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Biological Activities of Some Essential Oils from Plants of Mexico

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Abstract

México is a country with a valuable source of flora including more than 6000 medicinal plants. Those diverse floral compositions provide a vast number of natural products beneficial for human population due to the plants are a potential source of drug discovery against different ailments. Essential oils are complex mixtures of secondary metabolites. Their mainly components are monoterpenes that are responsible for their biological effects. However, their composition depends on different environmental factors. Actually, some scientifical research has demonstrated their biological activity: antimicrobial, antioxidant, anti-inflammatory and anticancer. This review describes the effect of some essential oils isolated from Mexican plants such as oregano, lavander, laurel, Rosemary and arantho between others. We described the extraction method, the phytochemical composition, mainly the major compounds and their potential effects against fungi, bacteria and cancer cells.

Keywords: Essential oil; Biological activity; Antimicrobial antioxidant; Anticancer

Abbreviations: Essential oil (EOs); Gas chromatography/Mass spectrometry (GC/MS); Minimum inhibitory concentration (MIC); Effective concentration (EC50)

Introduction

Essential oils (EOs) are complex mixtures of volatile compounds produced by living organisms and isolated by physical means only (pressing and distillation) from a whole plant or plant organs of known taxonomic origin [1]. They are volatile liquid, insoluble in water, highly soluble in alcohol, ether, vegetable and minerals oils. They can be characterized by their main volatile components [2]. These volatile compounds belong to various chemical classes: alcohols, ethers or oxides, aldehydes, ketones, esters, amines, amides, phenols, heterocycles, and mainly the terpenes.

The composition and the effect of the EOs depend mainly on the harvesting season, extraction method and geographical sources [3,4]. Many of these volatile substances have diverse ecological functions. They can act as internal messengers, or intermediary metabolic products, as defensive substances against herbivores or as volatile compounds directing not only natural enemies to these herbivores but also attracting pollinating insects to their host [5].

The proportion of the volatile components varies from one EO to another, even within species, providing to each species different toxic and medicinal properties [6]. In recent years, different groups have been studied the efficacy of EOs and their chemical constituents as source of new bioactive natural products [7]. Initially, EOs was considered as waste material of plant metabolism; however, currently their biological importance has been recognized for their therapeutic properties [8]. EOs is important in medicine for their pleasant flavor, palliative effect to the pain and their low toxicity [9]. Also, scientific research over the past two decades has demonstrated various biological activities of EOs including anticancer, antiviral, analgesic, antioxidant, antibacterial and antifungal activities, as well as their ability to facilitate the passage of active molecules through the skin [10].

México present a high diversity of flora and more than 6000 medicinal plant species are used for the treatment of various diseases [11]. Interestingly, the EO of different Mexican medicinal

plants have been isolated and tested because of their biological activities, such as antioxidant, antimicrobial, fungicidal and anticancer effect. Some species of plants are *Lippia graveolens L. berlandieri schauer, Rosmarinus officinalis, Laurus nobilis, Lavandula x intermedia, Thymus vulgaris,* between others.

Antibacterial Activity

The EO of *Lippia berlandieri* Shauer has been isolated from the aereal parts by conventional steam distillation process to evaluate its antioxidant activity by DPPH (2-2´-diphenyl-1-picrylhydrazyl) method. Also, the ethyl acetate extract was evaluated. The essential oil showed a low radical scavenging activity, while the extract exhibited this activity at higher concentrations (100µg/ml) [12].

Also, oregano and its derivatives have been studied for their antimicrobials effects; this effectiveness is attributed to two compounds in its EO, carvacrol and thymol that inhibit pathogenic microorganisms [13,14]. *Paredes-Aguilar* [13] assessed the antimicrobial effect of *L. berlandieri* Schauer and its EO against *Vibrio alginolyticus V. cholerae* no-01, *Vibrio mimicus, Vibrio parahaemolyticus* and *Vibrio vulnificus.* The plant was collected from Salaices, Chihuahua, Mexico where they used the leaves to prepared EO. The effect was determined by the minimal inhibitory concentration and minimal bactericidal concentration (MIC and MBC), the results showed a favorable antimicrobial effect of oregano on all five species of *Vibrio*, which did not show significant differences for MIC and MBC values, at concentrations of 1.5 to 2.5 % of oregano, and of 100-200mg/L of the EO.

Ortega-Nieblas [15] analyzed the antimicrobial activity of the EO of *Lippia palmeri* S. Wats leaves. The plants were collected of two localities *(Álamos and Puerto del Orégano)* in the State of Sonora, México and the EOs presented almost 60 constituents such as monoterpenes, sesquiterpenes and phenolics. The antimicrobial activity was against four Gram-positive and six Gram-negative bacteria. However, both EOs showed the strongest activity against *Escherichia coli* O157:H7 and *Staphylococcus aureus* using different dilutions of the EO (1:1, 1:5, and 1:10).

The EO of lavender *(L. x intermedia)*, rosemary *(R. officinalis)* and laurel *(L. nobilis)* were obtained from plants cultivated in Dolores Hidalgo, Mexico and were analyzed by GC/MS. The analysis showed a 3-and 2-fold increase in camphor and linalool concentration in rosemary and laurel. Also, their antibacterial activity was assessed on strains of Gram-positive *(Mycobacterium smegmatis)* and Gram-negative *(E. coli)* bacteria using the agar disc diffusion method, the results showed a better antibacterial activity of lavender and laurel EO (5µl) against *M. smegmatis* [16].

