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File: ■ Cinnamon (*Cinnamomum verum* syn. *C. zeylanicum*, Lauraceae)
■ Oral Candidosis
■ Denture Stomatitis

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RE: Cinnamon Leaf Essential Oil Inhibits *Candida* Growth In Vitro and Appears Safe as an Oral Mouthwash

de Araújo Oliveira J, da Silva ICG, Trindade LA, et al. Safety and tolerability of essential oil from *Cinnamomum zeylanicum* Blume leaves with action on oral candidosis and its effect on the physical properties of the acrylic resin. *Evid Based Complement Alternat Med.* 2014;2014:325670. doi: 10.1155/2014/325670.

Denture wearers are prone to denture stomatitis which forms between the dentures and gums and is associated with oral *Candida* infection. Treatments include the use of antifungal medications to control oral *Candida* populations, and education on the proper care and cleaning of dentures. Often though, denture stomatitis returns after treatment with antifungal medication ceases. Cinnamon (*Cinnamomum verum* syn. *C. zeylanicum*, Lauraceae) is known to have analgesic, antiseptic, and antimicrobial qualities. Cinnamon has also been found to have low toxicity in human subjects. This study was divided into 3 sections. First, the antifungal activity of the essential oil from cinnamon leaves was measured in vitro on 12 strains of *Candida*. Second, the effect of cinnamon essential oil was measured on the roughness and hardness of acrylic used in dentures. Lastly, the tolerance of mouthwash containing cinnamon essential oil was tested on subjects without oral *Candida* infections in a phase I clinical trial.

For each part of this study, essential oil from cinnamon leaves was purchased from Ferquima Ind. eCom. (São Paulo, Brazil). Secondary compounds in the essential oil were evaluated with mass spectrometry. Seventeen peaks were measured, with eugenol comprising 82.3% of the oil. In addition, nystatin (Sigma-Aldrich Brasil Ltda.; São Paulo, Brazil) was used as a positive control in the first 2 parts of the study. The minimum inhibitory concentration (MIC) of cinnamon essential oil was determined in 8 strains of *Candida albicans* and 4 strains of *Candida tropicalis* using serial dilutions. Once the MIC was determined, the minimum fungicidal concentration (MFC) was determined by growing the *Candida* strains in culture with the MIC for cinnamon essential oil. Two additional concentrations of essential oil (MICx2 and MICx4) were tested for MFC determination. The effect of cinnamon essential oil was measured on the roughness and hardness of polished denture-like acrylic samples. One side of each acrylic sample was marked with 3 lines. The samples were then stored in artificial saliva (source not given)

for 15 days. A negative control treatment received no further manipulation. The samples in the cinnamon treatment and the nystatin treatment were removed from the saliva 3 times per day and submerged in their respective treatments for 1 minute each time. The cinnamon treatment consisted of the MIC for cinnamon essential oil, Tween[®] 80 (source not given), and deionized water. The nystatin treatment consisted of 100,000 UI/mL of nystatin in deionized water. After treatment, the lines were measured for roughness. The hardness of the acrylic samples was measured before and after treatment with a Vickers diamond-tipped indenter, and an average Vickers hardness number (VHN) was generated.

In the last section of the study, healthy subjects who wore dentures were recruited. Oral *Candida* infection was assessed for each prospective subject. Subjects were excluded if they had oral candidosis, had taken antimicrobial medications in the last 6 months, or if they had a known sensitivity to cinnamon. Subjects were instructed to rinse their mouths for 1 minute 3 times per day with cinnamon mouthwash (distilled water, cinnamon essential oil at 625 µg/mL, and Tween 80) for 15 days. Subjects also cleaned their dentures with the cinnamon mouthwash at the same intervals. Subjects' mouths were photographed and examined prior to and after treatment. Subjects were also asked to record any side effects over the course of the study. Data were analyzed with analysis of variance and post-hoc Tukey's tests.

All 12 strains of *Candida* were inhibited by the cinnamon and nystatin treatments. A concentration of 625 µg/mL of cinnamon inhibited all strains of *Candida*. A cinnamon concentration of 312.5 µg/mL was found to inhibit 3 of the strains of *Candida*. The MFC was determined to be 625 µg/mL. The roughness of all acrylic samples increased and the hardness decreased significantly after 15 days of treatment ($P < 0.05$). The nystatin treatment resulted in a significantly rougher and softer surface than either the cinnamon treatment or the saliva control treatment ($P < 0.0001$ for both measures). Subjects ($n = 15$) did not show any change in gum appearance after 15 days of cinnamon mouthwash treatment. One subject noted a slight burning sensation on the tongue after using the cinnamon mouthwash that resolved in about 2 minutes. The sensation was not severe enough for the subject to discontinue treatment.

Cinnamon essential oil was found to inhibit the growth of *Candida* in vitro, result in less damage to acrylic dentures than nystatin, and be safe for use in the phase I clinical trial. The authors found only 1 prior pilot study on the use of cinnamon bark essential oil in controlling oral *Candida* infections in 5 patients; however, no studies were found on the use of cinnamon leaf essential oil mouthwash in subjects who wore dentures. The antifungal properties of cinnamon are attributed to the high concentration of eugenol in cinnamon leaf essential oil (and cinnamaldehyde plus eugenol in the bark essential oil). The authors recommend continued studies of the use of cinnamon mouthwash in the treatment of denture stomatitis and *Candida* infection in patients who wear dentures.

—Cheryl McCutchan, PhD

Referenced article can be accessed at <http://www.hindawi.com/journals/ecam/2014/325670/>.

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