ampliclox 30µg).

Table 5: Antibacterial Activity Profile of *Ocimum gratissimum* Leaf Hydro-methanol Extract against *Streptococcus aureus* and *Klebsiella pneumonia*.

Treatment	Zone of Inhibition(mm)	
	<i>Streptococcus pneumonia</i>	<i>Klebsiella pneumonia</i>
Standard drug(Ampiclox 30µg and ciproflaxin 10µg)	1.13±0.06 ^a	1.90±0.17 ^a
Extract (50mg/ml)	2.47±0.21 ^b	2.73±0.15 ^b
Extract (100mg/ml)	2.63±0.15 ^b	2.97±0.06 ^b
Extract (150mg/ml)	2.77±0.28 ^b	2.90±0.17 ^b

Values are presented as mean ± SD (n = 3) Values having same superscript down the column are not significantly different at (P>0.05) analysed using One-Way ANOVA, followed by Duncan multiple comparison test with SPSS version 20.0.

3.6 Minimum Inhibitory Concentration (MIC) of *Ocimum gratissimum* Leaf Hydro-methanol Extract against *Streptococcus pneumonia* and *Klebsiella pneumonia*.

This result revealed that the extract have minimum effect

against both *S. pneumonia* and *K. pneumonia*. The MIC showed the extract have a lower concentration of an antimicrobial that will inhibit growth of microorganisms on the bacteria strains at 10⁻¹, 10⁻², 10⁻³, 10⁻⁴, 10⁻⁵, 10⁻⁶

Table 6: Minimum Inhibitory Concentrations of the *Ocimum gratissimum* Leaf Hydromethanol Extract against *Streptococcus aureus* and *Klebsiella pneumonia*.

Test Bacteria	MIC (mg/ml)					
	10 ⁻¹	10 ⁻²	10 ⁻³	10 ⁻⁴	10 ⁻⁵	10 ⁻⁶
<i>Streptococcus pneumonia</i>	+	+	+	-	-	-
<i>Klebsiella pneumonia</i>	+	+	-	-	-	-

+ = present, - = absent

4. Discussion

Phytochemical screening of these fractions as shown in Table 3.3 revealed the absence of Flavonoids. However, the fractions contained Glycosides, Phlobotanins, Steroids, Phenols, Alkaloids, Tannins, Saponins and Anthraquinones. Tannins and glycosides are both present in these fractions because both of them usually have a glucose ring in them. The steroid found present in the chloroform extract of the leave may be a glycosidic steroid. The presence of glycosides in the extracts of *Ocimum gratissimum* and their antimicrobial efficacy against these organisms agrees with the findings of Ebana *et al.* (1999) which says cardiac glycosides inhibit pathogenic bacteria. Also Nguji (1998) reported that tannins are important in herbal medicine and are applied to the healing of wounds and arrests bleeding. This also agrees with the findings of Agunu *et al.* (2005) who reported that the leaves have anti-diarrhoeal activity. Most of the organisms were resistant to fractions of the other extracts which indicate that these extracts possess more than one active component. Harborne (1999) reported that the activity of plant extracts can sometimes change after fractionation and a pure compound eventually isolated may lack the activity of the original extract.

The result of phytochemical analysis agrees with previous analyses ((Arokiyaraj *et al.*, 2009; Agbede and Ibitoye, 2007; Ejikeme and Henrietta, 2010; Adejumo *et al.*, 2013) [8, 19]. These indicate a dominance of polar secondary metabolites and negligible steroidal components. This is particularly interesting as per the search for newer drugs with little or no side effects. The varying degrees of antimicrobial activity may be due to the different solvents adopted for extraction and fractionation (Freiburghausa *et al.*, 2000) [23]. The ability of the extracts to inhibit the growth of the pathogens might be as a result of the presence of bioactive substances such as alkaloids, saponins, tannins, flavonoids, cardiac glycosides, steroids, etc. (Elujoba, 1996; NCCLS, 1998) [20, 43], which acted in synergy (Elujoba, 1996; NCCLS, 1998; Kilani, 2006) [20, 43, 31]. The leaf crude extract was more or less inactive but the fractions exhibited antimicrobial activity. This may be due to antagonism among the phytochemicals in

the crude extract, which were separated by fractionation. This result agrees with earlier findings (Ejikeme and Henrietta, 2010; Kilani, 2006) [19, 31], using a different approach. The Plant parts inhibited both gram positive and gram negative bacteria, and pathogenic yeast. *Ocimum gratissimum* leaf could therefore be said to be a broad spectrum antibiotic plant (Todar, 2005) [57]. The Minimum Inhibitory Concentrations shows that at least 50 mg/ml of the plant extract and /or fractions is necessary for the observed antimicrobial activity. Statistical analysis showed that the test organisms were generally equally affected in terms of zone diameter of inhibition. These results however give an indication of the effectiveness of the plant extracts as antimicrobial agents.

