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Review Article

Phytochemical aspects and biological activities of essential oil of species of the family Canellaceae: A review

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Abstract

Survey have proven the popular Canellaceae family use to treat various diseases such as: muscular pains, infections, stomatitis, anti-malaric, healing, among others. The main use of these species is in the extracts form and essential oils extracted from the leaves and stem. Highlighting the importance of this family on the pharmacological point of view and the fact that few studies in the literature have reported the characterization of the essential oils compounds and their respective biological activities. The objective of this study was to carry out a systematic review of previous studies on essential oils of the Canellaceae family species and their biological activities. The databases Scopus, Web of Science and PubMed were used for the search and a bibliographical manager was used. A total of 143 files were analyzed, of which 21 presented the phytochemical analysis and / or essential oils biological activities of these species. Few species have been studied so far, such as *Canella winterana*, *Cinnamosma fragans*, *Cinnamosma madagascariensis*, *Cinnamodendron dinisii*. It can be observed that the major constituents for these species essential oils were: 1,8-cineol, linalool, limonene, alpha and beta-pinene. And that the main proven activities were: antibiotic, antifungal, insecticide, larvicide, trypanocidal, cytotoxic, molluscicide, immunomodulatory, anti-inflammatory and anticonvulcionate. From this literature review, it was possible to identify species that have not yet started studies and possible activities of their essential oils, mainly due to the almost homogeneous presence of the major constituents, making possible new research as well as projects and programs.

Keywords: anti-inflammatory; antimicrobial; cytotoxic; drimane sesquiterpenes

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Introduction

Essential oils are chemically complex products originated through the secondary metabolism of plants and responsible for activities that increase the plants resistance to the environment. They can be extracted from various aromatic plants and are

usually present in all plant organs, varying their content and composition according to some factors such as: the organ, collection time and place, species, among others. In general, they are liquid, volatile, soluble in organic solvents, less dense than water and colorless (1-4). Biological or pharmacological activity is an expression used to describe the beneficial or deleterious effects of a chemical compound or a compounds class on the various organisms (bacteria, fungi, animals, plants) (2).

The Canellaceae Mart. family has 5 generas: *Canella* P. Bowne, *Cinnamodendron* Endl., *Cinnamosma* Baill., *Pleodendron* Tiegh, *Warburgia* Engl. and 21 currently accepted species (5); they are trees and rarely shrubs, aromatic and most often with the cinnamon smell (6). They are native of Tropical America, Africa and Madagascar and characterized by the presence of secretory structures in their leaves and wood (6, 7).

Only the *Cinnamodendron* genus occurs in Brazil, with four species: *C.axillare* (Ness) Endl. ex Walp., *C. sampaioanum* Occhioni, *C. dinisii* Schwacke and *C. occhionianum* F.Barros & J.Salazar. These species can be found in the Amazon Forest, Atlantic Forest from the state of Minas Gerais to Rio Grande do Sul (6, 7). Representatives of this genera were also found on the Cardose island located in the city of Cananéia and on the Pereque River cliffs State of São Paulo (8).

The Canellaceae family has been studied since 1756 when P. Browne created the *Canella* genre (6). Since then publications with discoveries of other genera and species have been published, contributing even more to the knowledge of this family. There are reports on the chemical composition of extracts and essential oils extracted from the leaves and stem as the evidence of various pharmacological activities related to the presence of certain classes of compounds, others with isolated compounds and also the evaluation of the synergism between them (9-12). These studies confirm the traditional use of communities throughout the world that use this family plant parts for the treatment of muscular pain, wound healing and also have antibiotic, antifungal, pertussis, stomatitis, vermifuge, diuretic, anti-syphilis, antimalarial, inseticidal and citotoxic properties (9-17).

The genera *Cinnamodendron* with botanical synonym *Capsicodendron* Hoehne, in addition to the Brazilian species mentioned above, has another 6 species: *C. angustifolium* Sleumer, *C. corticosum* Miers., *C. cubense* Urb., *C ekmanii* Sleumer, *C. tenuifolium* Uittien and *C. venezuelense* Steyerm native of Tropical America (5) and like other family genera, have also been used by traditional communities to cure several diseases. However, only the *C. dinisii* had their studies started from a phytochemical point of view and until some biological activities (molluscicide, antimicrobial, antioxidant, insecticide) were confirmed for the essential oils and extracts extracted from this tree leaves and barks (4, 17-22).

Previously, during the beginning of this systematization, similarities were observed between the biological activities, the chemical composition of the essential oils of this family species and the traditional use by the communities around the world.

Due to the volume of this family studies on chemical composition and biological activities of the essential oils presented to date (143 documents) it is relevant to systematize for an understanding and identification of future research works and / or research programs.

