Research, Society and Development, v. 9, n. 10, e9599109270, 2020
(CC BY 4.0) | ISSN 2525-3409 | DOI: http://dx.doi.org/10.33448/rsd-v9i10.9270

Eremanthus arboreus (Gardner) MacLeish (Candeeiro)*:* natural source of α-Bisabolol

Eremanthus arboreus (Gardner) MacLeish (Candeeiro): fonte natural de α-Bisabolol

Eremanthus arboreus (Gardner) MacLeish (Candeeiro): fuente natural de α-Bisabolol

Received: 10/14/2020 | Reviewed: 10/21/2020 | Accept: 10/26/2020 | Published: 10/29/2020

Gledson Ferreira Macedo
ORCID: https://orcid.org/0000-0002-2609-6894
Regional University of Cariri, Brazil
E-mail: gled_fer@yahoo.com.br
José Weverton Almeida-Bezerra
ORCID: https://orcid.org/0000-0002-0966-9750
Federal University of Pernambuco, Brazil
E-mail: weverton.almeida@urca.br
Viviane Bezerra da Silva
ORCID: https://orcid.org/0000-0003-0581-2609
Regional University of Cariri, Brazil
E-mail: viviane.silva@urca.br
Elvis Estilak Lima
ORCID: https://orcid.org/0000-0002-1707-6736
Regional University of Cariri, Brazil
E-mail: elviselima@gmail.com
Saulo Almeida de Menezes
ORCID: https://orcid.org/0000-0001-6657-585X
Federal University of Pernambuco, Brazil
E-mail: saulomenezes99@gmail.com
Benedito Yago Machado Portela
ORCID: https://orcid.org/0000-0001-6799-3017
Catholic University Center of Quixadá, Brazil
E-mail: yagoportelaadm@gmail.com
Bruna Letícia Pereira Braga
ORCID: https://orcid.org/0000-0001-5745-4861
Federal Rural University of Pernambuco, Brazil
E-mail: brunaleticiapb@gmail.com

Janete de Souza Bezerra
ORCID: https://orcid.org/0000-0002-2674-0790
Regional University of Cariri, Brazil
E-mail: janete.bezerra@urca.br
Maraiza Gregorio de Oliveira
ORCID: https://orcid.org/0000-0002-2855-641X
Regional University of Cariri, Brazil
E-mail: maraaiza0104@hotmail.com
Damares Ribeiro Alencar
ORCID: https://orcid.org/0000-0001-8220-1567
Regional University of Cariri, Brazil
E-mail: damarisalencar@hotmail.com
Adrielle Rodrigues Costa
ORCID: https://orcid.org/0000-0003-1518-0115
Regional University of Cariri, Brazil
E-mail: adrielle.arc@gmail.com
Mikael Amaro de Souza
ORCID: https://orcid.org/0000-0001-7085-5870
Regional University of Cariri, Brazil
E-mail: mikael.amaro.08@hotmail.com
João Cruz Neto
ORCID: https://orcid.org/0000-0002-0972-2988
Regional University of Cariri, Brazil
E-mail: enfjcncruz@gmail.com
Thaís da Conceição Pereira
ORCID: https://orcid.org/0000-0002-1022-7466
Faculty of Juazeiro do Norte, Brasil
E-mail: thaispereira1914@gmail.com
Francisco Sydney Henrique da Silva
ORCID: https://orcid.org/0000-0002-4771-6570
Catholic University Center of Quixadá, Brazil
E-mail: sidneyhenrique.08@hotmail.com

Abstract

There is a growing search in the chemical composition of essential oils, as they have biological and pharmacological activities. Among the plants with homogeneous composition in essential oils stands out the species *Eremanthus arboreus* (Gardner) MacLeish, (Asteraceae) popularly known as the "candeeiro". This plant species is native to Chapada of Araripe - Ceará, Brazil. The objective was to characterize chemically the constituents of the essential oil (OE) of *E. arboreus* by means of Gas Chromatography and perform a review of its biological and pharmacological activities. The botanical material was collected in Chapada of Araripe, Barbalha - CE, Brazil, in April 2014, the extraction and collection of OE was done in Clevenger apparatus. The chemical composition of the OE was performed by Gas Chromatography coupled to Mass Spectrometry (CG/MS). As for the review, specialized scientific bases (Scopus, Scielo and Web of Science) were consulted. According to the results, 8 constituents were identified, where α-Bisabolol is mentioned as being the main component of the essential oil of this species. As for the biological and pharmacological activities of the OE, it was demonstrated that the species has the following activities: antimicrobial, larvicide, anti-inflammatory and antinociceptive. *Eremanthus arboreus* is a species with great pharmaceutical potential and also an alternative for industries that target products based on the constituent α-Bisabolol.

