Investigating antioxidant activity in *Cymbopogon citratus* (DC) Stapf: a comprehensive bibliographic study

Investigando a atividade antioxidante em *Cymbopogon citratus* (DC) Stapf: um estudo bibliográfico abrangente

Investigación de la actividad antioxidante en *Cymbopogon citratus* (DC) Stapf: un estudio bibliográfico completo

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ABSTRACT
The present study conducts an extensive bibliographical survey focusing on the antioxidant compounds found within *Cymbopogon citratus* (DC) Stapf extracts. This particular species holds significant importance as it is widely utilized in traditional medicine across diverse cultures. To fulfill the study's objective, an in-depth exploration of specialized literature was conducted to identify compounds exhibiting antioxidant properties along with other relevant activities. Noteworthy among the compounds discovered are terpenes, including citral and geraniol, as well as flavonoids and various phenolic compounds. This comprehensive investigation aims not only to identify these compounds but also to shed light on their potential therapeutic applications. By contributing to the expansion of scientific knowledge regarding chemical compounds, this study seeks to pave the way for further research advancements and the development of novel therapeutic interventions.

**Keywords:** Antioxidant, Traditional Medicine, *Cymbopogon citratus*, Terpenes.

RESUMO
O presente estudo realiza um extenso levantamento bibliográfico com foco nos compostos antioxidantes encontrados nos extratos de *Cymbopogon citratus* (DC) Stapf. Esta espécie em particular tem uma importância significativa, pois é amplamente utilizada na medicina tradicional em diversas culturas. Para cumprir o objetivo do estudo, foi realizada uma exploração aprofundada da literatura especializada para identificar compostos que apresentam propriedades antioxidantes, juntamente com outras atividades relevantes. Destacam-se entre os compostos descobertos os terpenos, incluindo citral e geraniol, bem como flavonóides e vários compostos fenólicos. Esta investigação abrange a não apenas identificar estes compostos, mas também esclarecer suas potenciais aplicações terapêuticas. Ao contribuir para a expansão do conhecimento científico sobre compostos químicos, este estudo busca abrir caminho para novos avanços na pesquisa e no desenvolvimento de novas intervenções terapêuticas.

**Palavras-chave:** Antioxidante, Medicina Tradicional, *Cymbopogon citratus*, Terpenos.

RESUMEN
El presente estudio realiza un extenso estudio bibliográfico centrado en los compuestos antioxidantes que se encuentran en los extractos de *Cymbopogon citratus* (DC) Stapf. Esta especie en particular tiene una importancia significativa ya que se utiliza ampliamente en la medicina tradicional en diversas culturas. Para cumplir con el objetivo del estudio, se realizó una exploración en profundidad de la literatura especializada para identificar compuestos que exhiben propiedades antioxidantes junto a otras actividades relevantes. Entre los compuestos descubiertos destacan los terpenos, entre ellos el citral y el geraniol, así como los flavonoides y diversos compuestos fenólicos. Esta investigación exhaustiva tiene como objetivo no sólo identificar estos compuestos sino también arrojar luz sobre sus posibles aplicaciones terapéuticas. Al contribuir a la ampliación del conocimiento científico sobre los compuestos químicos, este estudio
busca allanar el camino para futuros avances en la investigación y el desarrollo de nuevas intervenciones terapéuticas.

**Palabras clave:** Antioxidante, Medicina Tradicional, *Cymbopogon citratus*, Terpenos.

1 INTRODUCTION

The genus *Cymbopogon* comprises several species, including four relevant ones: *Cymbopogon distans*, *Cymbopogon flexuosus*, *Cymbopogon winterianus*, and *Cymbopogon schoenanthus*, along with *Cymbopogon citratus*. These species are widely known for their medicinal properties and are used in various cultures around the world. (Barbosa, 2007).

Lemongrass, *C. citratus* (DC) Stapf, also known as zacate limón, cana santa or caninha, is an herbaceous plant, originating in India and often used in traditional medicine for treatment from various ailments such as fever, cramps, digestive problems and also used as a natural insect repellent. It is estimated that this species was introduced into Brazil in colonial times as an ornamental plant and is currently found in practically all regions of Brazil (Vidal, Nunes, et al., 2007; Vásquez, Mendonça e Noda, 2014).

The species is widely cultivated in parts of Asia and South America to obtain its essential oil. Regarding its botanical aspects, this is a perennial, rhizomatous plant that can measure up to 2 meters in height. Its leaves are concentrated at the base, hairless, with a scaly surface, green in color and measuring 90 cm long by 2 cm wide. Its flowers are rare, but when they occur they can measure 25 cm in length (Yesil e Akalüm, 2015).

*C. citratus* is widely used in many countries to treat a variety of health conditions. In India, it is traditionally used against fever and digestive problems, while in Nigeria it is used to treat diabetes, inflammation and nervous disorders. In Argentina, it is used to relieve sore throats, flu-like symptoms and digestive problems. In Brazil, it is recognized for its analgesic, anti-inflammatory, diuretic, calming and anxiolytic properties. In studies cited, the use of these substances stands out as important therapeutic options for relieving pain, reducing inflammation, increasing urine production and combating anxiety. The
most common way of consuming these bioactive compounds is through tea, with phenolic compounds predominant, providing functional properties, especially antioxidant activity. Furthermore, *C. citratus* is used to combat high blood pressure, stomach pain, headache, acting as a calming, diuretic and relieving flu-like symptoms (Shah *et al*., 2011; Feijó, Pereira, *et al*., 2013; Avoseh *et al*., 2015; Magalhães e Santos, 2021).

