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REVIEW ARTICLE

Beneficial and Healthy Properties of Eucalyptus Plants: A Great Potential Use

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Abstract: Eucalyptus (*Eucapyptus* spp.), an evergreen tall tree native to Australia and Tasmania, has been used since ancient times by the aboriginal population for several purposes. In particular, the species *E. globulus* is widely used in the pulp industry, as well as for the production of eucalyptus oil extracted on a commercial scale in many countries as raw materials in perfumery, cosmetics, food, beverages, aromatherapy and phytotherapy. The 1,8-cineole (eucalyptol), the principal and the most important constituent extracted from eucalyptus leaves, demonstrated an antimicrobial and anti-inflammatory activities. Despite the fact that the healthy effects of eucalyptus have been well established by research, further studies are necessary to investigate other prime effects of the plant and its possible implication in the treatment of a greater number of pathological conditions.

Keywords: Antibacterial, Anti-inflammatory, Antioxidant, Essential oil, Eucalyptol, *Eucalyptus globulus* labill.

INTRODUCTION

In recent decades, the demand for plant derived products for therapeutic uses has been increased [1]. In many countries worldwide aromatic herbs are used in primary health care, especially in rural areas [2], and 80% of the populations in developing countries use these traditional resources [3]. For this reason, the use of essential oils extracted from plants for clinical purposes have become an important topic in scientific research and industrial application thanks to the different biological activities of oils, which exercise antimicrobial [4], antioxidant [5] and anti-inflammatory [6] activities. In this brief review, the authors will focus the attention on eucalyptus, which is a plant used for several purposes.

Eucalyptus (*Eucapyptus* spp.), is a large genus of the *Myrtaceae* family, which includes 900 species and subspecies. This evergreen tall tree is native from Australia and Tasmania and is the second largest genera after acacia [7]. Since the 1850s, it has been successfully introduced into 90 countries worldwide where it is now one of the most important and widely planted genera [8]. In ancient times the eucalyptus plant was used for several purposes by aboriginal people, both as medicine and as food. Nowadays, the plant is used in forestry (timber, fuel, paper pulp), environmental planting (water and wind erosion control), as a source of essential oil (medicinal, perfumery oils), for arts and craft [7]. Among all the species of Australian *Eucalyptus*, the E. *globulus* was widely introduced overseas [9], becoming largely cultivated in the subtropical and Mediterranean regions [10], as well as in Nigeria. *E. globulus* which has different vernacular names (eucalyptus in Bengali and in Hindi; blue-gum eucalyptus in English and Karpuramaram in Tamil [11]), is considerably used in the pulp industry, as well as for the production of eucalyptus oil (henceforth EO),

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extracted on commercial scale in many countries and adopted in perfumery, cosmetics, food, beverages, aromatherapy and phytotherapy [12].

Eucalyptus plants draw the attention of researchers and environmentalists worldwide because it represents a fast-growing source of wood as well as a source of oil used for several purposes. The oil is extracted from leaves, fruits, buds and bark showing antibacterial, antiseptic, antioxidant, anti-inflammatory, anticancer activities [11, 13] and for this reason used in the treatment of respiratory diseases, common cold, influenza, and sinus congestion [14, 15]. The aim of this paper is to provide and collect scientific information about eucalyptus plants in order to present the beneficial and healthy properties and its potential use.

Chemical Composition

E. globulus is a rich source of phytochemical compounds as flavonoids, alkaloids, tannins and propanoids, extracted in the leaf, stem and root of the plant [11]. Several researches were conducted with the aim to isolate the phytoconstituents from the plant's organs: several volatile constituents as 1,8-cineole (eucalyptol) aromadendrene, α-gurjunene, globulol, ß-pinene, pipertone, α-,ß-and γ-terpinen-4-ol, and allo-aromadendrene were found both in leaves and in shoots (eucalyptol is, in particular, the principal and the most important constituent found in eucalyptus, also in plant's buds); borneol, caproic acid, citral, eudesmol, fenchone, p-menthane, myrecene, myrtenol, α-terpineol, verbinone, asparagine, cysteine, glycine, glutamic acid, ornithine and threonine were extracted from fruits [16], while forming acid, dextrin and sucrose were extracted from flowers and the honey [17]. Despite the fact that more than 18 compounds were identified in EO, eucalyptol represents the 79.85% of the total chemical composition. The EO also showed a high content of oxygenated monoterpenes, which change between each *Eucalyptus* species, with a potential variation in therapeutic properties [18]. The composition pattern of essential oil is affected by factors such as geographical location [19] and seasons [20], with consequent influence on biological activities [21]. EO is widely used in many countries like China, India, South Africa, Portugal, Brazil and Tasmania [20] for perfumery, cosmetics, aromatherapy, phytotherapy products and for food and beverages preparation [22].

