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Mesosphaerum suaveolens (Lamiacae): Fonte de compostos antimicrobianos e antioxidantes

Mesosphaerum suaveolens (Lamiacae): Source of antimicrobial and antioxidant compounds

Mesosphaerum suaveolens (Lamiacae): Fuente de compuestos antimicrobianos y antioxidantes

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Resumo

O uso na medicina popular de folhas de *Mesosphaerum suaveolens* para o tratamento de doenças no aparelho digestivo e no sistema respiratório, levantou a hipótese de que seu óleo volátil possui propriedades biológicas contra microrganismos patogênicos. Para testar esta hipótese, as atividades antibacteriana e antifúngica contra cepas de levedura de *Candida*, bem como ação modificadora de antibióticos e potencial antioxidantes (DPPH) foram avaliadas *in vitro*. Além disso, foi determinado por Cromatografia Gasosa (GC-FID), os constituintes presentes no óleo essencial. Os resultados mostram que o óleo de *M. suaveolens* possui atividade antibacteriana contra cepas padrão e multirresistentes de *Staphylococcus aureus*, com uma CIM de 64 e 256 µg/mL, respectivamente, porém não tem capacidade para melhorar a ação de antibacterianos comerciais. Com relação à atividade anti-*Candida*, foi possível observar que houve ação biológica, uma vez que apresentaram IC_{50} de 18,15 µg/mL para *Candida albicans* URM e 40,4 para *Candida tropicalis* INCQS 40042. Além disso, o óleo foi capaz de modular o fluconazol para todas as cepas analisadas. Quanto à ação antioxidante, o óleo demonstrou que, mesmo em baixas porcentagens, existe uma ação na redução de radicais livres (IC_{50}> 200 µg/mL). Tais atividades podem estar relacionadas ao principal constituinte

do óleo, o sesquiterpeno β-cariofileno ($C_{17}H_{28}O_2$). Assim, o óleo de *M. suaveolens* é uma fonte natural com propriedades antimicrobianas e antioxidantes.

Palavras-chave: *Hyptis suaveolens*; Óleo essencial; Modulação; Planta medicinal; DIP's; Caatinga.

Abstract

The use in folk medicine of leaves of *Mesosphaerum suaveolens* for the treatment of diseases of the digestive system and respiratory system, raised the hypothesis that its volatile oil has biological properties against pathogenic microorganisms. To evaluate this hypothesis, the antibacterial, antifungal activity against *Candida* yeast strains, which modifies the action of antibiotics and antioxidants (DPPH) was evaluated *in vitro*. In addition, it was determined by means of Gas Chromatography (GC-FID), the constituents present in the essential oil. The results show that *M. suaveolens* oil has antibacterial activity against standard and multidrug-resistant strains of *Staphylococcus aureus*, with a MIC of 64 and 256 µg/mL respectively, however it does not have the capacity to enhance the action of commercial antibacterials. Regarding the anti-*Candida* activity, it was possible to observe that there was biological action, since they presented IC_{50} de 18.15 µg/mL for *Candida albicans* URM and 40.4 for *Candida tropicalis* INCQS 40042. In addition, the oil was able to modulate fluconazole for all strains analyzed. As for the antioxidant action, the oil demonstrated that even in low percentages, there is an action in the reduction of free radicals (IC_{50}> 200 µg/mL). Such activities may be related to the major constituent of the oil, the sesquiterpene β-caryophyllene ($C_{17}H_{28}O_2$). Thus, *M. suaveolens* oil is a natural source with antimicrobial and antioxidant properties.

Keywords: *Hyptis suaveolens*; Essential oil; Modulation; Medicinal plant; DIP’s; Caatinga.

Resumen

El uso de hojas de *Mesosphaerum suaveolens* en la medicina popular para el tratamiento de enfermedades en el sistema digestivo y en el sistema respiratorio, planteó la hipótesis de que su aceite volátil tiene propiedades biológicas contra los microorganismos patógenos. Para probar esta hipótesis, se evaluaron *in vitro* las actividades antibacterianas y antifúngicas contra las cepas de levadura *Candida*, así como la modificación de antibióticos y el potencial antioxidante (DPPH). Además, se determinó por cromatografía de gases (GC-FID), los componentes presentes en el aceite esencial. Los resultados muestran que el aceite de *M. suaveolens* tiene actividad antibacteriana contra cepas estándar y resistentes a múltiples

fármacos de *Staphylococcus aureus*, con un MIC de 64 y 256 µg/mL, respectivamente, sin embargo, no tiene capacidad para mejorar la acción de los antibacterianos comerciales. Con respecto a la actividad anti-*Candida*, fue posible observar que hubo acción biológica, ya que presentaron IC_{50} de 18.15 µg/mL para *Candida albicans* URM y 40.4 para *Candida tropicalis* INCQS 40042. Además, el aceite pudo modular el fluconazol para todas las cepas analizadas. En cuanto a la acción antioxidante, el aceite demostró que, incluso en porcentajes bajos, existe una acción en la reducción de radicales libres (IC_{50}> 200 µg/mL). Dichas actividades pueden estar relacionadas con el componente principal del aceite, el sesquiterpeno β-cariofileno ($C_{17}H_{28}O_2$). Por lo tanto, el aceite de *M. suaveolens* es una fuente natural con propiedades antimicrobianas y antioxidantes.

Palabras clave: *Hyptis suaveolens*; Aceite esencial; Modulación; Planta medicinal; DIP's; Caatinga.