Keywords: Terpenes; Sesquiterpene; Asteraceae; Review; *Vanillosmopsis arborea*.

Resumo

Há uma busca crescente na composição química dos óleos essenciais, por apresentarem atividades biológicas e farmacológicas. Dentre as plantas com composição homogênea em óleos essenciais destaca-se espécie *Eremanthus arboreus* (Gardner) MacLeish, (Asteraceae) conhecida popularmente como o candeeiro. Esta espécie vegetal é nativa da Chapada do Araripe - Ceará, Brasil. Objetivou-se caracterizar quimicamente os constituintes do óleo essencial (OE) de *E. arboreus* por meio da Cromatografia Gasosa e realizar uma revisão de suas atividades biológicas e farmacológicas. O material botânico foi coletado na Chapada do Araripe, Barbalha - CE, Brasil, em abril de 2014, a extração e coleta de OE foram feitas em aparelho de Clevenger. A composição química do OE foi realizada por Cromatografia Gasosa acoplada a Espectrometria de Massa (CG/MS). Quanto à revisão, foram consultadas bases científicas especializadas (Scopus, Scielo e Web of Science). De acordo com os resultados, 8 constituintes foram identificados, onde o α-Bisabolol é mencionado como sendo o

componente principal do óleo essencial desta espécie. Quanto às atividades biológicas e farmacológicas do OE, foi demonstrado que a espécie apresenta as seguintes atividades: antimicrobiana, larvicida, anti-inflamatória e antinociceptiva. *Eremanthus arboreus* é uma espécie com grande potencial farmacêutico e também uma alternativa para as indústrias que visam produtos baseados no constituinte α-Bisabolol.

Palavras-chave: Terpenos; Sesquiterpeno; Asteraceae; Revisão; *Vanillosmopsis arborea*.

Resumen

Existe una búsqueda creciente en la composición química de los aceites esenciales, ya que tienen actividades biológicas y farmacológicas. Entre las plantas con composición homogénea en aceites esenciales destaca la especie *Eremanthus arboreus* (Gardner) MacLeish, (Asteraceae) conocida popularmente como la lámpara. Esta especie de planta es originaria de Chapada del Araripe - Ceará, Brasil. El objetivo fue caracterizar químicamente los constituyentes del aceite esencial (OE) de *E. arboreus* mediante Cromatografía de Gases y realizar una revisión de sus actividades biológicas y farmacológicas. El material botánico fue recolectado en Chapada del Araripe, Barbalha - CE, Brasil, en abril de 2014, la extracción y recolección de OE se realizó en el aparato *Clevenger*. La composición química del OE se realizó mediante cromatografía de gases acoplada a espectrometría de masas (CG/MS). En cuanto a la revisión, se consultaron bases científicas especializadas (Scopus, Scielo y Web of Science). De acuerdo con los resultados, se identificaron 8 constituyentes, donde se menciona al α-Bisabolol como el componente principal del aceite esencial de esta especie. En cuanto a las actividades biológicas y farmacológicas de la OE, se demostró que la especie tiene las siguientes actividades: antimicrobiana, larvicida, antiinflamatoria y antinociceptiva. *Eremanthus arboreus* es una especie con gran potencial farmacéutico y también una alternativa para las industrias que se dirigen a productos basados en el constituyente α-Bisabolol.

Palabras clave: Terpenos; Sesquiterpeno; Asteraceae; Revisión; *Vanillosmopsis arborea*.

1. Introduction

In Brazil, the genus *Eremanthus* is recognized for its high vegetation diversity in areas of Cerrado and Campos Rupestres. The genus comprises about 20 species, most of which are popularly called “candeias”, because they are used as candles by traditional communities

(Zappi et al., 2015). In the Chapada of Araripe located in the south of the state of Ceará (Brazil), a species belonging to the genus is *Eremanthus arboreus* (Gardner) MacLeish, an endemic tree of the Cariri region that grows up to 4 m in height and is popularly known as "candeeiro" (Cavalcanti & Nunes, 2002). The popular name of this species is due to the wood of this plant to easily promote its combustion which is used by the populations at night (Teixeira et al., 2018).