The new finding obtained from this study give novel information on antibacterial activity from *Ocimum gratissimum* leaf extracts against human pathogenic bacteria which benefit and useful for antibiotic drug development.

4.1 Conclusion

The result revealed the antibacterial effects of some extracts of *Ocimum gratissimum* on *Streptococcus pneumonia* and *Klebsiella pneumonia*. It is shown that *Ocimum gratissimum* hydro-methanolic extract is an exceptional antiviral, immune-stimulant, anti-infectious, antibacterial, neurotonic and psychic stimulant. Other properties are muscle relaxant, antalgic, expectorant and anti-catarrh, (Baudoux, 2010).

5. References

1. Agarwal S, Kumar VR, Kumar A. Pharmacognostical characterization of *Ocimum* spp. J Pharmacogn Phytochem. 2013;2:219-24.
2. Agbede JO, Ibitoye AA. Chemical composition of scent leaf (*Ocimum gratissimum*): an underutilized fruit. J Food Agric Env. 2007;5(2):95-6.
3. Aguiyi J, Obi CI, Gyang SS, Igweh AC. Hypoglycaemic activity of *Ocimum gratissimum* in rats. Herbs Med. 2000;6:123-8.
4. Agunu A, Yusuf S, Andrew GO, Zezi AU, Abdurahman EM. Evaluation of five medicinal plants used in diarrhoea treatment in Nigeria. J Ethnopharmacol.

