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Ricinus communis treatment of denture stomatitis in institutionalised elderly

L. A. P. PINELLI*, A. A. B. MONTANDON†, S. C. T. CORBI‡, T. A. MORAES* & L. M. G. FAIS* *Departament of Dental Materials and Prosthodontics, Araraquara Dental School, UNESP - Univ. Estadual Paulista, Araraquara, SP, †Department of Community Dentistry, Araraquara Dental School, UNESP - Univ. Estadual Paulista, Araraquara, SP and ‡Departament of Diagnosis and Surgery, Araraquara Dental School, UNESP - Univ. Estadual Paulista, Araraquara, SP, Brazil

SUMMARY **This study compared the effectiveness of *Ricinus communis* (RC) with Nystatin (NYS) and Miconazole (MIC) in the treatment of institutionalised elderly with denture stomatitis (DS). They (n = 30) were randomly distributed into three groups: MIC, NYS or RC. Clinical and mycological evaluations were performed prior to the use of the antifungal (baseline) and repeated after 15 and 30 days of treatment. The sample was clinically examined for oral mucosal conditions. Standard photographs were taken of the palate, and the oral candidiasis was classified (Newton's criteria). Mycological investigation was performed by swabbing the palatal mucosa, and *Candida* spp. were quantified by counting the number of colony-forming units (cfu mL^{-1}). The clinical and mycological data were analysed, respectively by Wilcoxon and Student's t-test (α = 0·05). Significant improvement in the clinical appearance of DS in the MIC and RC groups was observed between the 1st and 3rd collections (MIC – P = 0·018; RC – P = 0·011) as well as between the 2nd and 3rd collections (MIC – P = 0·018; RC – P = 0·011). Neither groups showed a statistically significant reduction in cfu mL^{-1} at any time. Although none of the treatments decreased the cfu mL^{-1}, it was concluded that *Ricinus communis* can improve the clinical condition of denture stomatitis in institutionalised elderly patients, showing similar results to Miconazole.**

KEYWORDS: **candidiasis, dental care for aged, health of the elderly, homes for the aged, *Ricinus communis***

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Introduction

Denture stomatitis (DS) is the most frequent opportunistic infectious disease in the oral cavity, and it is caused by occasional parasitism by yeast of the genus *Candida*. Although DS has a multifactorial aetiology, *Candida albicans* is the most important and most virulent organism in its pathogenesis (1). The presence of this fungus in the oral cavity is considered normal commensalism (2–4), with percentages ranging from 25% to 50% of the total flora (5). However, a transition from the normal mucosal condition to a situation of parasitism or disease can occur when an imbalance occurs between the host and the fungus (3). Predisposing factors for DS include systemic diseases, immune deficiencies, reduced salivary gland function, continuous and nocturnal use of a denture (2, 6), use of broad-spectrum antibiotics or corticosteroids, smoking and dental plaque accumulation due to poor oral or prostheses hygiene (2, 7, 8).

DS has been reported in 11–67% of denture wearers (7, 9) and in 1·1–36·7% of partial removable dental prostheses wearers (10). Wearers of maxillary complete dentures show lower pHs and reduced saliva

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flow rates, along with loss of mechanical cleaning provided by the tongue (11); moreover, the acrylic resin of these prostheses provide a solid base for yeast adherence and colonisation (12). Therefore, this material has a higher probability of developing a fungal infection (13).

Elderly individuals are more susceptible to developed infections caused by *Candida* spp. (4, 14). This population may experience a reduction in salivary flow, a decrease in immune responses, frequent general health problems and daily use of various drugs, which promote an imbalance in indigenous microbiota, favouring the emergence of oral yeast infections (15, 16). The high prevalence of complete denture wearers, changes related to aging, poor oral hygiene and possible motor limitations, predispose the elderly to the development of DS (4). Moreover, the vast majority of institutionalised elderly individuals need the help of caregivers to fulfil their oral hygiene. Coleman *et al.* (17) suggested that caregivers may influence this care process.

DS may be treated with systemic or topical agents (4), such as polyenes (Nystatin), Imidazole derivatives (Clotrimazole) or Chlorhexidine (18). Nystatin and Miconazole are commonly prescribed (19) but have been associated with a decrease in the therapeutic response of DS (20). Furthermore, these drugs cause adverse effects. Miconazole, for example, may interact with anticoagulants, phenytoin, terbinafine, antipsychotics, cyclosporin and some statins used to treat hypercholesterolaemia. Nystatin may cause a bitter taste, allergic reactions and adrenal insufficiency (19, 21). Therefore, alternative antifungal agents are needed to deal with DS(20).