The *E. arboreus* specie has a high economic value due to the high content of its main chemical constituent, α-bisabolol ($C_{15}H_{26}O$). This constituent is a sesquiterpene found also in *M. chamomilla*, its main use is in dermatological products, as it has low toxicity and antimicrobial, antifungal and anti-inflammatory properties (Rodrigues et al., 2018). The α-bisabolol after being drawn varies from colorless to light yellow, has a point slightly viscous and strong floral scent, because of this feature is widely used for flavoring liquids and foods also being present in the make-up preparations, eye creams , moisturizers, antiperspirants, cleaning products and sunscreens (Saltão & Veiga, 2001; Bhatia et al., 2008).

The sesquiterpene under study has important biological and pharmacological activities, such as: antiparasitic activity against strains of Leishmania (Morales-Yuste et al., 2010; Corpas-López et al., 2018), gastroprotective activity (Bezerra et al., 2009; Rocha et al., 2011), anti-tumor activity in gliomas cells and induction of apoptosis (Cavalieri et al., 2004), anti-inflammatory activity and visceral antinociceptive activity (Leite et al., 2011), cytotoxic activity and antimutagenic activity (Gonçalves et al., 2011), antifungal activity (Van Zyl et al., 2006), antibacterial and modulating antibiotics (Brehm-Stecher & Johnson, 2003; Forrer et al., 2013; Oliveira et al., 2017).

Thus, the objective of this study was to chemically characterize the essential oil composition of *E. arboreus* by means of Gas Chromatography and to perform a review of its biological and pharmacological activities.

2. Methodology

2.1 Plant Material

In April 2014 the bark of *E. arboreus* was collected in the Chapada of Araripe in Barbalha, Ceará, Brazil under coordinates Lat: 7°22'6.10 "S, Long: 39°19'43.72" W. The collection time was at 9:00 a.m. to avoid that during hot times, the phytoconstituents did not volatize.

2.2 Extraction of Essential Oil

The extraction of the essential oil of *E. arboreus* was carried out in hydrodistillation system as proposed by Matos (2009). The *E. arboreus* bark was dried in a drying oven at 35ºC and crushed. Subsequently, 200 g of the shells were taken to the hydrodestination system with 4 liters of distilled water, and subjected to constant boiling for 2 hours. The essential oil was collected and stored in an amber bottle until the time of the phytochemical analysis.

2.3 Chemical Composition of Essential Oil

The essential oil after preparation was submitted to GC analysis in a Varian 3800 Gas Chromatograph equipped with a capillary fused silica column (25 m × 0.25 mm) coated with SE-54. The GC conditions used were: carrier gas He (1 mL/min); on column injector 200 °C; FID 250 °C; column temperature 60 °C to 325 °C at 4 °C/min. GC-MS analyses were performed on an HP 5973 - 6890 GC-MSD system operating in the EI mode at 70 eV, equipped with an HP-5 cross-linked capillary column (30 m × 0.25 mm). The temperature of the column and the injector were the same as those from GC.

Identification of the constituents of *Eremanthus arboreus* (candeeiro) essential oil was based on retention index (RI), determined with reference of the homologous series of n-alkanes, C7-C30, under identical experimental conditions, comparing with the mass comparison of the mass spectra with those of NBS Library (Massada, 1995) and those described by Adams (2017). The relative amounts of individual components were calculated based on the CG peak area (FID response).

2.4 Literature review

The bibliographical review consisted of the terms "*Vanillosmopsis arborea", "Eremanthus arboreus"* and "candeeiro" and was included in the Scopus, Scielo and Web of Science research bases, the publication period was not taken into account. The findings were categorized according to the biological and pharmacological properties of the species.

3. Results

3.1 Chemical composition

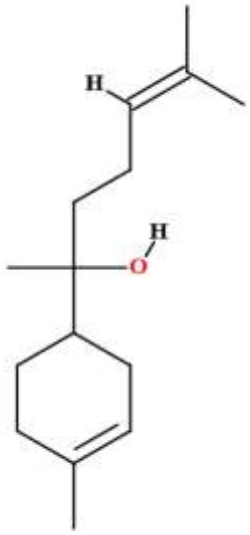
According to our results (Table 1), the phytochemistry of the essential oil of *E. arboreus* presented a homogeneous composition, since there were a total of 8 phyto-constituents. Among these, the major compounds were α-Bisabolol (Figure 1) with 81.09% presence in the essential oil. The percentage of other constituents reaches only 18.7%, so that α-Bisabolol was the terpene that dominated the composition of this oil.

