Fronteiras: Journal of Social, Technological and Environmental Science
http://periodicos.unievangelica.edu.br/fronteiras/
ISSN 2238-8869

FRONTEIRAS

OPEN ACCESS

Article

Ocimum carnosum (Spreng.) Link & Otto (Sin. *Ocimum selloi* Benth): A Species with Food and Medicinal Potential

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ABSTRACT

The species of the Lamiaceae family are known both for their use as condiments and for their biologically active properties, in this family is the genus *Ocimum*. This genus contains compounds such as flavonoids, carotenoids and vitamins, which have medicinal, food and cosmetic potential. *Ocimum carnosum* (Spreng) Link & Otto ex Benth (Lamiaceae), formerly known as *Ocimum selloi* Benth, is a herbaceous plant produced in the South and Southwest regions of Brazil. It is rich in compounds that can be used in various products. Thus, this study aims to present a review of studies involving the chemical composition and biological activities of *O. carnosum*, a versatile plant that has several potential.

Keywords: antioxidant; repellent; basil; essential oil.

RESUMO

As espécies da família Lamiaceae são conhecidas por seu uso como condimentos e atividades biológicas, com o gênero *Ocimum* pertencendo a esta família. Este gênero apresenta compostos como flavonoides, caretenoides e vitaminas, com potencial medicinal, alimentícia e cosmética. *Ocimum carnosum* (Spreng) Link & Otto ex Benth (Lamiaceae), anteriormente conhecida como *Ocimum selloi* Benth, é uma planta herbácea cultivada nas regiões do sul e sudeste do Brasil. É rica em compostos que podem ser utilizados em vários produtos. Assim, este trabalho tem como objetivo apresentar uma revisão de estudos envolvendo a composição química e atividades biológicas de *O. carnosum*, uma planta versátil que possui diversos potenciais.

Palavras-chave: antioxidante; repelente; manjericão; óleo essencial.

Submissão: 23/08/2022 Aceite: 04/08/2023 Publicação: 09/08/2023

v.12, n. 2, ago. 2023 • p. 202-220. • DOI http://dx.doi.org/10.21664/2238-8869.2023v12i2.202-220.

Introduction

Brazil is the country with the greatest plant diversity in the world, it is estimated that the number of species is between 350,000 and 550,000, but only 55,000 are catalogued (RIBEIRO et al., 2014). However, the medicinal properties of only 1,100 plants were studied and only 8% of the Brazilian flora was used for research in the search for compounds with biological activity (Heinzmann & Barros 2007).

The use of plants as an alternative for treatment and intervention in the health of humanity has been reported since antiquity (Silva & Valença, 2014). Some plants are used as alternatives to the use of synthetic drugs, successful examples are *Passiflora incarnata* Linn. (Sousa et al. 2018), *Bauhinia forficata* Link, popularly known as pata-de-vaca, has been used as a hypoglycemic agent for the treatment of diabetes (Pontes et al. 2017), *Alpinia zerumbet* Pers, known as a colony, has active principles with antihypertensive effect, so it is used in patients with hypertension (Nunes et al. 2015).

Some plants have other features that can be used to control pests (Santos et al. 2013). The use of these plant extracts has multiple advantages in preventing pesticide resistance, low cost and low permanence in the environment (Tembo et al. 2018), they can also be used as natural herbicides, as demonstrated by Oliveira et al. (2015a), when they evaluated the allelopathic potential of aqueous extracts of sunflower, brachiaria and sorghum on germination and initial growth of lettuce.

Others can be used as an antioxidant in industrialized products, such as in the production of biodiesel, a product that easily undergoes oxidation during storage, resulting in changes in its properties, thus requiring the use of antioxidants (Neuana et al. 2017).

Species of the Lamiaceae family are known for their spice use and biologically active properties and include plants belonging to the genus *Ocimum* (Lima & Cardoso, 2007). Some species of this genus are considered unconventional food plants (PANCs) (Lopes et al. 2021), containing antioxidant compounds such as flavonoids, carotenoids, vitamin C and vitamin E (Henrique et al. 2017), in addition to being studied due to its medicinal properties (Santos et al. 2021).

One of the species of this genus is *Ocimum carnosum* (Spreng) Link & Otto ex Benth (Lamiaceae) (Figure 1). Several authors consider that *Ocimum selloi* Benth. conspecific of *O. carnosum* (Crespo 1979; Hokche et al. 2008; Zuloaga et al. 2008; Walsingham & Paton, 2012; Jørgensen et al. 2014), with *O. carnosum* being the name considered valid by the Brazilian Plant Catalog and Fungi (Forzza et al. 2010), as well as in the work of other authors and in catalogues from other countries (Govaerts 2003; Harley 2012; Walsingham & Paton 2012; Villaseñor 2016; Jørgensen et al. 2014; Antar 2020). However, there are many authors who still use *O. selloi* in scientific publications (O'Leary 2017), but recent publications have started to use the name *O. carnosum* (Costa et al. 2009; Boaro et al. 2019; Ricarte et al. 2019; Ricarte et al. 2009; Boaro et al. 2019; Ricarte et al. 2020).