1. Introduction

Nosocomial infections are a major problem worldwide, because in addition to affecting immunocompromised individuals, organisms are showing resistance to antibiotics over time, due to their indiscriminate use (Rodrigues et al., 2019).

The main bacteria that are acquired in these environments are *Klebsiella pneumoniae*, *Staphylococcus epidermidis*, *Pseudomonas aeruginosa*, *Staphylococcus aureus* and *Escherichia coli*, the latter three being the most studied (Santos et al., 2019).

The bacterial strain, *P. aeruginosa* is a gram-negative bacillus that causes infections in several regions of the body, mainly in immunocompromised patients. Its ability to stay in different environments for a long time, in addition to developing resistance against antimicrobials has great consequences, such as a high mortality rate for patients (Bezerra et al., 2019).

Another factor that maximizes the problem is that *P. aeruginosa* has low levels of sensitivity to antimicrobial agents, in addition to having several resistance mechanisms such as the production of beta-lactamases, overexpression of efflux pumps and the loss or reduced expression of outer membrane proteins (Ferreira & Eliane, 2010; Veras et al., 2017).

The gram-negative uropathogenic strain *E. coli*, on the other hand, belongs to the Enterobacteriaceae family, which is characterized by presenting microorganisms capable of colonizing and causing infection in the urinary tract. It is worth mentioning that the infections

caused by this bacterium are not restricted to hospitals, they may be in the communities (Santos et al., 2019).

Finally, *S. aureus* is a gram-positive coccus-like bacterium that can cause diseases that differ in simple infections such as pimples, boils and cellulite and serious infections that are meningitis, pneumonia, endocarditis, toxic shock syndrome, among others (Rodrigues et al., 2019).

The resistance of *S. aureus* to antimicrobials is due to the appearance of resistance genes from other bacteria of the same species or possibly from other species and/or by mutations in their genes (Veras et al., 2017). Thus, due to resistance to commercial antibacterials, studies are needed that aim to modulate the action of drugs already known, since they have low toxicity and elucidated mechanisms of action (Coutinho et al., 2008; Costa et al., 2017).

Still dealing with diseases related to microbial resistance, fungal infections caused by yeasts of the genus *Candida*, it has been widely reported as a major problem for public health agencies (Navarro-Arias et al., 2019). These microorganisms are located in the oral cavity and mucous membranes. Many of them are symbiotic commensals, however, when the integrity of the mucosal barriers is affected or if the immune system is weak, they can cause disease (Martins et al., 2010).

To treat these fungal infections are generally used polyenes and derivatives of imidazol. However, some strains have become resistant to antifungal agents, so research is needed to find new drugs or products that can modulate the effect of standard drugs (Coutinho et al., 2008; Garcia-Cuesta et al., 2014).

Such products with modulating action may be of natural origin, such as medicinal plants, since they have the ability to produce compounds with bioactivities. Such compounds are derived from secondary metabolism, and are classified into phenolic compounds, alkaloids and terpenes, these can give rise to volatile terpenes, which are known as essential oils (Duarte et al., 2016; Bezerra et al., 2017).

Essential oils are complex mixtures of monoterpenes (C_{10}) and sesquiterpenes (C_{15}) that give aroma to plants, they can synergistically or in isolation, have biological and pharmacological actions, such as antimicrobials, insecticides, larva, antioxidant, among others.

Among the botanical taxa that stand out for presenting species that produce essential oils, is Lamiaceae. In this, oils have several purposes, such as use in cooking, medicine and aromatherapy (Raja, 2012; Uritu et al., 2018).

Figure 1. *Mesosphaerum suaveolens* population in an area of Caatinga (Type of seasonal tropical forest) in the state of Ceará - Brazil.

Source: Bezerra (2018).

In this taxon, some aromatic species are well known in popular medicine because they are used for various therapeutic purposes. Of these, *Mesosphaerum suaveolens* (L.) Kuntze (Figure 1), known in Brazil as "bamburral" and other locations in the world as "pignut", is popularly used in the treatment of diseases related to gastrointestinal and respiratory tract (Albuquerque et al., 2007).

Raised the hypothesis that its volatile oil has biological properties against pathogenic microorganisms. Thus, this work aimed to determine the chemical composition of the essential oil of *M. suaveolens* and to evaluate the antimicrobial effect against nosocomial microorganisms, as well as to verify if the oil has an antioxidant effect.