Due to the lack of information on the chemical composition and biological activities of the essential oils of the Canellaceae family occurring in Brazil, the present work had as objective to make a survey of which species of this family had studies on the chemical composition and also the biological activities of the essential oils.

Methodology

A systematic review was carried out through a bibliographical survey on essential oil and biological activities of the species of the botanical family Canellaceae.

The searches were carried out at the bases: Scopus, Web of Sciense and Pub Med from 1961 to May 2018. The following search strategy was used in each of the databases. The following ones were used as key words: 'Canellaceae', '*Canella*', '*Cinnamosma*', '*Cinnamodendron*', '*Capsicodendron*', '*Warburgia*' combined with 'Essential Oil'. In addition, as a second search strategy we selected for this survey books, complete texts of dissertations and other sites to complement some data.

The reference manager EndNot X7 was used. As inclusion criteria, it was established that all the archives available in these databases containing essential oil characterization surveys and / or pharmacological activities *in vivo* or *in vitro* would be analyzed. As exclusion criterion, it was established that the chemical composition and pharmacological activity of any other classes would not be addressed in the present study.

Results

A total of 143 files were analyzed, including scientific articles, communications, theses, dissertations and books. The PubMed and Web of Science databases, share some works with the Scopus base, however some can only be found in

the first two bases, especially those related to biological activities.

From this search, it was possible to see that the genera with the greatest number of works is the *Warburgia* with occurrence in the African continent, while the genera *Cinnamodendron* of occurrence in the Brazilian territory was the one with smaller number. It was also noticed that in general the Canellaceae family has few realized works that date from 1961 until the present day.

Of the 143 analyzed works, 21 were chosen because they comprised on the theme: phytochemistry of the essential oils of the Canellaceae family. In these works, four species had been explored phytochemical and pharmacological activities: *Canella winterana* (L.) Gaertn., *Cinnamosma fragrans* Baill., *Cinnamosma madagascariensis* Danguy., *Cinnamodendron dinisii* Schwacke.

Most of the works (38.09%) followed the extraction of essential oils by hydrodistillation method and the most used part was leaves (85.71%). Some studies (19.04%) did not extract the essential oil and opted for the use of commercial oils.

It was possible to realise that the compounds amount and their percentage change due to species, collection site, seasonality, type and time of extraction and organ used. However, the major chemical constituents for most species were: 1,8-cineole, linalool, limonene, alpha and beta-pinene, and driannic sesquiterpenes.

For the *Warburgia* genres, no studies were found on the essential oil chemical composition and its biological activities. In the works performed with the *Warburgia salutares* (Bertol. f) Chiov., *W. ugandensis* Sprague, *W. stuhlmannii* Engl., several extracts were used and the chemical compounds that were isolated form mainly drimic sesquiterpenes. These isolated extracts or compounds have demonstrated antihelmintic activities (12), trypanocidal (10), antimalarial (23), immunostimulatory (11), antimicrobial (24), molluscicide (25) among others.

Discussion

The Canellaceae family has five genera and 21 species, of which only 9 were studied regarding the chemical composition and biological activities up to the moment of this survey. The genera *Canella, Cinnamosma* and *Cinnamodendron* are the ones that have more work on the chemical composition and biological activities of the essential oils, however, when compared to the genera of other plant families, this number is still small.

The family chemotaxonomic marker are the drimane sesquiterpenes (26, 27). Chemotaxonomic markers are molecules present in secondary or primary metabolites that allow the differentiation of specimens at any hierarchical level and provide characteristics of a group of plants (family, genera). In addition, these markers can be used to label the metabolic rate of a vegetable group (28, 29).

The drimane sesquiterpenes are a class of saturated hydrocarbons that derive from sesquiterpene alcohol drimenol and present bactericidal, antifungal activities, plant growth modulator, cytotoxic, phytotoxic and pesticidal effect (30). In addition, they are also discouraging of the feeding of insects, anticancer, antibiotics and molluscicides (18).

Warburgia

Species of this genus have been used by traditional communities as: expectorant, antibiotic, antifungal, antirheumatic, anti-malarial and for gastrointestinal problems and skin disorders (31). The results showed that no scientific studies on the chemical composition and biological activities of the species of this genera were found.

Canella

Canella is a genera with only 1 species *Canella winterana*. The content of this essential oil extracted by steam distillation and hydrodistillation of leaves and stem, ranged from 0.42-0.65% and its major constituents: 1,8-cineol (3.76 - 37%), linalool (2 - 8.5%), caryophylene oxide (37.4%), (E)-caryophyllene (18.8%) and myrcene (9.1 - 68%) (14, 32-35). The biological activity demonstrated until this moment for this species is antibacterial for the bacteria of the *Mycobacterium* Lehmann & Neumann (*M. tuberculosis* Zopf, *M. avium* Chester 1901 emend. Thorel et al. and *M. kansasii* Hauduroy) genera that causes tuberculosis (14).