This it considered synonyms of *O. carnosum*: *Lumnitzera carnosa* Spreng.; *Ocimum atrovirens* Bartl.; *Ocimum ebracteatum* Pohl ex J.A. Schmidt, *Ocimum graveolens* Larrañaga and *Ocimum selloi* Benth. (Antar 2020).

This is a herbaceous plant native to Argentina, Bolivia, Brazil, Mexico, Paraguay, Uruguay and Venezuela (Royal Botanic Gardens, 2022). It was also introduced in India (Khosla 1995). Popularly known as anise, alfavaquinha (Martins et al. 1997), atroveram, paregoric elixir, fennel, small basil (Facanali et al. 2015), basil, basil (Costa et al. 2010), basil -anisada, women's herb, fennel (Lopes et al. 2011), chicken basil (Galvão et al. 2021), cinnamon, elevating, cinnamon basil, purple basil, cinnamon (Messias et al. al. 2015) and anise basil (Vieira & Simon 2000). In English it is known as basil-pepper (Paula et al. 2003), in Uruguay it is known as anis-de-campo and albahaca-anisada (Schroeder & Burgos 2012) and in Mexico as Teposhijiac (López 2011), albacar -de-monte and albacar-de-loco (Nova et al. 2019). In Guarani as Petÿ reaquã (Pereira et al. 2016). Geck et al. (2017) also cite the popular names hoja-de-colico, hierba-santa-maria and hierba-de-colico.

Figure 1. Specimen of *O. carnosum.* Source: The authors (2022)

It is a shrub with a height of 40 cm to 120 cm, its leaves are simple and opposite, with small white or purple flowers and its fruits are achenes (Morhy 1973; Panizza 1997; Boaro et al. 2019). The branches are quadrangular and it is aromatic (Lopes et al. 2011). It adapts well to well-drained soils in partial shade, since its propagation is by seeds, however, it is possible to use 20 cm cuttings (Lopes et al. 2011).

This work aims to present a review of studies involving the chemical composition and biological activities of *O. carnosum*, formerly known as *O. selloi*.

2. Traditional use

This species is considered of potential use by Leite & Pinha (2011), as it has a popular use, but it is still little commercialized. An example of informal cultivation and trade as a medicinal plant of *O. selloi* is reported in the urban region of Nova Friburgo and Petrópolis (Rio de Janeiro, Brazil) (Leitão et al. 2009). There are also reports of commercialization in traditional fairs in the cities of Botucatu (São Paulo) and Campos (Rio de Janeiro) (Vieira & Simon 2000). According to Oliveira et al. (2010), in the urban region of Jaboatão do Guararapes (Pernambuco, Brazil) the infusion and syrups of *O. selloi* are popularly used as antidiarrheal, digestive, anti-flu, and to control hypertension, in addition to seed to help remove the speck in the eye. Another study in this region reported the use of leaf baths and syrup as an antidiarrheal for colds and the use of seeds for eye spots (Oliveira et al. 2015c).

In the Ponta Grossa neighbourhood in Porto Alegre (Rio Grande do Sul, Brazil), it is reported to be used for the treatment of sedatives, colitis, menstrual cramps, nail fungus, throat infection, food use, bronchitis, cough and cramps (Vendruscolo & Mentz 2006). The use of *O. carnosum* infusion is reported for the treatment of influenza (Ribeiro et al. 2017; Galvão et al. 2021) and fever (Bieski et al. 2015). Duarte et al. (2005) reported the popular use of the infusion as an expectorant in the digestive tract. In the region of Diadema (São Paulo, Brazil), the infusion of aerial parts is used as a mosquito repellent (Garcia et al. 2010).

Conde et al. (2004) reports the use of *O. selloi* as a sedative in the city of Juiz de Fora (Minas Gerais, Brazil), as well as Borcard et al. (2015), identified that the most common use for this property is the oral use of the infusion.

In the urban region of Ouro Preto (Minas Gerais), infusion and decoction of *O. carnosum* leaves are used to treat flu, heart disease, and mouth and throat disorders, as an anti-asthmatic and expectorant (MESSIAS et al., 2015). In the work of Kujawska & Schmeda-Hirschmann (2022), the use of infusion and decoction of leaves and roots of *O. carnosum* to treat flatulence, hangover, indigestion and stomach pain is reported.