2. Materials and Methods

2.1 Methodological Details

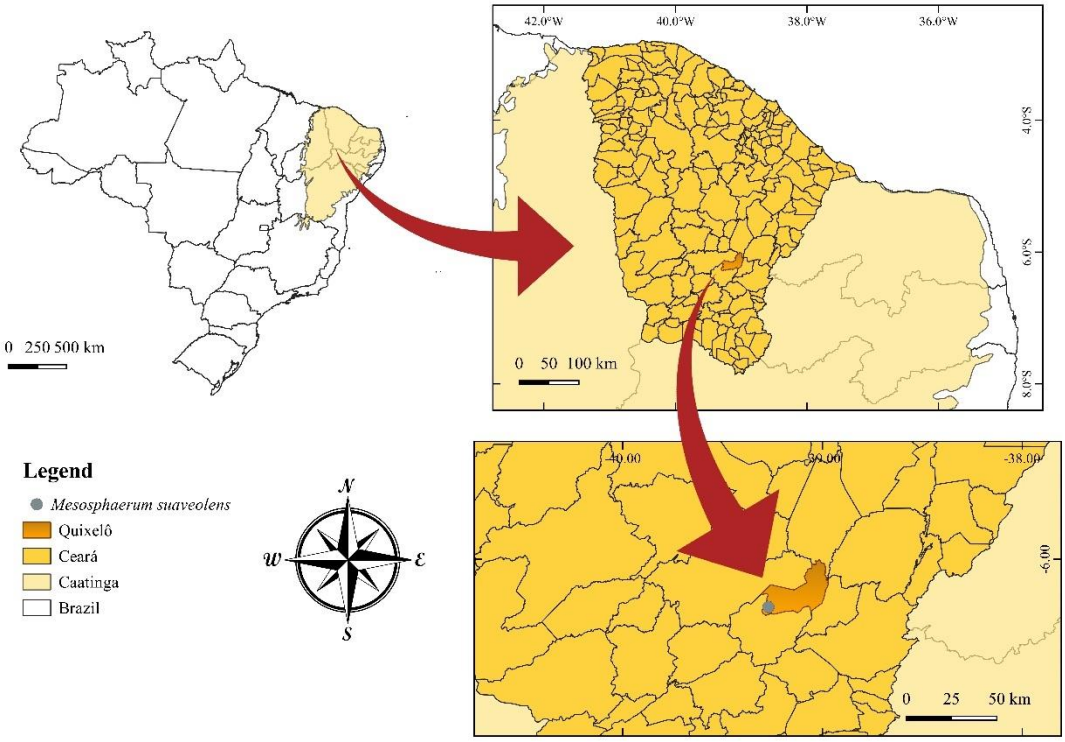
The present work consists of tests carried out in the laboratory and of a qualitative type, in order to investigate the composition as well as the antimicrobial properties of the essential oil of *Mesosphaerum suaveolens* leaves.

Phytochemical analysis of the essential oil was carried out by gas chromatographic methodology, for the identification and quantification of the compounds found. Antibacterial

properties were evaluated using the Minimum Inhibitory Concentration (MIC) methodology used by Bezerra et al. (2019) and by the broth microdilution technique (Coutinho et al., 2008). As well as the verification of antifungal and antioxidant activity by the method used in the study by Bezerra et al. (2019).

2.2 Collection of botanical material

Figure 2. Map of the collection of the species *Mesosphaerum suaveolens* in the state of Ceará, Brazil.



Source: Bezerra (2018).

Fresh leaves of *M. suaveolens* were collected in the municipality of Quixelô located in the state of Ceará (Brazil) (Figure 2).

2.3 Extraction of essential oil

The essential oil was extracted by the hydrodistillation system, in which the dried leaves were subjected to a constant boiling for the extraction of volatile compounds.

2.4 Phytochemical Analysis of Essential Oil by Gas Chromatography (GC-FID)

The gas chromatography (GC) analysis was performed with Agilent Technologies 6890N GC-FID system, equipped with DB-5 capillary column (30 m × 0.32 mm; 0.50 µm) and connected to a FID detector. The thermal programmer was 60 °C (1 min) to 180 °C at 3 °C/min; injector temperature 220 °C; detector temperature 220 °C; split ratio 1:10; carrier gas Helium; flow rate: 1.0 mL/min. The injected volume of *M. suaveolens* essential oil was 1 µL diluted in chloroform (1:10). Two replicates of sampleswere processed in the same way. Component relative concentrations were calculated based on GC peak areas without using correction factors (Bezerra et al., 2017).

2.5 Identification of the Components

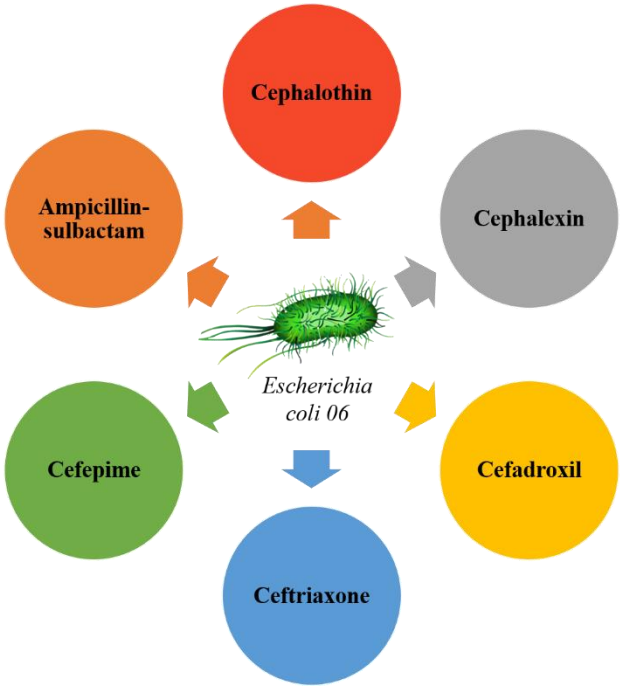
Identification of the constituents was performed on the basis of retention index (RI), determined with reference to the homologous series of n-alkanes, C_7–C_{30}, under identical experimental conditions, compared with the mass spectra library search (NIST and Wiley), and with the mass spectra literature date. The relative amounts of individual components were calculated based on the CG peak área (FID response).