Antiseptic and Antibacterial Effects

Eucalyptus plant was used traditionally as antiseptic and for the treatment of respiratory tract infections [23]: the herb is, in fact, very helpful for colds, flu, sore throats and chest infections including bronchitis and pneumonia [15]. Several studies showed a moderate antimicrobial activity of EO from *E. globulus* both on Gram-negative (*Salmonella enteritidis, Escherichia coli* and *Pseudomonas aeruginosa*) and Gram-positive bacteria (*Staphylococcus aureus, Enterococcus faecium, Listeria monocytogenes 4b* and *Listeria monocytogenes* EGD-e) and a bacteriostatic activity against all strains tested (with the exception of *Pseudomonas aeruginosa*) [24]. This effect on bacteria may be attributed to the dominant presence of eucalyptol which, in the past, has demonstrated a strong antimicrobial activities against many important pathogens [25]. To strengthen these results, other researchers showed a significant activity of EO from different *Eucapyptus* species against various microorganisms, including human pathogen spoilage bacteria, *Candida albicans* [9], *Propionibacterium acnes* and *Pityrosporum ovale* [26].

These studies supported the potential use of EO (specifically from *E. globulus* and *E. bridgesiana)* as natural preservative for food and pharmaceutical industries, which may be useful as an alternative antimicrobial agent in natural medicine for the treatment of numerous infectious diseases.

Antioxidant Properties

The infection process frequently induces inflammation which determines the release of free radicals from the phagocytes. Antioxidants are molecules able to scavenge reactive oxygen species or free radicals, protecting cells from damage and death. At a physiological level, these free radicals play important roles in energy production, synthesis of some biomolecules, phagocytosis, and cell growth in living systems [27]. An imbalance between free radical generation and unfavorable antioxidant defenses leads to oxidative stress, resulting in DNA or tissue damage [28, 29]. It is possible to distinguish among two categories of antioxidants, the natural and the synthetic. Recently, due to the adverse effects demonstrated by synthetic antioxidants, the interest in finding naturally antioxidant molecules in foods has increased considerably [30]. A study by Akolade and colleagues was conducted with an aim to determine the antioxidant effects of EO from *E. globulus* grown in Nigeria [18]. The antioxidant activity was evaluated by the ability of EO to scavenge 2,2-diphenyl-1-picrylhydrazyl (DPPH) radical in methanol (DPPH assay) and the results showed that, although its activity resulted lower when compared with ascorbic acid, the EO depending on concentration, exerts radical

scavenging activity. The low antioxidant capacity of the EO may be attributed to the absence of phenolics compounds (such as thymol and cavacrol) in Nigerian *E. globulus* leaf [18].

The major derivative compound from *E. globulus* are called Globulusin A and Eucaglobulin which demonstrated a suppressive effect on DPPH free radical development were examined. These molecules, in fact, scavenged DPPH free radical in a concentration dependent manner, and revealed an inhibitory activity stronger than ascorbic acid [31]. According to all these assessments, and considering the various experimental methods used, eucalyptus plant is an important source of antioxidants.

Anti-inflammatory Activity

The aromatic constituents of EO are used as analgesic, anti-inflammatory, and antipyretic remedies [14]. Juergens *et al*., examined the role of eucalyptol as inhibitor of the production and synthesis of tumor necrosis factor-α (TNF-α), interleukin-1β (IL-1β), leukotriene B4, and thromboxane B2 in human blood monocytes, suggesting that eucalyptol is a strong inhibitor of cytokines that might be suitable for long term treatment of airway inflammation in bronchial asthma and other steroid-sensitive disorders [32]. Moreover, in a double-blind, placebo-controlled trial, the anti-inflammatory activity of eucalyptol was evaluated in patients with severe asthma suggesting the efficacy of this molecule and a new rational for its use as mucolytic agent in upper and lower airway diseases [33]. These results should help to clarify functional applications for the future of eucalyptus plant and its EO in anti-inflammatory treatments.