There are also reports of the use of this plant as an anti-inflammatory, analgesic and antispasmodic (MARTINS et al. 1997). According to Lorenzi & Matos (2002), the leaves and flowers are also used to aid digestion, and eliminate intestinal gas, for fever, cough, bronchitis, vomiting and gastritis. Oliveira et al. (2015b) report the popular use of *O. carnosum* infusion for the treatment of gas and gastritis in Juiz de Fora (Minas Gerais, Brazil), obtained through popular cultivation.

It is described by Vendruscolo et al. (2005) that the aerial parts of *O. selloi* are used to treat blood cramps, colitis, menstrual cramps, stomach problems, and nail fungus, infected throat and heart problems. There are reports of the use of the infusion of leaves and/or seeds as a sedative, antihypertensive, treatment of urinary and gastrointestinal disorders, as well as refreshing in Campo Largo (Paraná) (Gonçalves et al. 2017).

Finally, the work by Gross et al. (2019) reports the use of *O. carnosum* as tea and food condiment.

3. Chemical composition

Research that uses medicinal plants presents analyzes that describe the chemical composition of extracts and essential oils obtained from *O. selloi*. Some studies show the composition of the essential oil of *O. selloi*, both in terms of relative abundance and diversity of compounds, presenting, mainly, the major compounds. Table 1 presents the identified compounds, the content variation and the plant part.

Table 1. Majority of *O. selloi* essential oil compounds

Compound name	**Part of the plant**	**Content (%)**	**References**
Metil chavicol	Leaf e flower	24.14 – 97.90	Martins *et al.* (1997); Vieira and Simon (2000); Moraes *et al.* (2002); Paula *et al* (2003); Paula *et al.* (2007); Franca *et al.* (2008); Costa *et al.* (2008); Costa *et al.* (2009a); Costa *et al.* (2009b); Martini *et al.* (2011); Souza *et al.* (2015); Costa *et al.* (2015); Menezes *et al.* (2020); Piva *et al.* (2021)
Linalool	Leaf e flower shoot	6.10 – 79.00	Silva *et al.* (2004); Nascimento *et al.* (2011); Vieira *et al.* (2014); Ricarte *et al.* (2020)
Anethole	Leaf	31.90 – 67.45	Silva *et al.* (2004); Vieira *et al.* (2014)

Compound name	**Part of the plant**	**Content (%)**	**References**
Methyl eugenol	Leaf e flower	0.79 – 66.18	Martins *et al.* (1997); Paula *et al.* (2007); Maia *et al.* (2007); Costa *et al.* (2009b)
Trans-anethole	Leaf	31.20 – 58.59	Moraes *et al.* (2002); Paula *et* al (2003); Paula *et al.* (2007); Piva *et al.* (2021)
Trans-caryophyllene	Leaf, flower e flower shoot	3.17 – 43.52	Martins *et al.* (1997); Moraes *et al.* (2002); Paula *et al.* (2007); Nascimento *et al.* (2011)
Eugenol	Leaf	37.27 – 38.95	Nascimento *et al.* (2011)
Spathulenol	Leaf	0.90 – 32.90	Costa *et al.* (2009b)
Bicyclogermacrene	Leaf	1.21 – 28.40	Costa et al. (2008); Costa *et al.* (2015); Menezes *et al.* (2020); Costa *et al.* (2009b)
1,8-Cineol	Leaf	1.20 – 21.02	Silva *et al.* (2004); Nascimento *et al.* (2011); Vieira *et al.* (2014)
Germacrene-D	Leaf and flower	1.30 – 18.50	Martins *et al.* (1997); Moraes *et al.* (2002); Costa *et al.* (2008); Costa *et al.* (2015); Menezes *et al.* (2020); Costa *et al.* (2009b)
α-Cadinol	Leaf	15.10	Silva *et al.* (2004)
β-Bisabolene	Leaf	0.30 – 10.00	Viera e Simon (2000); Costa *et al.* (2009b)
β-caryophyllene	Leaf	1.55 – 10.00	Viera e Simon (2000); Costa *et al.* (2008); Menezes *et al.* (2020); Costa *et al.* (2009b)
Tymol	Leaf	4.30 – 7.90	Viera and Simon (2000)
Bicyclosesquifellandrene	Leaf e flower	2.96 – 7.76	Martins *et al.* (1997)
Bisbolene epoxide	Flower	7.11	Martins *et al.* (1997)
Caryophyllene oxide	Leaf	0.30 – 6.20	Costa *et al.* (2009b)
Isoelemycin	Leaf	5.69	Paula *et al.* (2007)

Compound name	Part of the plant	Content (%)	References
isoaromadendrene	Leaf	4.83	Paula *et al.* (2007)
Cis-Anetol	Leaf e flower shoot	2.95 – 4.54	Moraes *et al.* (2002); Paula *et* al (2003)
β-selineno	Leaf e flower shoot	3.34 – 4.14	Moraes *et al.* (2002)

Source: Prepared by the authors (2022).