2.6 Antibacterial Activity

2.6.1 Bacterial strains, culture media and drugs

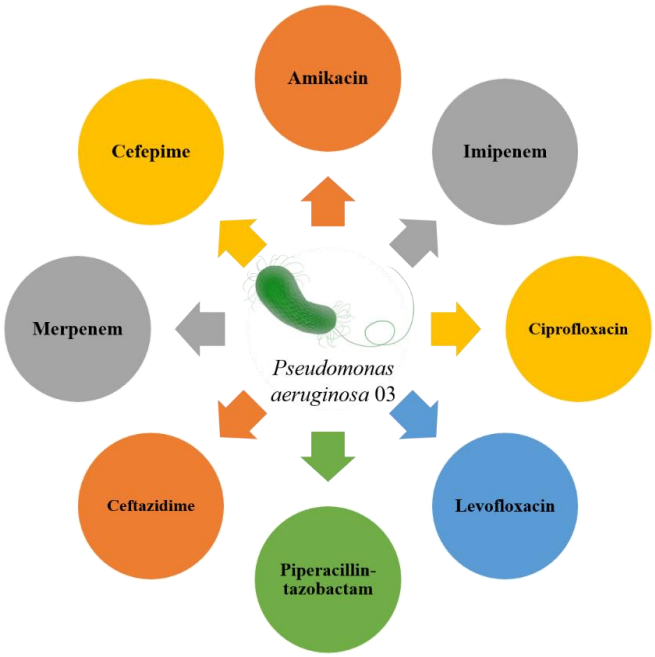
For the antibacterial tests, standard strains were used to determine minimum inhibitory concentration (MIC), being *E. coli* (ATCC 25922), *P. aeruginosa* (ATCC 25853) and *S. aureus* (ATCC 25923). In modulation tests and also in MIC, the resistant bacterial strains are: *E. coli* 06, in Figure 3 are all the dogresses to which this bacteria is resistant; *P. aeruginosa* 03, resistant to all antibacterials indicated in Figure 4; and *S. aureus* 10, Figure 5 describes the drugs to which this bacteria is resistant.

Figure 3. *Escherichia coli* 06 resistance profile to antibiotics from urine. Source: Laboratory of Microbiology and Molecular Biology - LMBM - Regional University of Cariri - URCA.



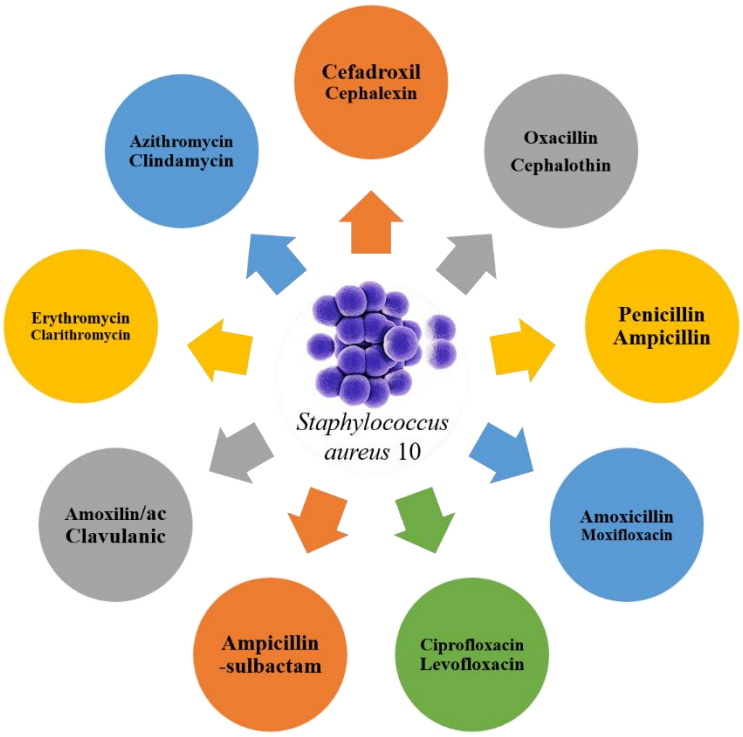
Source: Bezerra (2018).

Figure 4. *Pseudomonas aeruginosa* 03 resistance profile to antibiotics from Uroculture. Source: Laboratory of Microbiology and Molecular Biology - LMBM - Regional University of Cariri - URCA.



Source: Bezerra (2018).

Figure 5. *Staphylococcus aureus* 10 resistance profile to antibiotics from Rectal swab culture. Source: Laboratory of Microbiology and Molecular Biology - LMBM - Regional University of Cariri - URCA.



Source: Bezerra (2018).

Was used Brain Heart Infusion (BHI) broth as culture media for the growth of pathogenic bacteria. Regarding the drugs for the potentiation tests, gentamicin, Norfloxacin and Imipenem of the carbapenem class were used.

2.6.2 Minimal Inhibitory Concentration (MIC)

For determination of MIC, the methodology used by Bezerra et al. 2019 in which Eppendorf tubes was prepared a 1 mL solution containing 100 µL of inoculum and 900 µL of 10% BHI. Subsequently, this solution was distributed into 96 well plates filled in the numerical sense by the addition of 100 µL in each well. Subsequently, serial microdilutions were performed with 100 µL of the essential oil in concentrations ranging from 1,024 µg/mL to 1 µg/mL, thus, the plates were incubated for 24 hours at 37 °C. For reading the MIC was added 20 µL of a solution of resazurin in each well in order that the reactions occur oxirredutivas wells where there was bacterial growth. After 1 hour the color change of the

wells was observed, where the change from blue to red color corresponds to the microbial growth and the blue stay the absence of growth.