Table 1. Composition of the *Eremanthus arboreus* essential oils.

Compounds	**RI[a]**	***E. arboreus***	
		RI[b]	**(%)**
Eugenol	1356	1353	1.73
β-Cubebene	1389	1390	1.08
β-guaiene	1438	1439	4.15
β-Bisabolene	1511	1509	0.96
Elemicin	1557	1554	3.82
α-Cadinol	1650	1653	1.49
α-Bisabolol	1682	1683	81.09
Bisabolol oxide	1745	1744	5.47
Total identified (%)			**99.79**

Relative proportions of the essential oil constituents were expressed as percentages.
[a]Retention indices from literature (Adams[20]).
[b]Retention indices experimental (based on homologous series of *n*-alkane C_7-C_{30}).
Source: Authors, (2020).

Figure 1. Chemical structure of α-Bisabolol.



Source: Authors, (2020).

3.2 Review of the biological and pharmacological activities of *Eremanthus arboreus*

According to Table 2, as regards the activities of *E. arboreus*, it is reported that its essential oil has biological and pharmacological properties. As for the biological, it is shown that the essential oil besides antiparasitic action (Mota et al., 2012; Colares et al., 2013), antibacterial (Santos et al., 2011; Santos et al., 2013; Rodrigues et al., 2018) and antifungal (Rodrigues et al., 2018), is able to modulate the action of commercial drugs (Santos et al., 2011; Rodrigues et al., 2018), in addition, the essential oil and the ethanolic extract of the shells have larvicidal properties (Costa et al., 2010). Although there are extensive biological activities of *E. arboreus*, it has been demonstrated that the species does not present allelopathic action (Marco et al., 2015). Following the review, the essential oil has been extensively studied from a pharmacological point of view, so that there are many studies focusing on the antinociceptive action of the oil of the species (Leite et al., 2011a; Leite et al., 2011b; Leite et al., 2014; Santos et al., 2015), in addition, it has been demonstrated that there are other oil activities such as anti-inflammatory (Santos et al., 2015; Leite et al., 2011), sedative and gastroprotective (Santos et al., 2015; Leite et al., 2009).

Table 2. Biological and pharmacological activities of *Eremanthus arboreus*.

Product of *E. arboreus*	**Activity**	**Reference**
Essential oil	Antibacterial	Santos et al., 2011; Santos et al., 2013; Rodrigues et al., 2018
Essential oil	Antifungal	Rodrigues et al., 2018
Essential oil	Drug modulator	Santos et al., 2011; Rodrigues et al., 2018
Essential oil	Antinociceptive	Leite et al., 2011a; Leite et al., 2011b; Leite et al., 2014; Santos et al., 2015
Essential oil	Larvicide	Furtado et al., 2005; Silva et al., 2017
Essential oil	Anti-inflammatory	Santos et al., 2015; Leite et al., 2011a
Essential oil	Sedative	Santos et al., 2015
Essential oil	Antiparasitic	Mota et al., 2012; Colares et al., 2013
Essential oil	Gastroprotector	Leite et al., 2009
Ethanolic extract	Larvicide	Costa et al., 2010

Source: Authors, (2020).

4. Discussion

In fact, the specie under study is a natural source of α-Bisabolol, since its values were high. This composition corroborates with other authors about the major constituent of oil (Santos et al., 2013; Santos et al., 2015; Rodrigues et al., 2018). However there are some variations as to the amount of constituents and their percentage. In the study by Rodrigues et al (2018), the essential oil of the species shows only 4 compounds, being bisabolol oxide, α-bisabolol, eugenol methyl ether and diisooctyl phythalate. These two last ones were not found in our essential oil.

This variation in oil is due to several factors that are endogenous, such as genetic, or exogenous. In this case, the external factors that influence the chemical compositions of the essential oils are the levels of ultraviolet radiation, herbivory, climatic conditions, the mode and time of collection, the extraction method, and especially the geographical origin of the vegetal material (Bezerra et al., 2017; Gerdakaneh, Mohammadi, & Arji, 2018).