Figure 2 presents the six main compounds identified in essential oils of *O. selloi*.

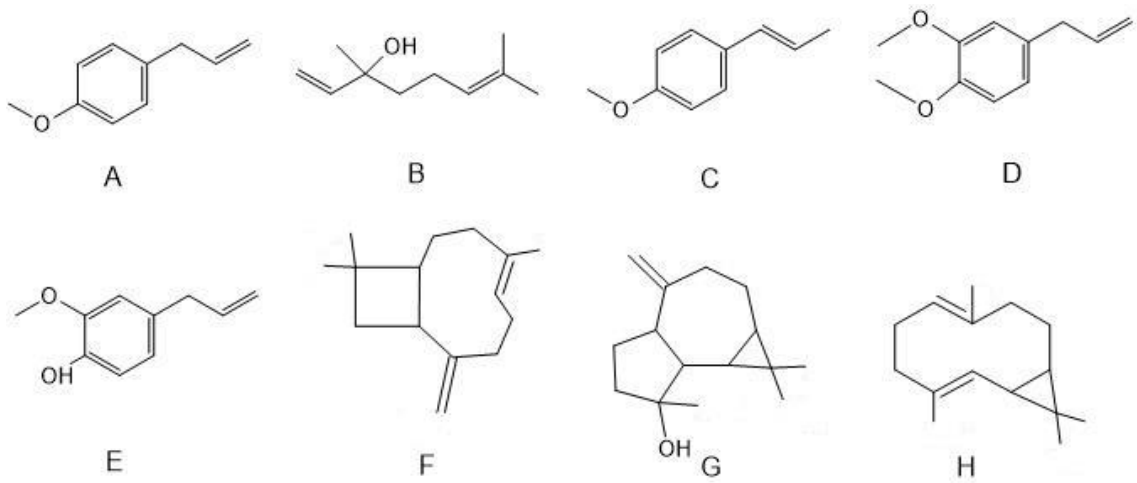

Figure 2. Main compounds present in essential oils of *O. selloi*. A) Methyl chavicol; B) Linalool; C) Anethole; D) Methyl eugenol; E) Eugenol F) Trans-Caryophyllene; G) Spathulenol; H) Bicyclogermacrene. Source: Prepared by the authors (2022).

In the study by Viera & Simon (2000), the essential oil composition of the leaves of two samples of *O. selloi* sold in popular markets identified methyl chavicol (38.9% and 30.6%) as the major compound present in the samples and others such as β-bisabolene (10.0% - 6.1%), β-caryophyllene (7.3% - 9.5%) and thymol (4.3% - 7.9%).

Methyl chavicol was also reported in the studies by Paula, Gomes-Carneiro & Paumgartten (2003), with an abundance of 55.3% and followed by trans-anethole (34.2%), cis-anethole (3.9%) and caryophyllene (2.1%). For Franca et al. (2008) methyl chavicol was the main chemical constituent of the essential oil of *O. selloi* leaves (98%).

Studies carried out by Costa et al. (2015), analyzing the chemical composition of the essential oil of *O. selloi*, also identified methyl chavicol as the major compound (92.32%), followed by βicyclogermacrene (2.22%), germacrene-D (1.33%), spathulenol (1.27%) and bicyclogermacrene (1.21%). Similar results were presented by Menezes et al. (2020), who identified the majority presence of methyl chavicol (92.32%), followed by β-bicyclogermacrene (2.31%), germacrene-D (1.78%) and β-caryophyllene (1.55%), as well as Souza et al. (2015) who obtained 97.57% of methyl chavicol. According to Gonçalves et al. (2003), the cultivation condition can interfere with the chemical composition of the essential oil of *O. selloi*, being able to occur both the difference in the contents and the presence of compounds.

Thus, some studies indicate that there may be a variation in the composition of the essential oil of this plant, which is directly related to factors such as collection at different times of the year and different parts of the plant, as reported by Moraes et al. (2002) who analyzed the essential oil of the leaves in January 2000 and 2001 and of the inflowerescences, obtained mostly trans-anethole with 41.34% and 45.42% for the leaves and 58.59% for the inflowerescence, while methyl chavicol presented 27.10% and 24.14% for the leaves and 29.96% for the inflowerescence.