2.6.3 Effect modulator of antibiotics

Some natural products do not present antibacterial activity in concentrations of clinical interest, however, some of them are able to modulate the effect of common Antibiotic. In order to evaluate the modulating capacity of the essential oil, the methodology proposed by Coutinho et al. (2008) was used, in which, after the MIC tests with the resistant bacteria, the results were used to determine the sub-inhibitory concentrations (MIC/8) to be used with the antibiotics at concentrations ranging from 1,024 μg/mL to 1 μg/mL. Thus, for the tests, 1,162 μl of 10% BHI were used, with 150 μL of the inoculum of each strain and the essential oil with volume corresponding to a sub-inhibitory concentration, whereas the control group were prepared with only 1,350 of BHI (10%) and 150 of bacterial suspension. Subsequently a serial microdilution was performed using the antibiotic, being performed with 100 μL of each drug until the penultimate well. The plates were incubated (24 hours at 37 °C) and read through the addition of 20 μL of resazurin.

2.7 Antifungal Activity

2.7.1 Fungal strains

The following strains were used: *Candida albicans* CA INCQS 40006 and *Candida tropicalis* CT INCQS 40042 of National Institute of Quality Control in Health (INCQS) and *Candida tropicalis* LM 23 and *Candida albicans* LM 77 of Laboratory of Mycology of the Federal University of Paraíba (UFPB).

2.7.2 Determination of IC_{50} and cell viability curve

To determine the IC_{50}, the microdilution test in sabouraud dextrose broth was used (Bezerra et al., 2019). For that purpose, inoculants of *Candida* strains were added to each well, along with CDS and the natural product under study. Since it started from the concentration of 1.024 μg/mL and microdiluted to 1 μg/mL. Subsequently, the material was taken to a microbial growth oven at 37 °C for, after 24 hours, readings were performed on an

ELISA spectrophotometer (Termoplate) (630 nm). In addition, the minimum fungicidal concentration (MCF) was determined in a petri dish on sabouraud dextrose agar (SDA). As a reference control, fluconazole, of the azole class, was used.

2.7.3 Evaluation of the modulating effect of fluconazole

To assess whether the oil has the capacity to modulate the effect of the standard drug, sub-inhibitory concentrations (MFC/8) of the same were used. For this, the essential oil of *M. suaveolens* together with fluconazole was added in plates containing the culture medium and the inoculum. The procedures follow item 2.6.2.

2.8 Antioxidant activity against free radical DPPH

The methodology followed Bezerra et al. (2019). In which solutions of DPPH (0.3 mM) were tested against different concentrations (25-250 µg/mL) of the essential oil of *M. suaveolens*. The medium was placed at rest for 30 minutes (25 °C) and later its absorbance was read at a wavelength of 517 nm. As a positive control, arscorbic acid (Vitamin C) was used.

2.9 Statistical analysis

The results were measured, their averages and respective standard deviations were calculated, to be subsequently submitted to a one-way analysis of variance in GraphPad Prism (6.0), followed by a Tukey test at 95% reliability. Finally, the CL_{50} were calculated by linear regression of antifungal activities.

3. Results and Discussion

As can be seen from Table 1, the essential oil is rich in mono and sesquiterpenes, with sesquiterpenes being the majority of the compounds found. Among the 44 compounds identified in the essential oil of *M. suaveolens*, the highlights are β-Caryophyllene (18.6%), Sabinene (15.92%), spathulenol (11.08%), main compounds.

Table 1. Composition of *Mesosphaerum suaveolens* essential oil.

Compounds	RI[a]	RI[b]	oil %
α-Thujene	989	931	1.07
α-Pinene	940	939	0.87
Sabinene	976	976	15.92
β-Pinene	980	980	2.13
Myrcene	994	991	0.23
δ-2-Carene	999	1001	0.52
α-Phellandrene	1006	1005	1.34
α-Terpinene	1019	1018	1.09
p-Cymene	1030	1029	0.71
Limonene	1031	1031	5.24
1-8-Cineole	1037	1033	3.01
(Z)-β-Ocimene	1041	1040	0.1
(E)-β-Ocimene	1055	1050	0.11
γ-Terpinene	1060	1061	2.98
cis-Sabinene hydrate	1068	1068	0.59
Linalool	1095	1098	0.45
cis-p-Menth-2-en-1-ol	1123	1121	0.25
t-Sabinol	1139	1140	0.18
4-Tepineol	1178	1177	6.79
p-Cymen-8-ol	1183	1183	0.26
α-Terpineol	1191	1189	0.95
δ-Elemene	1335	1338	1.16
α-Copaene	1377	1376	0.07
β-Elemene	1390	1391	0.8
β-Cedrene	1416	1417	0.11
β-Caryophyllene	1421	1418	18.6
β-Gurjunene	1433	1432	0.28
γ-elemene	1435	1433	1.39
aromadendrene	1439	1439	0.30
α-humelene	1453	1454	1.19
alloaromadendrene	1461	1462	0.49
γ-muurolene	1477	1477	0.19
germacreno D	1481	1480	5.20
β-selinene	1486	1485	0.9
Bicyclogermacrene	1501	1488	7.50
γ-cadinene	1512	1513	0.38
δ-cadidene	1525	1520	0.09
germacrene B	1559	1556	0.28
spathulenol	1576	1576	11.08
caryophyllene oxide	1580	1581	3.11
globulol	1582	1583	0.69
Cubenol	1641	1642	1.06
β-eudesmol	1649	1649	0.14
α-Cadinol	1656	1653	0.45
Total identified (%)			**99.97**

Relative proportions of the essential oil constituents were expressed as percentages. [a]Retention indices experimental (based on homologous series of *n*-alkane C_7-C_{30}). [b]Retention indices from literature.
Source: The Author