In the popular culture of Chapada of Araripe (Ceará-Brazil), the species *Eremanthus arboreus* is used as mosquito repellent due to the production of oil by the shells, supporting the hypothesis that this oil has other biological or pharmacological activities (Furtado et al., 2005). The species also has proven biological activities, including antiparasitic (Mota et al., 2012; Colares et al., 2013), antibacterial (Santos et al., 2011; Santos et al., 2013; Rodrigues et al. , 2013; Rodrigues et al., 2013;., 2018) and antifungal (Rodrigues et al., 2018) of essential oil.

These activities can be attributed to the presence of the major compost α-Bisabolol. In the case of the antifungal action of the essential oil for *Candida* Berkh. strains, this can be justified because the major constituent interferes in the biosynthetic pathways, such as ergosterol, causing structural and morphological alterations, essential for fungus survival (Ahmad et al., 2011; Rodrigues et al., 2018).

5. Conclusion

Thus, it is evident that *E. arboreus* is a species with great pharmaceutical potential and also an alternative for the pharmaceutical industries to obtain the mentioned sesquiterpene α-bisabolol. However, it should be pointed out that management studies of the species must be carried out in order to avoid extinction, since it is endemic to the southern region of Ceará in Brazil.

References

Adams, R. P. (2017). *Identification of essential oil components by Gas chromatography/mass spectroscopy* (5nd ed.). Gruver, TX UDA: Texensis Publishing.

Ahmad, A., Khan, A., Akhtar, F., Yousuf, S., Xess, I., Khan, L. A., & Manzoor, N. (2011). Fungicidal activity of thymol and carvacrol by disrupting ergosterol biosynthesis and

membrane integrity against *Candida*. *European journal of clinical microbiology & infectious* diseases, 30(1), 41-50.

Marco, C. A., Santos, H. R., Feitosa, A. S., Feitosa, J. V., & Costa, J. M. (2015). Teor, rendimento e qualidade do óleo essencial de *Vanillosmopsis arbórea* (Gardner) Baker (candeeiro) e sua ação alelopática. *Revista Cubana De Plantas Medicinales,* 20(1).

Bezerra, J. W. A., Costa, A. R., da Silva, M. A. P., Rocha, M. I., Boligon, A. A., da Rocha, J. B. T., ... & Kamdem, J. P. (2017). Chemical composition and toxicological evaluation of *Hyptis suaveolens* (L.) Poiteau (LAMIACEAE) in *Drosophila melanogaster* and *Artemia salina*. *South African Journal of Botany*, 113, 437-442.

Bezerra, S. B., Leal, L. K. A. M., Nogueira, N. A. P., & Campos, A. R. (2009). Bisabolol-induced gastroprotection against acute gastric lesions: role of prostaglandins, nitric oxide, and K+ ATP channels. *Journal of medicinal food*, 12(6), 1403-1406.

Bhatia, S. P., McGinty, D., Letizia, C. S., & Api, A. M. (2008). Fragrance material review on α-bisabolol. *Food and chemical toxicology*, 46(11), S72-S76.

Brehm-Stecher, B. F., & Johnson, E. A. (2003). Sensitization of *Staphylococcus aureus* and *Escherichia coli* to antibiotics by the sesquiterpenoids nerolidol, farnesol, bisabolol, and apritone. *Antimicrobial agents and chemotherapy*, 47(10), 3357-3360.

Cavalcanti, F. S., & Nunes, E. P. (2002). Reflorestamento de clareiras na floresta nacional do Araripe com *Vanillosmopsis arborea* Baker. *Revista Brasileira de Farmacognosia*, 12, 94-96.

Cavalieri, E., Mariotto, S., Fabrizi, C., de Prati, A. C., Gottardo, R., Leone, S., ... & Suzuki, H. (2004). α-Bisabolol, a nontoxic natural compound, strongly induces apoptosis in glioma cells. *Biochemical and biophysical research communications*, 315(3), 589-594.

Colares, A. V., Almeida-Souza, F., Taniwaki, N. N., Souza, C. D. S. F., da Costa, J. G. M., Calabrese, K. D. S., & Abreu-Silva, A. L. (2013). *In vitro* antileishmanial activity of essential oil of *Vanillosmopsis arborea (*Asteraceae) baker. *Evidence-Based Complementary and Alternative Medicine*, 2013.