In this research, the inflowerescence presented 4.54% of cis-anethole, 3.47 trans-caryophyllene and 3.34% β-selinene, the essential oil of the leaves from the 2000 collection presented 4.21% germacrene D, 4.14 % of β-selinene and 3.95% cis-anethole, while the sample collected in 2001 showed 2.96% of cis-anethole. Ricarte et al. also studied the chemical composition of the essential oil of the inflowerescence of *O. carnosum* and obtained linalool as the major compound (79.00%).

Cultivation conditions can also interfere with the composition of the essential oil. Costa et al. (2008) analyzed the effect of using different concentrations of bovine and poultry manure as fertilizer on the composition of the essential oil of *O. selloi* and found that the absence of fertilization induced a greater diversity of compounds in the oil, while all crops with fertilization showed more than 90% of methyl chavicol. The effect of different shading on essential oil production in *O. selloi* leaves and its chemical composition was evaluated by Costa et al. (2009a), who observed that sunlight-induced the production of essential oil with a higher concentration of methyl chavicol (93.2%) compared to red (87.6%) and blue (86.1%) shading. It also identified differences in the other constituents, with β-caryophyllene being the second and third most abundant constituents for the plant grown under exposure to sunlight (2.2%) followed by germacrene D (1.3%), while the cultivated plant with the red shading it presented the compounds bicyclogermacrene (4.4%) and germacrene D (3.5%) and in the blue shading the same compounds of the red shading in the respective concentrations of 3.3% and 2.9%.

Costa et al. (2009b) analyzed the variation in the chemical composition of the essential oil of the whole leaves and ground leaves of *O. selloi*, verified the presence of methyl chavicol as the major compound for both samples, and the oil obtained from the whole leaves showed a content of 97.9% and the oil with the leaves previously ground had a content of 93.9%. Values similar to these were reported in studies by Martini et al. (2011), analyzing the chemical composition of essential oils from the leaves of *O. selloi* collected in different locations and at different times of the year, with methyl chavicol contents between 93.6% and 97.6%.

The study by Martins et al. (1997) studied two samples of leaves and flowers from different locations, obtaining mostly methyl chavicol for leaves (81.81 and 80.70%) and methyl eugenol for flowers (63.00 and 63.08%). This study also identified trans caryophyllene (3.17 and 4.30%), bicyclosesquifellandrene (2.96 and 4.56%) and germacrene B (3.38 and 4.56%) for leaves while trans caryophyllene (5.50 and 6.84%), bicyclosesquifellandrene (6.79 and 7.76%), germacrene B (absent and 11.87%) and bisabolene epoxide (6.79 and 7.79%).

Vieira et al. (2014), obtained a different chemical composition, obtaining mostly anethole (52.2%) and linalool (16.8%), followed by 1,8-Cineole (7.4%), p-methoxycinnamaldehyde (2.9%), (Z)-linalool oxide (2.8%) and (E)-linalool oxide (2.6%). The chemical composition of the essential oil was also studied by Nascimento et al. (2011), who used the aerial parts (leaves and thin stems) in two different collections (August 2005 and February 2006), obtaining eugenol as the major components (38.95% and 37.27%), 1.8 -cineole (18.68% and 21.02%), trans-caryophyllene (8.31% and 7.00%) and linalool (6.10% and 6.83%). Piva et al. (2021) obtained the composition for the essential oil of *O. selloi* leaves with methyl chavicol (45.95%) and trans-anethole (47.49%).

The chemical composition of the essential oil from leaves of wild and urban *O. selloi* was studied by Paula et al. (2007), who determined a variation in the chemical composition between the samples, since the one grown in urban areas showed mostly methyl chavicol (46.33%) and trans-anethole (31.20%), while in the wild one, methyl eugenol was found (45.17%) and trans-caryophyllene (43.52%), indicating that the culture medium influences the chemical composition of the essential oil.

The study by Maia et al. (2012) focused on two accessions collected in Minas Gerais (Brazil), where it was observed that one of the accessions consisted of 94.95% in the leaves and 92.54% in the flowers, while the other had 65.49% of methyl eugenol in the leaves and 66.18% in the flowers.

Silva et al. (2004) analyzed the composition of the essential oil obtained by steam distillation, microwave distillation and supercritical extraction with CO_2. According to these authors, the major compound was anethole with values of 64.6% for extraction by steam distillation, 67.4% with microwave oven and 31.9% by supercritical extraction with CO_2, followed by linalool (20 .6%, 20.9% and 23.2%, respectively), while the third most abundant compound showed variation, with 1.8-cineole (7.4%) for steam distillation, 4-terpineol (2, 9%) for microwave oven distillation and epi-α-cadinol (15.1%) for CO_2 extraction, the other compounds also showed variations in their contents.