The bioactive compounds of *C. Citratus* are called secondary metabolites, which are chemical substances produced by plants that have a complex structure and low molecular weight. These substances are responsible for several biological activities, such as defense against predators, attracting pollinators and competition for resources. Unlike primary metabolites, which are essential for the basic functioning of the plant, secondary metabolites are found in low concentrations and only in certain groups of plants (Silva e Lima, 2015). Secondary metabolites are divided into three main groups: terpenoids, which are derived from isoprene and include compounds such as essential oils and carotenoids; phenolic compounds include flavonoids, tannins and nitrogenous compounds that include alkaloids (Miranda, 2012).

In view of the above and, knowing the need to expand knowledge about natural products in the upper Solimões region, the present work aimed to carry out a bibliographical survey, using scientific articles, theses and specialized academic databases, of the main antioxidant compounds and other relevant properties of *Cymbopogon citratus*.

2 METHODOLOGY

The present study was carried out through a bibliographical survey of data contained in the literature from 2007 to 2021 on the antioxidant activity, and others that are relevant, of the chemical compounds of *C. citratus* (DC) Stapf. Articles, monographs, dissertations and theses present in the Google Scholar and SciELO - Brazil databases were used. Keywords such as Cymbopogon were systematically used, citratus, biological activities, chemical compounds, lemongrass and lemongrass.
3 RESULTS AND DISCUSSION

Based on a bibliographic review of scientific articles, websites and theses about *C. citratus* and its biological activities, it was found that the species contains a variety of chemical compounds belonging to the class of alkaloids, terpenoids, flavonoids, carotenoids, tannins, glycosinolates, pigments, waxes, oils, steroids and chlorophyll (Lins et al., 2015). It was observed that in the essential oil of *C. citratus* leaves, several compounds from the monoterpenene group are present, such as citral and geraniol, myrcene, limonene, terpinolene, ocimene, pineme, caryophyllene, phallandrene and oxobisabolene (Roma, 2020). Furthermore, the leaves contain coumarins, stilbenes, lignans and lignins, according to literature reports (Azevedo, Almeida, et al., 2011). Phenolic acids and alkaloids are also found in the species (Oliveira e Bastos, 2011).

The species *C. citratus* has essential oil in its leaves that mainly contains the citral compound, with an amount of 65-80%. Furthermore, myrcene is another characteristic compound of the species, present in 27.04% of the essential oil. Limonene is also a compound frequently found in oil (Roma, 2020; Jesus, 2019; Oladej, Adelow, Ayodele e Odelabe, 2019).

It is important to note that citral is a compound found in large quantities in the leaves of *C. citratus* and is known for its antioxidant properties. It is worth noting that some studies have shown that citral has free radical capture activity and the ability to inhibit oxidation, which makes it a potent antioxidant (Hacker, 2021).

In a study carried out by Soares et al. (2013), research was carried out to verify the antioxidant capacity of *C. citratus* leaf extracts. The results of this study indicated that the three extracts have antioxidant activities. Furthermore, citral has also shown anti-inflammatory, antifungal and antimicrobial activity. It is stated that among the biological properties of Citral, its fungicidal and antimicrobial action stands out (Kolb et al., 2007).

In addition to Citral, other compounds present in the hydroethanolic extract of *C. citratus*, such as geraniol, also showed significant antioxidant activity. Geraniol is an important chemical constituent of several essential oils, being pure, transparent and yellow that dissolves in most organic solvents. It is worth mentioning that geraniol is one of the
components of the species' essential oil, its antioxidant capacity is due to its ability to neutralize free radicals in the body and is attributed to its chemical structure, which has hydroxyl groups in its composition. It is worth mentioning that it has antioxidant effects on different biological systems, such as combating oxidative stress and preserving cellular damage (Hacker, 2021).

On the other hand, phenolic compounds are chemical compounds found in plants that have an aromatic ring containing one or more hydroxyl groups (OH) as substituents. These compounds can vary in structure and function, and are present in a wide variety of plants (Rocha et al., 2011). Furthermore, phenolic compounds are a class of chemical compounds found in plants that have a phenolic structure, that is, they contain a benzene ring. These compounds are known for their antioxidant properties and can play an important role in protecting plants, falling into several classes such as flavonoids, stilbenes, tannins, lignans and lignins (Azevedo et al., 2011).

Flavonoids are considered to be the main groups of secondary metabolites found in plants, being widely distributed in fruits, tea leaves and wines. These compounds are normally included in the human diet and are recognized by health professionals as natural defenders of the body against various harmful effects (Rodrigues et al., 2015).

Lemongrass, lemongrass and lemongrass contain flavonoids such as luteolin, quercetin, kaempferol, isoorientin and isoscoparin in their leaves and rhizomes (Oliveira et al., 2019). Thus, flavonoids are a type of phenolic compound found in several plants that have antioxidant properties, including C. citratus. These antioxidant properties are beneficial for human health, as they can help combat damage caused by free radicals (Silva et al., 2017).

In short, the species C. citratus presents biological activities scientifically proven by several studies. These properties can be attributed to the presence of flavonoids and other compounds (Figure 1) in its chemical composition that act as protective agents in the human body. Furthermore, studies point to the potential use of C. citratus in the prevention and treatment of various diseases (Hacker, 2021). Therefore, scientific investigation into the biological activities of this botanical species shows promise and can contribute to the development of new natural products.
4 CONCLUSION

Based on the literature review carried out, the importance of lemongrass in folk medicine, due to its medicinal properties, the most relevant being antioxidant. The plant presents a variety of chemical compounds, including terpenes such as citral and geraniol, flavonoids and phenolic compounds. In addition to its antioxidant potential, lemongrass also has antimicrobial, anti-inflammatory and anticancer properties. Finally, the literature review highlights *C. citratus* as a promising source of chemical compounds with
antioxidant activities and other properties, thus providing valuable insights for future research and applications with potential significant therapeutic benefits.
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