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The application of Tea tree essential oil in Dentistry

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Abstract

Tea tree oil, an essential oil extracted from the leaves of Melaleuca alternifolia by steam distillation and supercritical fluid extraction has found a wide range of antimicrobial activities as antiviral, antifungal, and antibacterial due to the presence of terpinen–4-ol as the major constituent. Tea tree oil is natural products, so it is non-toxic, easily accessible, biodegradable, and biocompatible. The several advantages of tea tree oil make it one of the beneficial product having therapeutic effects. The present review article is based on the application of tea tree oil, extraction process of tea tree oil, constituents, safety considerations etc

Introduction

Oral diseases such as dental caries and periodontal diseases are caused by microorganisms belonging to the resident micro flora rather than by classic microbial pathogens [1]. Oral microbial flora is dominated by Gram-positive microorganisms, and hence dental plaque which is formed on the tooth surface contains Gram-positive cocci and bacilli [2]. With the exponential advancement in the field of dentistry, various preventive measures have emerged targeting the causative factors of the oral diseases [3]. Many complementary and alternative medicines have enjoyed increased popularity in recent decades. Efforts to validate their use have seen their putative therapeutic properties come under increasing scrutiny in vitro and, in some cases, in vivo. One such product is tea tree oil (TTO), the volatile essential oil derived mainly from the Australian native plant Melaleuca alternifolia [4].

History of production

Traditionally, Melaleuca alternifolia leaves were crushed and the oil was inhaled by the indigenous Bundjalung people of eastern Australia for the treatment of coughs, colds and also for the treatment of wounds. An infusion of Melaleuca alternifolia leaves was used to treat sore throats or skin ailments [5, 6]. The essential beneficial effects of Melaleuca alternifolia oil came into focus when the first reports of its anti-microbial activity were published in a series of papers in the 1920s and 1930s. The use of tea tree oil in industry came into existence when the antimicrobial activities of Melaleuca alternifolia were first reported by Penfold and was rated to be 11 times more active than phenol. But after World War II, the entry of antibiotics declined the use of natural products in medicine, which has negative effect on the production of tea tree (Melaleuca alternifolia) oil. The interest in natural products like tea tree oil grew in the year 1970s which appeared as a period of general renaissance of natural products. Commercial plantations were established in the 1970s and 1980s, which led to a large-scale production of a consistent essential oil product [7, 8]. TTO is used by Aborigines to treat abrasions, cuts, colds and influenza. TTO is now used around the world in many cosmetic, medicinal and dental products (e.g., 'natural' toothpastes).

Figure 1: Melaleuca alternifolia

Composition and Chemistry

TTO is composed of terpene hydrocarbons, mainly monoterpenes, sesquiterpenes, and their associated alcohols. Terpenes are volatile, aromatic hydrocarbons and may be considered polymers of isoprene, which has the formula C5H8. Early reports

on the composition of TTO described 12, 21, and 48 components [7, 9, and 11]. The seminal paper by Brophy and colleagues examined over 800 TTO samples by gas chromatography and gas chromatography-mass spectrometry and reported approximately 100 components and their ranges of concentrations [12].

Extraction of tea tree oil

Tea tree oil is extracted by steam distillation of the leaves and terminal branches of Melaleuca alternifolia. Once condensed, the clear to pale yellow oil is separated from the aqueous distillate. The yield of oil is typically 1 to 2% of wet plant material weight [12]. Supercritical fluid extraction (SFE) is also used for the extraction purpose under a range of supercritical carbon dioxide (scCO2) densities and chamber temperatures at flow rate of 0.25 g/mL scCO2 density at a chamber temperature of 110oc. Supercritical fluid extraction overcomes the drawbacks associated with steam distillation process like loss of components due to thermal degradation , hydrolysis or volatilization. On the other hand, Supercritical fluid extraction is non-toxic and cheap involving little or no organic solvents, safe extraction of thermo labile compounds ,extraction conditions can be effectively controlled through temperature and/or pressure modifications, easy achievement of the supercritical state (scCO2) since CO2 possesses a critical temperature of 31oC [13].