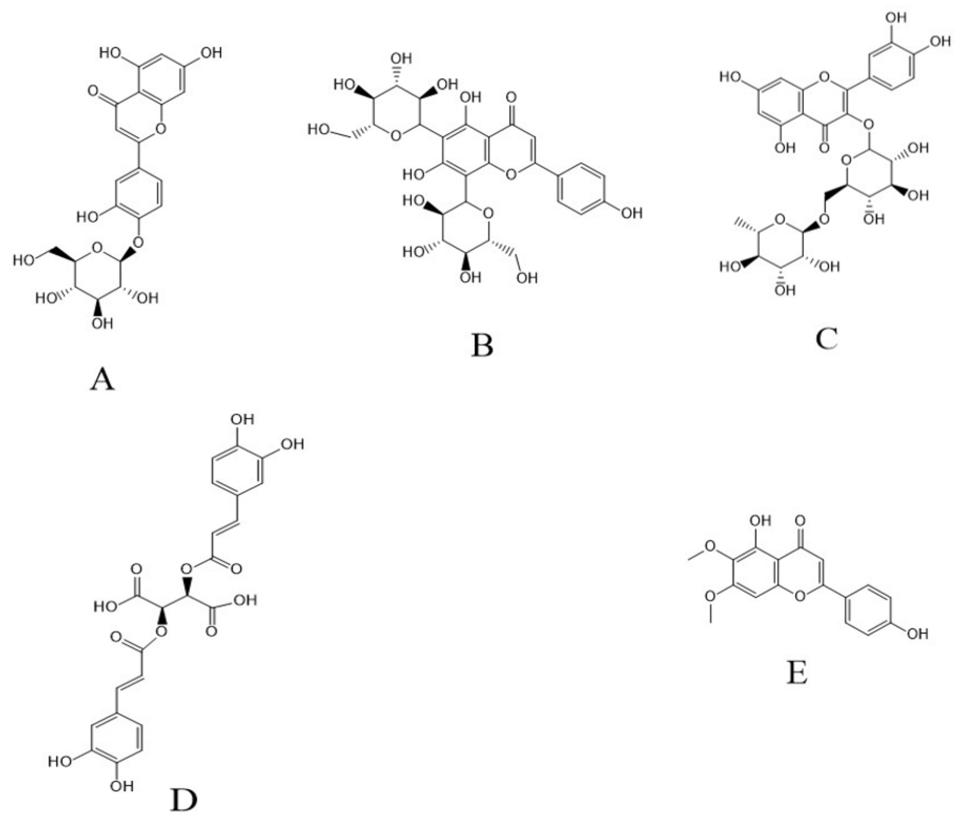

Figure 3. Structures of compounds identified in the aqueous extract of O. selloi leaves. A) luteolin-4'-O-glucoside; B) apigenin-6,8-di-C-glucoside; C) rutin; D) chicory acid; E) cirsimaritin. Source: Prepared by the authors (2022).

Freitas et al. (2018) used the techniques of Nuclear Magnetic Resonance (NMR), Gas Chromatography coupled to Mass Spectrometry (GC-MS) and Gas Chromatography with Flame Ionization Detector (GC-FID) to perform the chemotypic identification of the essential oil of the leaves. of species of the genus *Ocimum*, and *O. selloi* was classified in the group rich in methyl chavicol, with the NMR showing the best ability to quantify the major compounds and the GC-MS and GC-FID techniques identifying a greater number of compounds.

Silva et al. (2008) analyzed the presence of ursolic acid in dry leaves of eight different species of *Ocimum* and found that *O. selloi* presented 0.45%, being the fifth species with the highest abundance. The methanolic extract of *O. selloi* leaves showed 42 mg of gallic acid equivalent (AGE) g^{-1}, 0.06 mg of rosmarinic acid equivalent g^{-1}, 0.03 mg of lithospermic acid equivalent g^{-1}, 0.12 mg p-coumaric acid equivalent g^{-1}, 0.11 mg hydroxy Libenzoic acid equivalent g^{-1} (Hakkim et al. 2008). The ethanolic extract of the aerial part of *O. selloi* presents values of 234.87 mg gallic acid equivalent g^{-1} (Morais et al. 2013), whereas the infusion of the leaves of *O. selloi* presented 107.1 mg AGE g^{-1} (Santos et al. 2021).

The aqueous extract of the leaves of *O. selloi* presented 107.10 mg of AGE g^{-1}, also presenting the flavonoids glycosides luteolin-4'-O-glucoside, apigenin-6,8-di-C-glucoside, rutin and cirsimaritin, in addition to chicory acid (Figure 3) (Piva et al. 2021).

O. selloi leaves are also sources of macro and micronutrients (Table 2), reinforcing the potential spice use of the species (Schroeder & Burgos 2012).