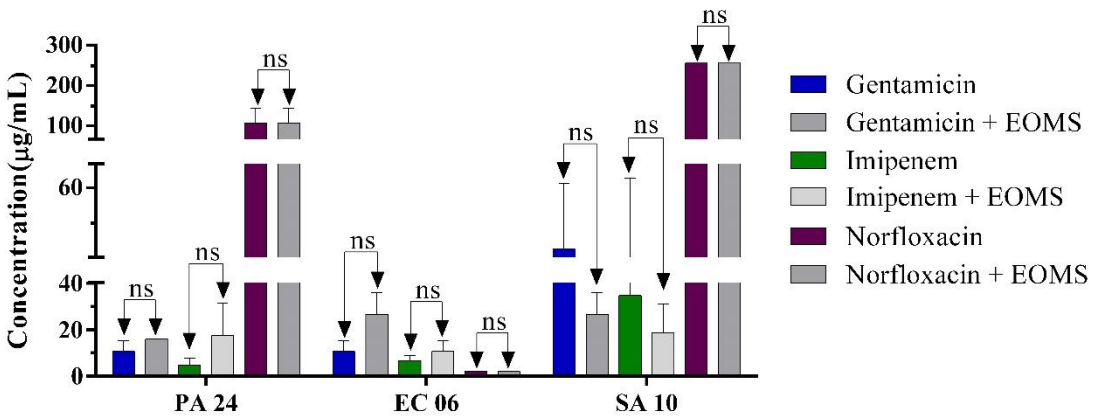
As can be seen from Table 2, the essential oil of *M. suaveolens* was able to inhibit the growth of *S. aureus*, both the standard and the resistant strain with MIC of 64 and 256 µg/mL, respectively. For the strains of *P. aeruginosa* and *E. coli* no growth inhibition was observed.

Table 2. Minimal Inhibitory Concentration (µg/mL) of essential oil of *Mesosphaerum suaveolens* against conventional bacterial (ATCC) and multiresistant strains.

Strains	*Pseudomonas aeruginosa*	*Escherichia coli*	*Staphylococcus aureus*
Strains standards (ATCC)	>512	>512	64
Multi-resistant Strains	>512	>512	256

Source: The Author

Figure 6. Antibiotic modifying potential of *Mesosphaerum suaveolens* essential oil.

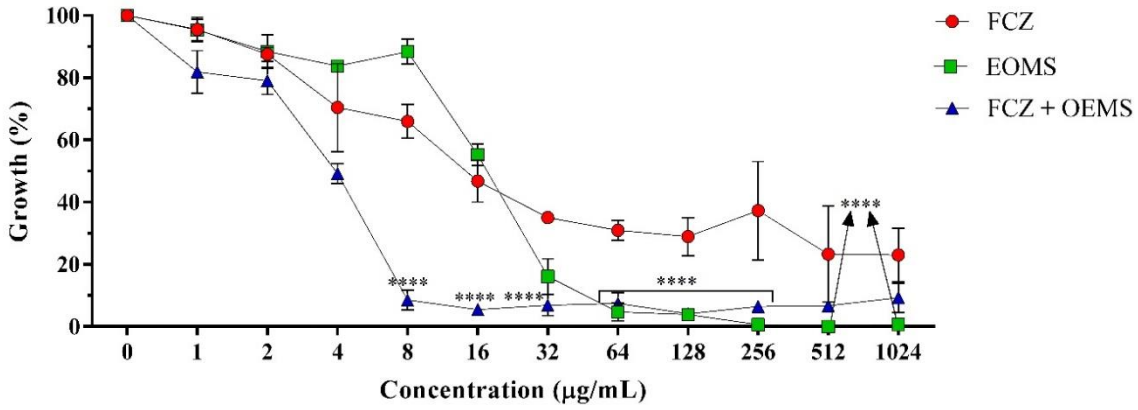


Source: Bezerra (2018).

Figure 6 shows the effect of combining essential oil with clinically used antibiotics. The data obtained were not significant, which shows that the essential oil of M. suaveolens has no modulating effect among the tested drugs.

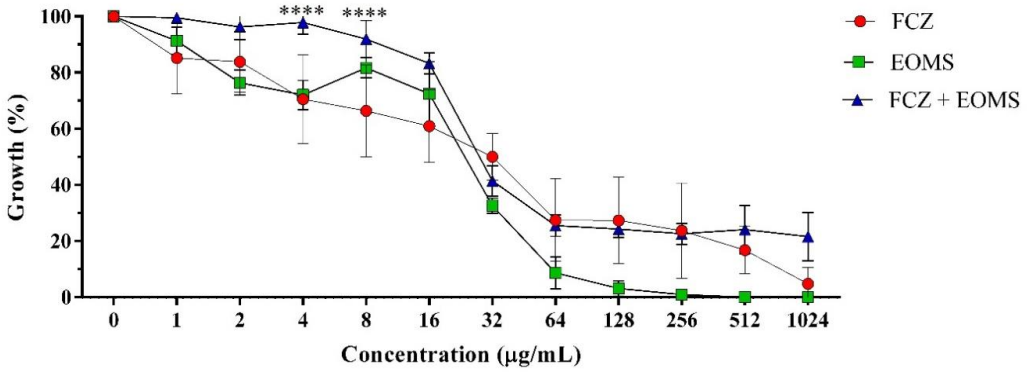
The results of antifungal activity indicate that the essential oil of *M. suaveolens* has chemical constituents with antifungal potential in concentrations of clinical interest. In Figure 7, it is noted that for strains of *Candida albicans* 77 URM, the product reduced cell growth from the concentration of 1 µg/mL, showing a concentration-dependent anti-*Candida* action. Moreover, the oil was able to completely inhibit growth at a concentration of 256 µg/mL, thus being a fungicidal drug type. The same effect for *Candida albicans* 40006 INCQS strains, shown in Figure 8. Regarding the modulation of fluconazole, the volatile terpenes of the species had a significant effect (p <0.0001) in concentrations ≥ 8 µg/mL for the first strains. However, for *C. albicans* 40006, the oil had an antagonistic effect at concentrations of 4 and 8 µg/mL. Such antifungal effects are promising, since the IC_{50} of the isolated and combined essential oil is <100 µg/mL (Table 3).