Mechanism of action

Interactions with the hydrophobic structures of bacteria play a key role in the antimicrobial actions of hydrocarbons [14]. Consequently, assumptions regarding the mechanism of action of TTO have been based on the nature of its components. In the present investigation, S. aureus cells in the stationary phase of growth were killed by TTO and its components. Organisms in this growth phase are generally less sensitive to injury than those in the exponential phase [11], and this has been shown for Escherichia coli treated with TTO [15].

Application of tea tree oil

The major component of the Tea Tree Oil, terpinen-4-ol, which is extracted from leaves of Melaleuca alternifolia, has been found to have several medicinal effects as an anti-inflammatory effect, antibacterial, onychomycosis, candidiasis, clearance of bronchial congestion; effective in asthma, coughs, sinusitis, whooping cough, tuberculosis, antifungal and an anticancer activity in human melanoma cell lines (M14) as well as in lung cancer cells [16]. Due to its intrinsic properties, terpinen-4-ol can cause allergic reactions when applied directly in the skin, limiting its use [17].

1. **Burners and vaporizers**: In vapour therapy, Tea tree oil helps with colds, sinusitis, bronchitis and any other respiratory ailment and is also of use to help the mind cope aftershock [18].
2. **Blended massage oil or in the bath** As a blended massage oil or diluted in the bath, Tea tree oil helps with all respiratory ailments, as well as arthritis, colds, dermatitis, skin infections, scalp disorders, sinusitis, viral infections, nettle rash, babies colds and coughs, bronchitis, as well as for sweaty feet [18].
3. **In wash or applied neat** When it is added to the water for washing it has great value to treat abscesses, bed sores, acne, boils, lice, dandruff, wounds, as well as animal or human bites and can also be applied neat on problem areas with a cotton bud. For lice - apply neat onto the scalp - leave for 40 minutes and wash the hair. This must be repeated every second day for twelve days. Fungal outbreaks such as athlete's foot and nail infections (paronychia) as well as vaginal thrush and cradle cap can be treated with frequent direct application of a 2.5% dilution of tea tree oil [19].
4. **Mouthwash:** The Tea tree oil can be used as a mouthwash for gum infections, mouth ulcers, throat infections and tonsillitis, while garlic eaters believe that it reduces the smell of garlic on the breath [20].
5. **Cream or lotion:** When Tea tree oil is blended into a cream or lotion and applied to the skin, it will help to clear up any fungal, bacterial as well as viral infections - and can therefore be used for a variety of problems - ranging from boils, abscesses, acne, bite wounds from animals and humans (although a medical practitioner must also be consulted), dandruff and other scalp disorders and is also effective to help sort out bed sores, diaper rash or any other rashes [21]. The Tea tree oil has been shown to inhibit cellular respiration in E. coli, and by disrupting the permeability barrier of microbial membranes the oil causes the cells to die [22].There is the death of E. coli, Proteus mirabilis, Staphylococcus aureus and Pseudomonas aeruginosa after exposure to a mixture of tea tree oil and jojoba oil [23]. The Tea tree oil has the ability to control the growth of five bacteria Bacillus subtitles, Escherichia coli, Micrococcus roseus, Sarcina luteus, and Serratia marcescens.

Tea tree oil and dentistry

The efficacy of TTO in dental applications has been assessed. An evaluation of the effect of a 0.2% TTO mouthwash and two other active agents on the oral flora of 40 volunteers suggested that TTO used once daily for 7 days could reduce the number of mutans streptococci and the total number of oral bacteria, compared to placebo treatment. The data also indicated that these reductions were maintained for 2 weeks after the use of mouthwash ceased [24]. In another study, comparison of mouthwashes containing either approximately 0.34% TTO, 0.1% chlorhexidine, or placebo on plaque formation and vitality, using eight volunteers [25], showed that after TTO treatment, both plaque index and vitality did not differ from those of subjects receiving placebo mouthwash on any day, whereas the results for the chlorhexidine mouthwash group differed significantly from those for the placebo group on all days [24]. Lastly, a study comparing a 2.5% TTO gel, a 0.2% chlorhexidine gel, and a placebo gel found that although the TTO group had significantly reduced gingival index and papillary bleeding index scores, their plaque scores were actually increased [26].These studies indicate that although TTO may cause decreases in the levels of oral bacteria, this does not necessarily equate to reduced plaque levels. However, TTO may have a role in the treatment of gingivitis, and there is also some evidence preliminary suggesting that TTO reduces the levels of several compounds associated with halitosis [27].