Table 2. Synthesis of the biological activities evaluated for the species *O. selloi*

Element	Concentration
Nitrogen	1.03 – 2.44%
Phosphor	0.40 – 0.58%
Potassium	1.86 – 4.58%
Sulfur	0.20 – 1.12 mg kg^{-1}
Iron	11.55 – 41.02 mg kg^{-1}
Magnesium	120.0 - 315.5 mg kg^{-1}
Copper	33.00 – 85.55 mg kg^{-1}
Zinc	14.0 – 55.2 mg kg^{-1}

Source: Prepared by the authors (2022) based on data from Schroeder & Burgos (2012).

4. Biological activities

The biological activities of extracts and essential oils of *O. selloi* are also explored in different studies, and it is clear that it is a plant with high potential (Table 3).

One of the properties being investigated is the fungicidal effect that was explored in the studies by Costa et al. (2015), using the essential oil against fungi and obtained as a response to the inhibition of spore germination of the fungi *Moniliophthora perniciosa* (93%) and *Colletotrichum gloesporioide* (87%). Another fungus that showed sensitivity to essential oil with 100% inhibition of spore germination at a concentration of 0.5% was *Pseudocercospora griseola*, responsible for common bean angular leaf spot (Hoyos et al. 2012).

The essential oil of this species was also analyzed against fungi of the genus *Candida*, showing minimum inhibition concentration between 312.5 and 1250 μg mL^{-1} and minimum fungicidal concentration between 625 and 5000 μg mL^{-1}, with significant values for *Candida parapsilosis* (Vieira et al. 2014). The antimicrobial potential was also reported by Nascimento et al. (2011), which demonstrated the antimicrobial action of the essential oil of aerial parts (leaves and thin stems) of *O. selloi* against the gram-positive bacterium *Staphylococcus aureus* ATCC

25923. While Martini et al. (2011) identified antimicrobial activity of the essential oil in bacteria *Escherichia coli*, *S. aureus* MRSA (BMB9393) and *Lactobacillus casei*, and for the fungus *Aspergillus niger*, demonstrating efficiency against *Candida albicans* ATCC 36802.

Table 3. Synthesis of the biological activities evaluated for the species *O. selloi*

Activity	Type of study	Type of preparation	Part of the plant	Reference
Fungicide	*In vitro*	Essentila oil	Leaf	Costa *et al*. (2015); Hoyos *et al*. (2012); Vieira *et al.* (2014); Nascimento *et al*. (2011)
Bactericide	*In vitro*	Essentila oil	Leaf	Vieira *et al.* (2014); Nascimento *et al*. (2011)
Mutagenicity	*In vivo*	Essentila oil	Leaf	Paula *et al*. (2007); Santos et al. (2021)
Antispasmodic	*In vivo*	Essentila oil	Leaf	Souza *et al*. (2015)
Antidiarrheal	*In vivo*	Essentila oil	Leaf	Franca *et al*. (2008)
	Clinical	Essentila oil	Leaf	Paula *et al.* (2003); Paula *et al*. (2004)
Repellency				
Anti-inflamatory	*In vivo*	Essentila oil and aqueous extract	Leaf	Piva *et al*. (2021)
Anticancer	*In vitro*	Essentila oil	Inflowerescence	Ricarte et al. (2020)
Larvicide	*In vivo*	Essentila oil	Leaf and inflowerescence	Menezes *et al*. (2020); Ricarte *et al*. (2020)
Antihypertensive	*In vivo*	Ethanolic extract	Leaf	Alegría-Herrera *et al*. (2019)
Antioxidant	*In vitro*	Ethanolic extract	Leaf and aerial part	Hakkim *et al.* (2008); Morais *et al*. (2013)
Anti Alzheimer	*In vitro*	Ethanolic extract	Leaf	Morais *et al*. (2013)
Inseticide	*In vivo*	Ethanolic and hexanic extracts	Leaf	Moreira *et al*. (2004)

Source: Prepared by the authors (2022).

The study by Santos et al. (2021) evaluated the effect of the infusion of *O. selloi* leaves on onion seeds and rootlets and observed a reduction in the germination index and mitotic index, demonstrating a potential allelopathic effect, however, mutagenicity and cell death rates were not observed at the concentration of 1 mg mL^{-1}.

Piva et al. (2021) analyzed the anti-inflammatory effect of the aqueous extract and essential oil of *O. selloi* leaves, identifying that the two preparations significantly inhibited induced pleurisy and prevented paw oedema in mice.

Studies developed by Ricarte et al. (2020), using the essential oil from the infloweresence of *O. carnosum* against human breast adenocarcinoma (MCF-7), lung carcinoma (NCI-H292), promyelocytic leukaemia (HL-60) and cervical adenocarcinoma cells (HEP-2) and promyelocytic leukaemia cell lines (HL-60), obtained a mean inhibitory concentration (IC_{50}) of 13.2 μg mL^{-1} against promyelocytic leukaemia (HL-60), 20.1 μg mL^{-1} against cervical adenocarcinoma (HEP-2) and 25.5 μg mL^{-1} against breast adenocarcinoma (MCF-7).