Figure 7. Antifungal and modulatory effect of essential oil of *Mesosphaerum suaveolens* (EOMS) against *Candida albicans* 77 URM strains. $p<0.0001$.



Source: Bezerra (2018).

Figure 8. Antifungal and modulatory effect of essential oil of *Mesosphaerum suaveolens* (EOMS) against *Candida albicans* 40006 INCQS strains. $p<0.0001$.



Source: Bezerra (2018).

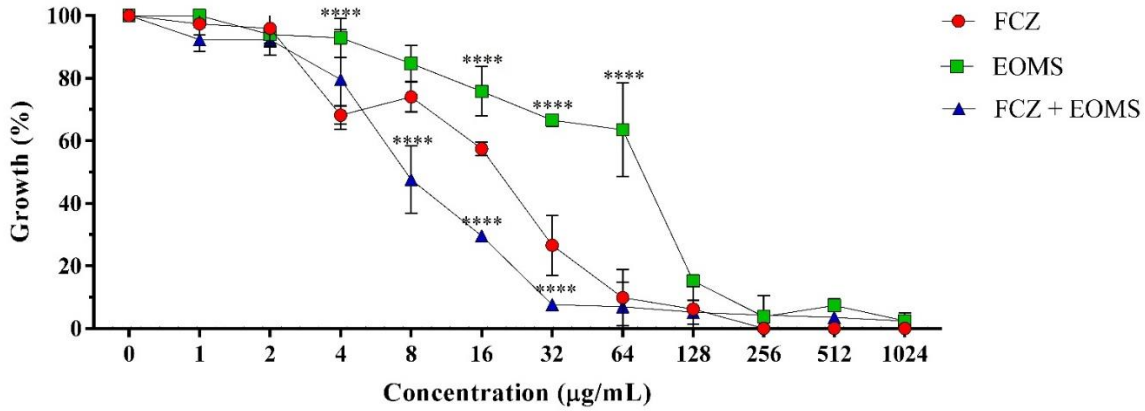
Table 3. Inhibitory concentration (IC_{50} µg/mL) of the Essential Oil of *Mesosphaerum suaveolens* (EOMS) against species from the *Candida* genus.

Products Tested	**Strains**			
	CA URM 77	**CA INCQS 40006**	**CT URM 23**	**CT INCQS 40042**
Fluconazole (FCZ)	7.09	29.81	17.03	363
EOMS	18.15	27.46	65.52	40.4
EOMS + FCZ	3.88	23.5	8.1	8.87

Legend: CA: *Candida albicans*; CT: *Candida tropicalis*; INCQS: National Institute for Health Quality Control. URM: University Recife Mycology. Source: Bezerra (2018).

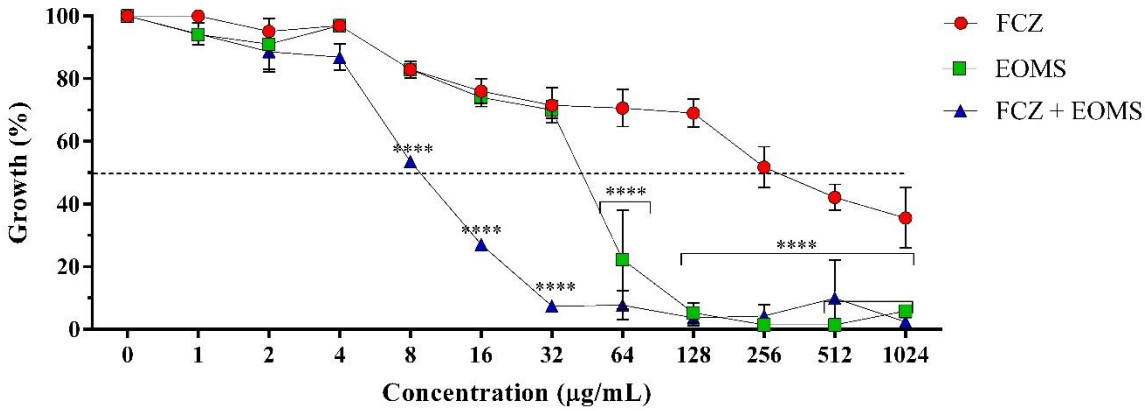
According to Figure 9, the growth of the *Candida tropicalis* 23 URM colony was reduced by the essential oil of *M. suaveolens*, and the product had a MIC >1.024 µg/mL. For this group of yeasts, there was a significant modulating action (p <0.0001) from the concentration of 8 µg/mL, in addition there was a reduction in its IC_{50} from 17.03 µg/mL to 8.1 µg/mL. As for *Candida tropicalis* 40042 INCQS, this strain showed resistance to fluconazole (Figure 10), as it presented an IC_{50} of 363 µg/mL, considered high when compared with the other strains of the genus (Table 3). As for the activity of *M. suaveolens*, its oil showed both antifungal activity (40.4 µg/mL) as a modulator fluconazole (8.87 µg/mL).