Cytotoxic and Toxic Features

Extracts and components isolated from some *Eucalyptus* species showed cytotoxic activities. In the two studies presented in this section, the cytotoxicity of the compounds derived from Eucalyptus was evaluated measuring the concentration of sample that inhibited 50% of cell growth (IC_{50}). The first research was conducted on Cladocalol, a formylated triterpene isolated from *E. cladocalyx* leaves, which showed cytotoxic effect on the myeloid leukemia cell line HL-60 [34]. The second study was carried out in Brazil and investigated the cytotoxic activity of *E. benthamii* EO *in vitro*. The authors compared the activity of EO with some other terpene compounds (α-pinene, terpinen-4-ol and γ-terpinene) on different pathogenetic cells lines, such as Jurkat (T leukemia cells), J774A.1 (murine macrophage tumor), and HeLa (cervical cancer) cells lines. The results demonstrated a cytotoxicity of EO mainly against Jurkat and HeLa cell lines comparing to the isolated terpenes, showing the potential use of *E. benthamii* as an alternative herbal source [35]. These studies demonstrated the cytotoxicity of EO on some cells, showing the importance to study the characteristics of this plant for its potential use in the treatment of diseases. For what concern the toxicity, the information in scientific literature related to EO showed the toxic effect of this compound when ingested. Several cases of ingestion, especially in children, were recorded (the most common effects were burning sensation in mouth and throat, abdominal pain and vomiting) [36]. A case reported the story of a 3-years old boy who accidentally ingested EO, causing a central nervous system depression within 30 minutes [36], while Day *et al*. conducted a survey to investigate the unintentional EO poisoning in children with the aim to develop a strategy for the prevention [37], and Webb and Pitt reported, in 7 years of study, 41 cases of EO poisoning among children under 14 years [38].

Other Positive Effects

Besides the collected data on antiseptic and anti-inflammatory properties, little is known about the influence of EO extract on the cellular components of the immune system, and in particular on the monocytic/macrophagic system, which are one of the primary cellular effectors of the immune response against pathogen attacks [39]. The effect of EO extract on the phagocytic ability of human monocyte derived macrophages (MDMs) was investigated both *in vitro* and *in vivo*, on rat peripheral blood monocytes/granulocytes, after EO oral administration. The results demonstrated that EO is able to induce activation of MDMs stimulating the phagocytic response, decreasing the release of pro-inflammatory cytokines, acting as a complement receptor-mediated phagocytosis. Implementation of innate cell-mediated immune response was also observed *in vivo* after EO administration, mainly involving the peripheral blood monocytes/granulocytes [39].

Eucalyptol showed an important activity also in the therapy of symptomatic chronic obstructive pulmonary disease, thanks to its efficacy in reducing frequency, severity and duration of inflammatory exacerbation [40]. Like menthol, EO decongests the upper respiratory tract in case of common cold activating the nasal receptors, and stimulates the bronchial epithelium, determining an expectorant and mucolytic effect [11].

The benefits of eucalyptus extract on skin health and integrity were also reported [41]. Several studies described a

close relationship between the levels of ceramides and water-holding functions or between psoriasis or atopic dermatitis and dry skin [42 - 44]. It is well established that some substances (*i.e*. lactic acid and nicotinamide) increase ceramide levels in the stratum cornum [43, 45], and a recent study identified and demonstrates that eucalyptus extract is able to increase the level of ceramide in human stratum corneum, improving the water holding and barrier functions [41]. The enhancement of these functions might be the result of the increase of ceramide levels in stratum corneum, keratinocytes and epidermis, due to an increase of proteins biosynthesis involved in ceramide metabolism. The results of Ishikawa and co-workers indicate that eucalyptus extract plays an important role in ceramide metabolism and confirm the possibility to use this plant in therapeutic treatments of skin [41].

Furthermore, sideroxylonal was extracted from the flowers of *E. albens*., a new molecule that showed various bio-property [46]. This compound exhibits inhibitory activity against human plasminogen activator inhibitor type-1 (PAI-1) which is related to the pathogenesis of arterial and thrombotic diseases. It means that the molecule extracted from *E. albens* . should be a novel way to enhance fibrinolysis and to prevent the development of thrombotic diseases [47, 48].

CONCLUSION

In conclusion, studies conducted on eucalyptus plant demonstrated its biological activities, due to the multitude of compounds contained in the leafs, stem and roots [49, 50]. In particular, the abundance of bioactive secondary metabolites, such as terpenoids, tannins, flavonoids, and phloroglucinol derivatives confers both the antiviral and antibacterial effects [51] that explain the traditional use of the plant as an antiseptic and in the treatment of respiratory tract infections. Among the genus *Eucalyptus*, the species *E. globulus* is the most widely cultivated in the subtropical and Mediterranean regions, which reach a therapeutic importance thanks to its phytochemicals compounds. However, despite the several known healthy effects of eucalyptus plant, further studies are necessary to investigate other prime effects of the plant and the possible implication in the treatment of other pathological conditions, and in case of plant toxicity, the diffusion of injuries prevention strategies.

CONFLICT OF INTEREST

The authors confirm that this article content has no conflict of interest.

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