- 2005;(Abstract)(Epub ahead of print).
5. Ajayi AM, Ben-Azu B, Onasanwo SA, Adeoluwa O, Eduviere A, Ademowo OG. Flavonoid-rich fraction of *Ocimum gratissimum* attenuates lipopolysaccharide-induced sickness behavior, inflammatory and oxidative stress in mice. *Drug Res.* 2019;69:151-8.
 6. Akara EU, Okezie E, Ude VC, Uche-Ikonne C, Eke G, Ugbogu AE. *Ocimum gratissimum* leaf extract ameliorates phenylhydrazine-induced anaemia and toxicity in Wistar rats. *Drug Metab Pers Ther.* 2021.
 7. Akinyemi OF, Ayodele MS. Seedling morphology and molecular characterization of some *Ocimum* L. species (Lamiaceae) in Southwest states of Nigeria. *Feddes Repert.* 2020;131:213-24. <https://doi.org/10.1002/fedr.202000003>.
 8. Arokiyaraj K, Perinbam P, Agastian R, Mohan K. Phytochemical analysis and antibacterial activity of *Ocimum gratissimum*. *Int J Green Pharm.* 2009;34:162-4.
 9. Awosika F. Local medicinal plants and the health of the consumers. *J Clin Phar Her Med.* 1991;9:28-30.
 10. Ayandele AA, Adebisi AO. The phytochemical analysis and the antimicrobial screening of extracts of *Olex subscorpioidea*. *Afr J Biotechnol.* 2007;6(7):868-70.
 11. Bankole AE, Adekunle AA, Umebese CE, Salisu WB. Ethnobotanical survey of medicinal plants sold in markets of Ijebuode and Ijebu-igbo, Ogun state, Nigeria. *Niger J Sci Res.* 2018;17:245-56.
 12. Bailey RW, Elvyn BS. *Diagnostic microbiology.* The C.V. Mosby Coy. St. Louis; 1970. p. 120-60, 289-306.
 13. Barley, Day. Studies on essential oils for their antibacterial and antifungal properties: Preliminary screening of 35 essential oils. *J Sci Ind Res.* 1989;2:11-5.
 14. Benitez NP, Leon EMM, Stashenko EE. Eugenol and methyl eugenol chemotypes of essential oil of species *Ocimum gratissimum* L. and *Ocimum campechianum* Mill. from Colombia. *J Chromatogr Sci.* 2009;47:800-3.
 15. Casanova LM, da Silva D, Sola-Penna M, Camargo LM, Celestrini D, Tinoco LW, *et al.* Identification of chicoric acid as a hypoglycemic agent from *Ocimum gratissimum* leaf extract in a biomonitoring *in vivo* study. *Fitoterapia.* 2014;93:132-41.
 16. Chitwood DJ. Phytochemical based strategies for nematode control. *Annu Rev Phytopathol.* 2002;40:221-49.
 17. Chah KF, Eze CA, Emuelosi CE, Esimone CO. Antibacterial and wound healing properties of methanolic extracts of some Nigerian medicinal plants. *J Ethnopharmacol.* 2006;104:164-7.
 18. Dash BK, Sultana S, Sultana N. Antibacterial activities of methanol and acetone extracts of *Ferrugreek (Trigonella foenum)* and *Coriander (Coriandrum sativum)*. *Life Sci Med Res.* 2011;27:1-8.
 19. Ejikeme N, Henrietta OU. Antimicrobial activities of leaf of *Ocimum gratissimum* on some bacteria. *Researcher.* 2010;2(3):37-47.
 20. Elujoba AA. Standardization of phytomedicines: Proceedings on an international workshop on commercial production of an indigenous plant, Lagos, Nigeria; 1996. p. 19.
 21. El Said F, Sofowora EA, Malcom SA, Hoffer A. An investigation into the efficacy of *Ocimum gratissimum* Linn as used in Nigeria native medicine. *Planta Med.* 1970;17:195.
 22. Fatope MO, Adoum OA, Takerda Y. Palmitate Ximenia Americana. *Pharm Biol.* 2001;38(5):391-3.
 23. Freiburghaus F, Kaminsky R, Nkonya MHH, Brun R. Evaluation of African medicinal plants for their *in vitro* trypanocidal activity. *J Ethnopharmacol.* 1996; 55:1-11.
 24. Gills LS. *Ocimum gratissimum* in: Ethno-medical uses of plants in Nigeria. Uniben Press; 1992. p. 176.
 25. Harborne JB. *Phytochemical methods.* Chapman and Hall Limited; 1999. p. 49-188.
 26. Heslop-Harrison JSP. Morphology, adaptation and speciation. *Ann Bot.* 2017; 120:621-4. <https://doi.org/10.1093/aob/mcx130>.
 27. Igberaese PO, Ogbale OO. Ethnobotanical survey of plants used in the treatment of typhoid and its complication(s) in Esan North East Local Government Area, Uromi, Edo State. *Nig J Pharm Res.* 2018;14:175-88.
 28. Imosemi IO. A review of the medicinal values, pharmacological actions, morphological effects and toxicity of *Ocimum gratissimum* Linn. *Eur J Pharm Med Res.* 2020;7:29-40.
 29. Ironi EA, Agboola SO, Obboh G, Boligon AA. Inhibitory effect of leaves extracts of *Ocimum basilicum* and *Ocimum gratissimum* on two key enzymes involved in obesity and hypertension *in vitro*. *J Intercult Ethnopharmacol.* 2016;5:396-402.
 30. Joshi RK. Chemical composition, *in vitro* antimicrobial and antioxidant activities of the essential oils of *Ocimum gratissimum*, *O. Sanctum* and their major constituents. *Indian J Pharm Sci.* 2013;75:457-62.
 31. Kilani AM. Antibacterial assessment of whole leaf of *Ocimum gratissimum* against some Enterobacteriaceae. *Afr J Biotechnol.* 2006;5:958-9.
 32. Kpetehoto WH, Hessou S, Dougnon VT, Christian R, Boni G, Houéto EE, *et al.* Étude ethnobotanique, phytochimique et écotoxicologique de *Ocimum gratissimum* Linn (Lamiaceae) à Cotonou. *J Appl Biosci.* 2017;109:10609-17.
 33. Kpoviessi KBGH, Kpoviessi SDE, Ladekan Y, Gbaguidi F, Fré'derich M, Moudachirou M, *et al.* *In vitro* antitrypanosomal and antiplasmodial activities of crude extracts and essential oils of *Ocimum gratissimum* Linn from Benin and influence of vegetative stage. *J Ethnopharmacol.* 2014;155:1417-23.
 34. Lahlou S, Interaminense L, Leal-Cardoso JH, Morais SM, Duarte GP. Cardiovascular effects of the essential oil of *Ocimum gratissimum* leaves in rats: role of the autonomic nervous system. *Clin Exp Pharmacol Physiol.* 2004;31:219-25.
 35. Lal RK, Gupta P, Chanotiya CS, Mishra A, Kumar A. The nature and extent of heterosis, combining ability under the influence of character associations, and path analysis in Basil (*Ocimum basilicum* L.). *Ind Crops Prod.* 2023;195:116421. <https://doi.org/10.1016/j.indcrop.2023.116421>.
 36. Latha SP, Kannabiran K. Antimicrobial activity and phytochemicals of *Solanum erimobatum* Linn. *Afr J Biotechnol.* 2006;5(23):2402-4.
 37. Lin KW. Ethnobotanical study of medicinal plants used by Jah Hut people in Malaysia. *Indian J Med Sci.* 2005;59:156-61.
 38. Mahapatra SK, Roy S. Phytopharmacological approach of free radical scavenging and anti-oxidative potential of