Figure 9. Antifungal and modulatory effect of essential oil of *Mesosphaerum suaveolens* (EOMS) against *Candida tropicalis* 23 URM strains. p<0.0001.



Source: Bezerra (2018).

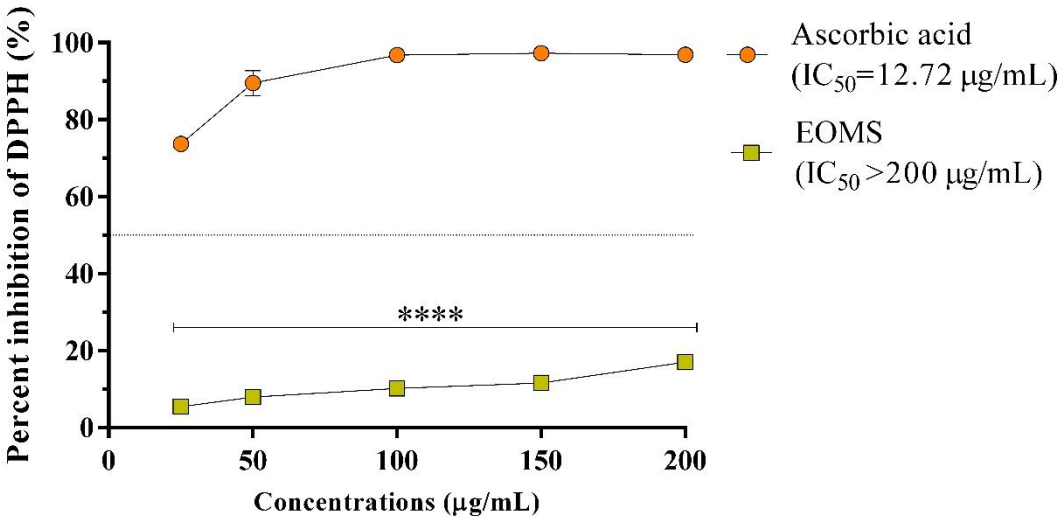
Figure 10. Antifungal and modulatory effect of essential oil of *Mesosphaerum suaveolens* (EOMS) against *Candida tropicalis* 40042 INCQS strains. p<0.0001.



Source: Bezerra (2018).

The essential oil of *M. suaveolens* did not show significant *in vitro* antioxidant activity (p <0.0001) against the free radical DPPH when compared to the positive control. Although there is no significance, the oil has a rate of about 20% inhibition of free radicals (Figura 11).

Figure 11. Antioxidant activity of essential oil of *Mesosphaerum suaveolens* (EOMS) against the free radical DPPH. p<0.0001.



Source: Bezerra (2018).

The anti-*Candida* activity observed in this study was remarkable, such an effect can also be attributed to its major compound, β-Caryophyllene. This sesquiterpene is a remarkable compound with antifungal activity against *Aspergilus niger* ATCC 40067 (MIC: 500 µg/mL), *Fusarium solari* ATCC 40099 (MIC: 1,000 µg/mL), *Aspergilus fumigatus* ATCC 40014 (MIC: 500 µg/mL) and *Aspergilus parasiticum* ATCC 40100 (MIC: 1,000 µg/mL) (Selestino et al., 2017). This constituent, in addition to helping to combat pathogenic fungi, can act to fight cancer cells as evidenced by Ramachandhiran et al. (2019). The mechanism of action used by the bicyclic sesquiterpene is to promote oxidative stress and apoptosis in KB cells through activation of the mitochondrial-mediated pathway.

Costa et al. (2020), demonstrated that the aqueous extracts of the leaves and aerial parts (leaves, stem, flowers, fruits and seeds) of *M. suaveolens* are also capable of modulating the effect of fluconazole when evaluated against strains of *C. albicans* (77 URM and 40006 INCQS) and *C. tropicalis* (23 URM and 40042 ICQS).

Regarding the antioxidant action, although low, the essential oil of the species under study is able to reduce the amount of free radicals. Bezerra et al. (2018) evaluated the

antioxidant potential of extracts of the species, and found excellent results, being the most notable for the ethanolic extract of the leaves that presented an IC_{50} of 7.06 ± 0.82 μg/mL, and the aqueous extract of the same organs presented 20.32 ± 0.61 μg/mL of IC_{50}. Such differences can be attributed to the chemical constitution of the products, since the essential oil is composed of terpenes (isoprene units) while the extracts are rich in phenolic compounds (Bezerra et al., 2017).

There are many scientific contributions in the literature about the action of natural products and their derivatives. Some essential oils are retarded because they have antimicrobial and antioxidant activities that can be attributed to their chemical constitution. Our study contributed to the chemical profile of the essential oil of *Mesosphaerum suaveolens* leaves, as well as its antibacterial activity against the Gram-positive bacteria *S. aureus*. The results of the antifungal activity indicate that the essential oil of *M. suaveolens* has chemical constituents with antifungal potential in concentrations of clinical interest. It showed no antioxidant activity.

4. Conclusion

The objectives described in this study have been achieved. We identified the chemical profile of *Mesosphaerum suaveolens* essential oil, indicating that the compounds β-Caryophyllene, Sabinene and spathulenol are found in their composition in greater quantity. The essential oil of *Mesosphaerum suaveolens* exhibits antibacterial activity against strains of *Staphylococcus aureus* so that its phytochemicals can be used in the formulation of new drugs. Regarding antifungal activity, it is possible to note that the species is a source of compounds with activity against *Candida* strains. It showed no antioxidant activity. Additional toxicity studies must be carried out to determine the toxic profile of this natural product.

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