TTO has been evaluated as a mouthwash in the treatment of or pharyngeal candidacies. In a case series, 13 human immunodeficiency virus-positive patients who had already failed treatment with a 14-day course of oral fluconazole were treated with an alcohol-based TTO solution for up to 28 days [28]. After treatment, of the 12 evaluable patients, 2 were cured, 6 were improved, 4 were unchanged, and 1 had deteriorated. Overall, eight patients had a clinical response and seven had a mycological response. In subsequent work the same TTO solution was compared with an alcohol-free TTO solution [29]. Of patients receiving the alcohol-based solution, two were cured, six improved, four were unchanged, and one had deteriorated. Of patients receiving the alcohol-free solution, five were cured, two improved, two were unchanged, and one had deteriorated. Three patients were lost to follow-up and were considered no responders. Support for TTO possessing in vivo antiviral activity comes from a pilot study investigating the treatment of recurrent herpes labialis (cold sores) with a 6% TTO gel or a placebo gel [30]. Comparison of the patient groups (each containing nine evaluable patients) at the end of the study showed that reepithelialisation after treatment occurred after 9 days for the TTO group and after 12.5 days for the placebo group. Other measures, such as duration of virus positivity by culture or PCR, viral titers, and time to crust formation, were not significantly different, possibly due to small patient numbers. Interestingly, when TTO was evaluated for its protective efficacy in an in vivo mouse model of genital HSV type 2 infections, it did not perform well [31. In contrast, the oilcomponent1, 8-cineole performed well, protecting 7 of 16 animals from disease.

In vivo, topically applied TTO has been shown to modulate the edema associated with the efferent phase of a contact hypersensitivity response in mice[32] but not the development of edema in the skin of non sensitized mice or the oedematous response to UVB exposure. This activity was attributed primarily to terpinen-4-ol and terpineol. When the effect of TTO on hypersensitivity reactions involving mast cell degranulation was examined in mice, TTO and terpinen-4-ol applied after histamine injection reduced histamine-induced skin edema, and TTO also significantly reduced swelling induced by intradermal injection of compound 48/80 [33].

Safety and toxicity

Despite the progress in characterizing the antimicrobial and anti-inflammatory properties of tea tree oil, less work has been done on the safety and toxicity of the oil. The rationale for continued use of the oil rests largely on the apparently safe use of the oil for almost 80 years. Anecdotal evidence over this time suggests that topical use is safe and that adverse events are minor, self-limiting, and infrequent. More concrete evidence such as published scientific work is scarce, and much information remains out of the public domain in the form of reports from company-sponsored work [23].

Conclusion

A paradigm shift in the treatment of infectious diseases is necessary to prevent antibiotics becoming obsolete, and where appropriate, alternatives to antibiotics ought to be considered. There are already several non antibiotic approaches to the treatment and prevention of infection, including probiotics, phages, and phytomedicines. Alternative therapies are viewed favorably by many patients because they are often not being helped by conventional therapy and they believe there are fewer detrimental side effects. In addition, many report significant improvement while

taking complementary and alternative medicines. Unfortunately, the medical profession has been slow to embrace these therapies, and good scientific data are still scarce. However, as we approach the “post antibiotic era” the situation is changing. A wealth of in vitro data now supports the long-held beliefs that TTO has antimicrobial and anti-inflammatory properties. Despite some progress, there is still a lack of clinical evidence demonstrating efficacy against bacterial, fungal, or viral infections. Large randomized clinical trials are now required to cement a place for TTO as a topical medicinal agent.

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