Corpas-López, V., Merino-Espinosa, G., Acedo-Sánchez, C., Díaz-Sáez, V., Navarro-Moll, M. C., Morillas-Márquez, F., & Martín-Sánchez, J. (2018). Effectiveness of the sesquiterpene (-)-α-bisabolol in dogs with naturally acquired canine leishmaniosis: An exploratory clinical trial. *Veterinary research communications*, 42(2), 121-130.

Costa, J. G. M., Campos, A. R., Brito, S. A., Pereira, C. K. B., Souza, E. O., & Rodrigues, F. F. G. (2010). Biological screening of araripe basin medicinal plants using *Artemia salina* Leach and pathogenic bacteria. *Pharmacognosy Magazine*, 6(24), 331-334.

Forrer, M., Kulik, E. M., Filippi, A., & Waltimo, T. (2013). The antimicrobial activity of alpha-bisabolol and tea tree oil against *Solobacterium moorei*, a Gram-positive bacterium associated with halitosis. *Archives of oral biology*, 58(1), 10-16.

Furtado, R. F., Lima, M. G., Andrade Neto, M., Bezerra, J. N. S., & Silva, M. D. V. (2005). Larvicidal activity of essential oils against *Aedes aegypti* L.(Diptera: Culicidae). *Neotropical Entomology*, 34(5), 843-847.

Gerdakaneh, M., Mohammadi, N., & Arji, I. (2018). Study of Seasonal Variation on Essential Oil Content and Constituents of *Eucalyptus (Eucalyptus globulus*) in Three Zones of Kermanshah Province. *Journal of Medicinal Plants*, 2(66), 50-62.

Gonçalves, O., Pereira, R., Gonçalves, F., Mendo, S., Coimbra, M. A., & Rocha, S. M. (2011). Evaluation of the mutagenicity of sesquiterpenic compounds and their influence on the susceptibility towards antibiotics of two clinically relevant bacterial strains. *Mutation Research/Genetic Toxicology and Environmental Mutagenesis*, 723(1), 18-25.

Leite, L. H. I., Leite, G. D. O., Coutinho, T. S., Sousa, S. D. G., Sampaio, R. S., Costa, J. G. M., ... & Campos, A. R. (2014). Topical antinociceptive effect of *Vanillosmopsis arborea* Baker on acute corneal pain in mice. *Evidence-Based Complementary and Alternative Medicine*, 2014, 1-6.

Leite, G. O., Leite, L. H. I., Sampaio, R. S., Araruna, M. K. A., Rodrigues, F. F. G., de Menezes, I. R. A., ... & Campos, A. R. (2011a). Modulation of topical inflammation and

visceral nociception by Vanillosmopsis arborea essential oil in mice. *Biomedicine & Preventive Nutrition*, 1(3), 216-222.

Leite, G. O., Leite, L. H. I., Sampaio, R. S., Araruna, M. K. A., de Menezes, I. R. A., da Costa, J. G. M., & Campos, A. R. (2011b). (−)-α-Bisabolol attenuates visceral nociception and inflammation in mice. *Fitoterapia*, 82(2), 208-211.

Leite, G. O., Penha, A. R., Fernandes, C. N., Souza, H. H. F., Costa, J. G. M., & Campos, A. R. (2009). Gastroprotective mechanism of *Vanillosmopsis arborea* bark essential oil. *Fitoterapia*, 80(1), 77-80.

Massada, Y. (1995). *Analysis of essential oil by chromatography and spectrometry*. New York: John Wiley & Sons.

Matos, F. J. A. (2009). *Introdução à Fitoquímica Experimental*. Fortaleza: UFC.

Matos, M. E. O., Sousa, M. P., Matos, F. J. A., & Craveiro, A. A. (1988). Sesquiterpenes from *Vanillosmopsis arborea*. *Journal of natural products*, 51(4), 780-782.

Morales-Yuste, M., Morillas-Márquez, F., Martín-Sánchez, J., Valero-López, A., & Navarro-Moll, M. C. (2010). Activity of (-) α-bisabolol against *Leishmania infantum* promastigotes. *Phytomedicine*, 17(3-4), 279-281.

Mota, M. L., Lobo, L. T. C., da Costa, J. M. G., Costa, L. S., Rocha, H. A., e Silva, L. F. R., ... & de Andrade Neto, V. F. (2012). In vitro and in vivo antimalarial activity of essential oils and chemical components from three medicinal plants found in northeastern Brazil. *Planta medica*, 78(07), 658-664.