The essential oil of the aerial parts of *Lantana achyranthifolia* Desf. (Verbenaceae) were collected in Zapotitlan de las Salinas, Puebla. The EO was studied by GC and GC–MS. The major components found were carvacrol, 1, 8-cineole, isocaryophyllene, bisabolene and -bisabolol. The oil exhibited antibacterial activity against fourteen Gram-positive and Gram-negative bacteria such as *V. cholerae, Shigella boydii, S. aureus, S. epidermidis, Bacilus subtilis* and Sarcina lutea; and the MIC were between 0.25 and 1mg/ml [17].

Antifungal Activity

In a study of *Guerra [18]*, et al, 2015, the antibacterial and antioxidant effect of EO of some species such as *T. vulgaris, R. officinalis* and *Origanum majorana* from northeastern México were evaluated. The results showed that the EOs of *T. vulgaris and O. majorana* inhibited the growth of *Trychophytum rubrum, T. tonsurans, T. mentagrophyte,* between others; and the minimum inhibitory concentration (MIC) values were between 62.5 and 500µg/mL; however, the antioxidant activity was low, with effective concentration (EC50) values >250µg/mL.

The EO of the leaves of *T. vulgaris L*. was collected in Guadalajara, Jalisco, Mexico. It was chemically analyzed by GC/MS and evaluated for its fungicidal activity. The main constituents reported were borneol (28.4%), thymol (16.6%), carvacrol methyl ether (9.6%), camphene (6.9%), α-humulene (6.4%) and carvacrol (5.0%). The fungicidal activity showed an inhibitory effect against *Alternaria citri* using a concentration of 1000ppm [19].

Anticancer activity

Estanislao [20] evaluated the antitumoral effect of the leaves of the EO *Decatropis bicolor* plant from The Cardonal, Hidalgo, and Mexico. The results demonstrated that the EO induced a cytotoxic effect on MDA-MB-231 breast cancer cell line with an IC50 of 53.8µg/ml. Also, the EO induced an apoptotic cell death with activation of the intrinsic pathway, DNA fragmentation and morphological changes.

In the same way, *Torres [21]*, evaluated the EOs of fifty plants belonging to the Myrtaceae, Schisandraceae, Lauraceae, Asteraceae and Pinacea Family, between others. They analyzed the anti-inflammatory and anticancer activity of the EOs. The results showed that five and seven EOs produced cytotoxicity in the human pancreatic cancer cell lines MIAPaCa-2 and BxCP-3, respectively, when using 100µg/ml. Also, some EOs induced the activation of caspases corresponding to apoptotic cell death.

Discussion

Despite their rich and complex composition, the use of EOs remains wide and limited to the cosmetics and perfumery. It is important to develop a better understanding of their chemistry and the biological properties and their individual components for new and valuable applications in human health, agriculture, and the environment. EOs could be exploited as effective alternatives or complements to synthetic compounds of the chemical industry, without inducing the same secondary effects [22].

Monoterpenes are a class of volatile organic compounds whose, with others, are responsible for the main medicinal and olfactory properties of EOs. The proportion of these compounds

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usually determines the quality of EOs used as perfumery standards (high content of linalool and linalyl acetate combined with trace amount of camphor) or as medicinal standards (high contents of bioactive monoterpenes) [16].

Since ancient times traditional Mexican medicine has used a wide variety of plants to treat different disorders, so the studied of the EOs is important to provided information about its biological effects such as antibacterial, antioxidant and anticancer, between other. Antibacterial activity of EOs and their constituents have been showed the hydrophobicity of the EOs, allows them to partition into lipids of the cell membrane of bacteria, disrupting the structure, and making it more permeable. This can then cause leakage of ions and other cellular molecules [23-25].

The antioxidant potential of an EO depends on its composition, the phenolics and secondary metabolites with conjugated double bonds usually show substantial antioxidative properties [26]. EOs with scavenging capacity of free radicals play an important role in some disease prevention, such as brain dysfunction, cancer, heart disease and immune system decline [27].

Finally, anticancer activities of EOs have been intensively explored in recent years due to the necessity to obtain new drugs or complementary treatments for cancer. Various mechanisms involved in cancer treatment are activation of detoxification enzymes, modulation of DNA repair signaling, antimetastasis and antiangiogenesis. Also, multiple pathways are involved in the antiproliferative activity produced by EOs [27].

Conclusion

Many plant species possess potential for use as a beneficial therapeutic remedy with multiple pharmacological actions with the advantage to not induce adverse reactions in contrast to the synthetic drugs. Particularly the EOs possess multiple compounds that present a great potential in the field of medicine since they effectively destroy different type of cells and pathogens. In this review we summarized the performed investigations about EOs of Mexican medicinal plants where antibacterial, antifungal, antioxidant and anticancer activities were observed. Nevertheless further analyses needs to be undertaken in order to identify the compound or compounds that induces those activities as well as to carry out pharmacological and clinical studies to establish scientific basis for the future development of new drugs.

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