Cinnamosma

Cinnamosma is a genera with 3 species *C. fragrans, C. macrocarpa* and *C. madagascariensis. C. frangrans* is indicated in the Madagascar pharmacopoeia for the treatment of pertussis, stomatitis, verminoses, liver diseases, diuretic and anti-syphilis (13). The studies do not contemplate the information on the content of this essential oil. The essential oils were obtained from the steam distillation or hydrodistillation of the leaves and stems, where the major constituents were: 1,8 cineole (45 – 57.5%), alpha-pinene (3.5 – 7%), beta-pinene (5 – 11.8%), linalool (2 – 95.8%) and sabinene (10.6%) (36-42). Among the biological activities proven for this species are: antibacterial (37-39), antiviral (38), anti-inflammatory, analgesic, healing, immunoregulatory and antipruritic (42).

The *C. madascariensis* is indicated by Madagascar pharmacopoeia for the treatment of coughs and dysentery (13). The content of this essential oil extracted by steam distillation of

leaves and stems have a content between 0.42-0.65% and its major constituents: linalool (6.6 – 30.1%), limonene (12 – 17.8%), alpha-pinene (8.4 – 19.5%), beta-pinene (7.1 – 49.9%), myrcene (17.9%) and beta-phellandren (15.3%) (43-45). Its proven biological activities were anticonvulsant, sedative (45) and lavicide for *Culex quinquefasciatus* Say (44).

For the *Cinnamosma macrocarpa* no works were found on the essential oil chemical composition and biological activities.

Cinnamodendron

This is a genera of Brazilian occurrence with four species: *C. axillare*, *C. dinisii*, *C. occhionianum* and *C. sampaioanum* (6-8) and 6 other species: *C. angustifolium* Sleumer, *C. corticosum* Miers., *C. cubense* Urb., *C ekmanii* Sleumer, *C. tenuifolium* Uittien and *C. venezuelense* Steyerm natives of Tropical America. It was observed that the only species in which studies conducted on essential oil chemical composition and biological activities was the *C. dinisii*, which is traditionally used to treat the various diseases ("panacéia") (7). The studies performed and obtained the essential oil through hydrodistillation. The content of this oil extracted from stem has 0.17± 0.08%) (19) and oil extracted leaves varied between (0.16-2.03%) (4, 20, 21). The main constituents of leaf essential oil are: limonene (68.5%), bicyclogermacrene (7.56 – 30.8%), and espatulenol (13.5%), in addition to the presence of the drimane sesquiterpenes drimenol (0.2 – 2.05%) (4, 20-22, 46-48). For this essential oil, the following biological activities have been proven: antibacterial (4, 47), antifungal (4, 47) antioxidant (4, 20), cytotoxic (22, 49), leishmanicide (22), and insecticide (46).

It has been observed that species no works were recorded on the essential oil chemical composition and biological activities for the species such as *C. axillare*, *C. occhionianum*, *C. sampaioanum*, *C. angustifolium*, *C. corticosum*, *C. cubense*, *C. ekmanii*, *C. tenuifolium* and *C. venezuelense*.

Conclusion

The Canellaceae family has numerous species that are widely used by traditional communities around the world. The essential oils of the species of this family have a complex mixture of monoterpenes and sesquiterpenes. It was possible to observe the similarity between the chemical constituents in different species analyzed and there is also difference in the quantity and the percentage of these compounds depending up on the species, extractive method and time duration of extraction, seasonality, collection site and biological activities of the used part. The essential oils that have been proven by studies are antibacterial, antifungal, anti-inflammatory, antipruritic, analgesic, antioxidant (β-carotene), anti-infectious, anticonvulatory, antimalarial, healing, cytotoxic, insecticide, larvicide, leishmanicide, sedative, trypanocidal and health promoter, which proves the traditional use of these oils and demonstrates the pharmacological importance of this family.

In general, few species of this family have been studied for the chemical composition, pharmacological activities and essential oil content. For *Warburgia*, *Pleodendron* and *Cinnamodendron* genera (except *Cinnamodendron dinisii*) and *Cinnamosma macrocarpa*, no references were found on the subject mentioned. It is believed that more studies on the species of this family should be formulated, mainly due to the already proven biological activities. It is suggested that the studies be performed also for roots, flowers, seeds and fruits aiming to unravel the information on the essential oils of the species of the family Canellaceae.

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Authors' contributions

All authors contributed to the content of the manuscript and approved the final version.

Competing Interest

The authors declare that they have no competing interest.

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