Oliveira, F. S., de Freitas, T. S., da Cruz, R. P., do Socorro Costa, M., Pereira, R. L. S., Quintans-Júnior, L. J., ... & Serafini, M. R. (2017). Evaluation of the antibacterial and modulatory potential of α-bisabolol, β-cyclodextrin and α-bisabolol/β-cyclodextrin complex. *Biomedicine & Pharmacotherapy*, 92, 1111-1118.

Rocha, N. F. M., de Oliveira, G. V., de Araújo, F. Y. R., Rios, E. R. V., Carvalho, A. M. R., Vasconcelos, L. F., ... & de Sousa, F. C. F. (2011). (−)-α-Bisabolol-induced gastroprotection is associated with reduction in lipid peroxidation, superoxide dismutase activity and neutrophil migration. *European Journal of Pharmaceutical Sciences*, 44(4), 455-461.

Rodrigues, F. F. G., Colares, A. V., Nonato, C. D. F. A., Galvão-Rodrigues, F. F., Mota, M. L., Braga, M. F. B. M., & da Costa, J. G. M. (2018). In vitro antimicrobial activity of the essential oil from *Vanillosmopsis arborea* Barker (Asteraceae) and its major constituent, α-bisabolol. *Microbial pathogenesis*, 125, 144-149.

Saltão, R., & Veiga, F. (2001). Ciclodextrinas em novos sistemas terapêuticos. *Brazilian Journal of Pharmaceutical Sciences*, 37(1), 1-17.

Santos, N. K. A., Coutinho, H. D. M., Viana, G. S. B., Rodrigues, F. F., & Costa, J. G. (2011). Chemical characterization and synergistic antibiotic activity of volatile compounds from the essential oil of *Vanillosmopsis arborea*. *Medicinal chemistry research*, 20(5), 637-641.

Santos, N. K., Rodrigues, F. F., Coutinho, H. D., Viana, G. S., & Costa, J. G. (2013). Isolation of alpha-bisabolol from the essential oil of *Vanillosmopsis arborea* baker and modulation of antibiotic activity using gaseous contact. *Journal of Essential Oil Bearing Plants*, 16(6), 826-831.

Santos, N. K., Viana, G. S., Cunha, W., Campos, A., & Costa, J. G. M. (2015). The essential oil from *Vanillosmopsis arborea* Baker (Asteraceae) presents antinociceptive, anti-inflammatory, and sedative effects. *International Journal of Green Pharmacy* (IJGP), 9(2), 138-142.

Silva, T. I., Alves, A. C. L., Azevedo, F. R., Marco, C. A., Santos, H. R., & Azevedo, R. (2017). Actividad larvicida de aceites esenciales en *Aedes aegypti* L. (Diptera: Culicidae). *Idesia (Arica)*, 35(2), 63-70.

Teixeira, A. M. R., Lima, I. K. C., Xavier, M. R., Pereira, R. L. S., Gonçalves, B. G., de Sena Junior, D. M., ... & de Faria, J. L. B. (2018). Vibrational spectroscopy study of essential oils

from *Plectranthus amboinicus* Lour. Spreng and *Vanillosmopsis arborea* Baker. *Vibrational Spectroscopy*, 98, 22-29.

Van Zyl, R. L., Seatlholo, S. T., Van Vuuren, S. F., & Viljoen, A. M. (2006). The biological activities of 20 nature identical essential oil constituents. *Journal of Essential Oil Research*, 18(sup1), 129-133.

Zappi, D. C., Filardi, F. L. R., Leitman, P., Souza, V. C., Walter, B. M., Pirani, J. R., ... & Forzza, R. C. (2015). Growing knowledge: an overview of seed plant diversity in Brazil. Rodriguésia, 66 (4), 1085-1113.

Percentage of contribution of each author in the manuscript

Gledson Ferreira Macedo – 8%

José Weverton Almeida-Bezerra – 10%

Viviane Bezerra da Silva – 9%

Elvis Estilak Lima – 6%

Saulo Almeida de Menezes – 6%

Benedito Yago Machado Portela – 6%

Bruna Letícia Pereira Braga – 5%

Janete de Souza Bezerra – 5%

Maraiza Gregorio de Oliveira – 5%

Damares Ribeiro Alencar – 5%

Adrielle Rodrigues Costa – 9%

Mikael Amaro de Souza – 9%

João Cruz Neto – 5%

Thaís da Conceição Pereira – 6%

Francisco Sydney Henrique da Silva – 6%