According to Souza et al. (2015), evaluating the essential oil of this plant in guinea pigs, found an antispasmodic effect associated with the blockade of calcium channels. *O. selloi* essential oil reduced contraction and induced diarrhoea in rats (Franca et al. 2008).

The literature also mentions the use of *O. selloi* essential oil as a mosquito repellent and according to Paula et al. (2003), this oil has a repellent activity that was found to reduce bites in volunteers who used it directly on the skin. A similar study was developed by Paula et al. (2004), with the essential oil of the leaves of *O. selloi* against the mosquito *Anopheles braziliensis* Chagas, being noticed that the dilution of 10% of the essential oil in ethanol reduced by 98.1% the bites in the volunteers concerning the control without the essential oil. According to Van Langenhove & Paul (2015), the repellent property of the essential oil of *O. selloi* can be used to make clothes with a repellent finish.

Ricarte et al. (2020) evaluated the larvicidal effect of the essential oil from the infloweresence of *O. carnosum* applied to *Aedes aegypti* Linnaeus larvae, obtaining 100% mortality with a concentration of 250 μg mL^{-1}. Menezes et al. (2020) applied *O. selloi* essential oil to *Spodoptera frugiperda* larvae and found that the oil-induced a 100% lethality at a concentration of 1 mg mL^{-1} after 48 hours.

Other ways of obtaining the extract of *O. selloi* are reported as the extract obtained by maceration in ethanol: water 70% of the aerial parts of this plant that was tested in rats to evaluate the effect of reducing the vascular risk resulting from hypertension, being observed that the extract stopped the damage caused by the administration of angiotensin II (Alegría-Herrera et al. 2019).

The ethanolic extract of *O. selloi* leaves showed a reduction of 42.4% of the DPPH radical, the absorbance of 0.29 of the reduction of iron III and 32.3% of the reduction of superoxide (Hakkim et al. 2008). The research developed by Piva et al. (2021) produced craft beer with the addition of *O. selloi* leaves at different stages of manufacture, obtaining a stable product about storage due to the antioxidant activity of the species.

In the study by Morais et al. (2013) an average IC_{50} of 2.70 mg mL^{-1} in the DPPH radical was observed, with a correlation with the content of phenolic compounds for the ethanolic extract of the aerial parts of *O. selloi*, an analysis of this extract as an inhibitor was also performed. of the enzyme acetylcholinesterase *in vitro* to verify the potential for the elaboration of drugs against Alzheimer's disease, however, no inhibition halos were observed (Morais et al. 2013). The ethanolic and hexane extract from the leaves of *O. selloi* has already been tested as an insecticide against *Diaphania hyalinata* (Broca das Cucurbitaceae), however, no biological effect was observed (Moreira et al. 2004).

5. Toxicity

The essential oil from the leaves of *O. selloi* was also tested in other types of investigation, such as in the studies by Paula et al. (2003) using rats, which were administered doses at a concentration of 250 mg kg^{-1} of body weight and equal to or greater than 1500 mg kg^{-1} analyzed that the mildest doses did not cause adverse effects, however, at the highest concentration, rats showed signs of intoxication and deaths, mainly among females.

Paula et al. (2007) evaluated the mutagenicity of essential oil from leaves of wild and urban *O. selloi* using male and female rats and did not observe signs of mutagenicity at concentrations tested from 1000 to 2000 mg kg^{-1} for the urban sample and from 500 to 1000 mg kg^{-1} for the wild-type sample.

However, Vigna et al. (2015) reported a case of intoxication with the infusion of *O. selloi* leaves in a newborn, associating this effect with the presence of eugenol, methyl eugenol and archival. Therefore, the use of this plant should be avoided for pregnant women, lactating women and newborns, and studies on this are necessary.

6. Final considerations

It can be inferred that this plant has a high potential for employability in different products and for different purposes, this can be observed in the face of the diversity of studies described in the literature. Furthermore, it is a plant rich in bioactive compounds that can compose foods, drugs and cosmetics with a vast field for research, mainly with an investigation of new applications. It is expected, through this study, to make a contribution, in practical terms, to new studies and products and also to serve as a compiled reference of works with the plant.

Acknowledgment

To Financiadora de Inovação e Pesquisas (FINEP), Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES) for Thiago Luis Aguayo de Castro, Gleice Américo do Carmo Pinto and Maria do Socorro Mascarenhas (Código 001) and Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq) Claudia Andrea Lima Cardoso (312671/2021-0).

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