- eugenol and *Ocimum gratissimum* Linn. Asian Pac J Trop Med. 2014;7S1:S391-7.
39. Martins ML, Jeronimo GT, Figueredo AB, Tancredo KR, Bertaglia EA, Furtado WE, et al. Antiparasitic agents. Aquacult Pharmacol. 2021;169-217.
 40. Melo RS, Azevedo AMA, Pereira AMG, Rocha RR, Cavalcante RMB, Matos MNC, et al. Chemical composition and antimicrobial effectiveness of *Ocimum gratissimum* L. essential oil against multidrug-resistant isolates of *Staphylococcus aureus* and *Escherichia coli*. Molecules. 2019;24:3864.
 41. Mohr FB, Lermen C, Gazim ZC, Gonçalves JE, Alberton O. Antifungal activity, yield, and composition of *Ocimum gratissimum* essential oil. Genet Mol Res. 2017.
 42. Mukaila YO, Oladipo OT, Ogunlowo I, Ajao AA, Sabiu S. Which plants for what ailments: A quantitative analysis of medicinal ethnobotany of Ile-Ife, Osun State, Southwestern Nigeria. Evid Based Complement Altern Med. 2021;2021:5711547.
 43. National Committee for Clinical Laboratory Standards (NCCLS). Methods for dilution in antimicrobial susceptibility test. Performance standards for antimicrobial susceptibility testing. 1998;15(14):100-56.
 44. Nweze EI, Eze EE. Justification for the use of *Ocimum gratissimum* L in herbal medicine and its interaction with disc antibiotics. BMC Complement Altern Med. 2009;9:37.
 45. Offiah VN, Chikwendu UA. Antidiarrhoeal effects of *Ocimum gratissimum* leaf extract in experimental animals. J Ethnopharmacol. 1999;68:327-30.
 46. Oyelakin A, Olubode T, Olawale B. Ethnobotanical survey and phytochemical analysis of selected medicinal plants used in treating digestive disorder. J Med Plants Stud. 2020;8:38-42.
 47. Parekh J, Chanda S. *In vitro* antibacterial activity of the crude methanol extract of *Woodfordia fruticosa* Kurz. flower (Lythaceae). Braz J Microbiol. 2007;38:204-7.
 48. Pessoa LM, Morais SM, Bevilacqua CM, Luciano JH. Anthelmintic activity of essential oil of *Ocimum gratissimum* Linn. and eugenol against *Haemonchus contortus*. Vet Parasitol. 2002;109:59-63.
 49. Prabhu KS, Lobo R, Shirwaikar AA, Shirwaikar A. *Ocimum gratissimum*: A review of its chemical, pharmacological and ethnomedicinal properties. Open Complement Med J. 2009;1:1-15. <https://doi.org/10.2174/1876391X00901010001>.
 50. Priyanka C, Shivika S, Vikas S. *Ocimum gratissimum*: A review on ethnomedicinal properties, phytochemical constituents, and pharmacological profile. In: Kumar N, editor. Biotechnological approaches for medicinal and aromatic plants. Springer; 2018.
 51. Rahman IU, Afzal A, Iqbal Z, Ijaz F, Ali N, Shah M, et al. Historical perspectives of ethnobotany. Clin Dermatol. 2019;37:382-8. <https://doi.org/10.1016/j.clindermatol.2018.03.018>.
 52. Rawat R, Tiwari V, Negi KS. A comparative study of morphological and anatomical structures of four *Ocimum* species in Uttarakhand, India. J Drug Deliv Ther. 2016;6:1-6. <https://doi.org/10.22270/jddt.v6i6.1322>.
 53. Shaw M, Wu J, Wang M. Antihypertensive effects of *Ocimum gratissimum* extract: angiotensin-converting enzyme inhibitor *in vitro* and *in vivo* investigation. J Funct Foods. 2017;35:68-73.
 54. Shittu ST, Shittu SA, Olatunji AA, Oyeyemi WA. *Ocimum gratissimum* leaf extract may precipitate infertility. JBRA Assist Reprod. 2019;23:34-44.
 55. Sofowora A, Ogunbodede E, Onayade A. The role and place of medicinal plants in the strategies for disease prevention. Afr J Tradit Complement Altern Med. 2013;10:210-29.
 56. Tanko Y, Magaji GM, Yerima M, Magaji RA, Mohammed A. Anti-nociceptive and anti-inflammatory activities of aqueous leaves extract of *Ocimum gratissimum* (Labiata) in rodents. Afr J Tradit Complement Altern Med. 2008;5:141-6.
 57. Todar K. Antimicrobial agents used in the treatment of infectious diseases. Department of Bacteriology, University of Wisconsin Madison; 2005. p. 1-8.
 58. Venuprasad MP, Kandikattu HK, Razack S, Khanum F. Phytochemical analysis of *Ocimum gratissimum* by LC-ESI-MS/MS and its antioxidant and anxiolytic effects. S Afr J Bot. 2014;92:151-8.