SHORT COMMUNICATION

Antibacterial activity of commercially available plant-derived essential oils against oral pathogenic bacteria

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This work investigated the antibacterial activity of 15 commercially available plant-derived essential oils (EOs) against a panel of oral pathogens. The broth microdilution method afforded the minimum inhibitory concentrations (MICs) and minimum bactericidal concentrations (MBCs) of the assayed EOs. The EO obtained from Cinnamomum zeylanicum (Lauraceae) (CZ-EO) displayed moderate activity against Fusobacterium nucleatum (MIC and MBC = 125 μg/mL), Actinomyces naeslundii (MIC and MBC = 125 μg/mL), Prevotella nigrescens (MIC and MBC = 125 μg/mL) and Streptococcus mutans (MIC = 200 μg/mL; MBC = 400 μg/mL). (Z)-isosafrole (85.3%) was the main chemical component of this oil. We did not detect cinnamaldehyde, previously described as the major constituent of CZ-EO, in specimens collected in other countries.

Keywords: Cinnamomum zeylanicum; Streptococcus mutans; cariogenic bacteria

1. Introduction

Dental caries and other periodontal diseases are a major public health concern that affects the populations of many countries worldwide. These diseases are associated with acidogenic and aciduric bacteria that adhere to the tooth surface as a structurally and functionally organized biofilm (dental plaque) (Duarte Moreira et al. 2014). These bacteria can reach the bloodstream and trigger other diseases such as endocarditis, brain abscesses, throat infections, respiratory and gastrointestinal system infections, and bacteraemia (Aas et al. 2005). The most efficient way to prevent these diseases is to remove the biofilm by brushing and flossing (Barnett 2006).
However, most people fail to maintain a sufficient level of control through mechanical removal only. Therefore, the use of chemicals as a complementary measure to diminish the tooth surface biofilm is necessary and has proven to be a valuable tool to diminish the tooth surface biofilm (Furiga et al. 2008). Currently, chlorhexidine is the gold anticariogenic standard; however, the regular use of oral care products containing this chemical is often related to several side effects (More et al. 2008). In this scenario, the search for new potential chemotherapeutic agents for incorporation in dental products has escalated in recent years.

As part of our ongoing research on the antibacterial activities of essential oils (EOs) as potential leads for use in dental products (Aguiar et al. 2013), this paper reports on the evaluation of the antibacterial activity of fifteen commercially available plant-derived EOs against a panel of oral pathogenic bacteria.

2. Results and discussion

This work investigated the antibacterial activity of 15 EOs against 13 oral bacterial strains – 7 aerobic and 6 anaerobic bacteria – in terms of their minimum inhibitory concentration (MIC) and minimum bactericidal concentration (MBC). Classification of the antibacterial activity was based on MIC values, as follows: MIC ≤ 100 μg/mL, good; 100 < MIC ≤ 500 μg/mL, moderate; 500 < MIC ≤ 1000 μg/mL, weak; MIC > 1000 μg/mL, inactive (Santos et al. 2008). Most of the evaluated EOs were inactive or weakly active against the panel of selected oral bacteria (Supplementary Tables S1 and S2). The EO of Cinnamomum zeylanicum (CZ-EO) afforded the lowest MIC and MBC values against Fusobacterium nucleatum (MIC and MBC = 125 μg/mL), Actinomyces naeslundii (MIC and MBC = 125 μg/mL) and Prevotella nigrescens (MIC and MBC = 125 μg/mL). CZ-EO displayed moderate activity against Streptococcus mitis (MIC and MBC = 350 μg/mL), Streptococcus mutans (MIC 200 μg/mL; MBC = 400 μg/mL), Lactobacillus casei (MIC = 300 μg/mL; MBC = 400 μg/mL) and Porphyromonas gingivalis (MIC and MBC = 250 μg/mL). The moderate activity of CZ-EO against S. mutans is an interesting result because very few natural compounds can inhibit this bacteria, one of the primary causative agents of dental caries (Saleem et al. 2010). None of the tested EOs was significantly active against Enterococcus faecalis, Bacteroides fragilis, Streptococcus sobrinus and Peptostreptococcus anaerobius.

Gas chromatography (GC-FID) and gas chromatography–mass spectrometry (GC–MS) aided analysis of the chemical composition of CZ-EO, which gave the lowest MIC and MBC values among the evaluated EOs. The analyses revealed a total of 20 compounds, as listed in Supplementary Table S3. The chemical composition of CZ-EO was similar to the composition of other EOs extracted from C. zeylanicum specimens collected in other countries (Unlu et al. 2010), except for (E)-cinnamaldehyde (1, Figure S1), which did not occur in CZ-EO. The major constituent of CZ-EO was (Z)-isosafrole (85.2%) (2, Figure S1). (Z)-isosafrole has also been reported as the major compound of EOs obtained from other plant species, such as Canangium odoratum (Annonaceae) (Huang et al. 1999) and Piper marginatum (Piperaceae) (Sanchez et al. 2011). These differences between the chemical compositions of the EOs extracted from different C. zeylanicum specimens can be related to differences in the climate, soil composition, age and vegetative cycle stage (Masotti et al. 2003).

Unlu and co-workers investigated the antibacterial properties of an EO of C. zeylanicum obtained from specimens collected in Turkey against several Gram-positive and Gram-negative bacteria (Unlu et al. 2010). For this purpose, these authors used agar disc diffusion and MIC methods. This EO furnished MIC of 1120 μg/mL against E. faecalis (ATCC 29121). (E)-cinnamaldehyde, the major constituent of this EO, has proven to be particularly effective against some Gram-positive and Gram-negative bacterial species (Unlu et al. 2010). Here, CZ-EO was inactive against E. faecalis (ATCC 4082). The differences between our results and the data
reported by Unlu et al. (2010) might be due to a combination of factors, such as distinct E. faecalis strains from ATCC and different EO chemical compositions. (Z)-isosafrole, the main constituent in CZ-EO, is also the major component of some EOs that have antibacterial activity (Sanchez et al. 2011). However, to the best of our knowledge, data on the antimicrobial activity of (Z)-isosafrole are still scarce in the literature. In principle, this compound might underlie the antimicrobial activity of CZ-EO against some of the tested bacteria. However, (Z)-isosafrole may participate in intricate synergic and/or additive effects with other minor CZ-EO constituents (Melo et al. 2011). Therefore, further studies to identify the compound(s) that account for the antibacterial activity of CZ-EO against F. nucleatum, A. naeslundii, P. nigrescens, S. mitis, and S. mutans are necessary.

3. Conclusions
In summary, the EO of C. zeylanicum was the most active among the evaluated EOs. CZ-EO displayed moderate activity against F. nucleatum (MIC and MBC = 125 µg/mL), A. naeslundii (MIC and MBC = 125 µg/mL), P. nigrescens (MIC and MBC = 125 µg/mL) and S. mutans (MIC 200 µg/mL; MBC = 400 µg/mL). (Z)-isosafrole was the main component of CZ-EO, whereas cinnamaldehyde, commonly reported as the major component of the EOs of C. zeylanicum, did not occur in the C. zeylanicum specimens collected for this work. Further studies to identify commercially available plant-derived EOs that could afford promising leads for the development of new oral care products are underway.

Supplementary material
Supplementary material relating to this article is available online, alongside Tables S1–S3 and Figure S1.

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