To minimise these allopathic side effects, new treatment options have been studied. Microwave disinfection (22), photodynamic therapy (23) and herbal drugs showed interesting results(24–27). A mouthwash (Perioquil), composed of ricinoleic acid, which is synthesised from fatty acids molecules of *Ricinus communis*, should be evaluated. Panghal *et al.* (28) concluded that *Ricinus communis* could have significant antimicrobial activity against clinical isolates of oral cancer, while other authors found that ricinoleic acid has antimicrobial activity against gram-positive bacteria and yeast (29, 30). Thus, the aim of this study was to compare the effectiveness of *Ricinus communis* with Nystatin and Miconazole in the treatment of institutionalised elderly with denture stomatitis (DS). The null hypothesis is that all tested treatments have no clinical and mycological effectiveness for DS remission.

Material and Methods

This study was carried out collaboratively by the long-term care institution Lar São Francisco de Assis* and was approved by the committee of Ethics of Araraquara Dental School, UNESP - Univ. Estadual Paulista (Process 64/08).

A total of 150 patients over 60 years old who were residents at this institution were examined for oral disease by one specialised dental clinician. Clinical examinations were held in a common chair or bed, depending on the degree of mobility of the individual, with the aid of a wooden spatula and flashlight. During this evaluation, Newton's criteria (31) were used to classify the DS degree into one of the following categories: Type I- localised simple inflammation or pinpoint hyperaemia; Type II- generalised simple inflammation; Type III- inflammatory papillary hyperplasia (32). Patients with DS had their palate condition recorded with standard photographs.

The inclusion criteria were male or female adults older than 60 years residing in the long-term care institution, with a clinical diagnosis of DS, maxillary complete denture wearers for at least 6 months, and not having taken antibiotics or steroids in the last month. Of the 150 elderly examined, 30 patients (20%) were selected to participate according to the inclusion criteria.

For the quantification of *Candida* spp. (8), mycologic samples were taken by rigorously swabbing the inflamed areas of the palatal mucosa using sterile swabs.† Each swab was individually immersed in a test tube containing 5 mL 0·9% sterile saline solution and vigorously vortexed for 1 min to suspend the organisms. Serial 10-fold dilutions from 10^0 to 10^{-3} were plated onto Sabourand Dextrose Agar‡ with 5 μg mL^{-1} chloramphenicol. SDA plates were incubated at 37 °C for 48 h and then the viable colonies of *Candida* spp. were visually quantified to determine the number of colony-forming units per milliliter

*Araraquara, SP, Brazil.

†CB Products Ind & Com Ltda., Corumbataí, SP, Brazil.

‡SDA, Himedia; Biosystems Com. Imp. Exp. Produtos Lab. Ltda., Curitiba, PR, Brazil.

(cfu mL^{-1}). The procedures were performed in duplicate.

The elderly were randomly divided into three groups, and different treatments were provided. All treatments were performed during 30 days. Patients of the MIC group were treated with Miconazole oral gel,[§] applying the product in the oral cavity, 4 times day^{-1}. In the second group (NYS), patients used Nystatin,[¶] applying an eyedropper on the tongue 4 times day^{-1}. The third group (RC) used the *Ricinus communis*** as a mouthwash 4 times day^{-1}. All the patients received oral hygiene instructions, including avoiding the nocturnal use of the denture, which should be immersed in filtered water (200 mL) overnight.

Two follow-ups were conducted (after 15 and 30 days of treatment). Clinical response to the treatment was registered with standard photographs of the palate, and mycologic samples were re-taken. Therefore, clinical and mycologic data could be compared at baseline, 15 and 30 days after treatment.

The data were analysed by Bioestat 5.0 software and statistical tests, including the Wilcoxon test (clinical trials) and Student's *t*-test (mycological evaluations), both with a significance level of 5% ($P = 0{\cdot}05$).

Results

Of the 30 patients who composed the sample, 24 (80%) were women, and 6 (20%) were men; 24 (80%) were white, with an average age of 81·4 ± 9·9 years. All of them were complete denture wearers: 14 (47%) wore bimaxillary complete dentures, 13 (43%) wore only the maxillary complete denture and 3 (10%) wore a mandibular removable partial prosthesis.

At the initial clinical evaluation, it was observed that type II DS occurred more frequently; however, no significant difference was found regardless of the degree of oral candidiasis (Newton's classification) among the groups (Table 1).

No statistically significant differences were observed for the degree of DS in any period for NYS (1st versus 15th day – $P = 0{\cdot}06$; 1st versus 30th day – $P = 0{\cdot}06$; 15th versus 30th day – $P = 0{\cdot}22$). However, in groups MIC and RC, significant differences showing clinical improvement were observed between 1st and the 30th day (MIC – $P = 0{\cdot}018$; RC – $P = 0{\cdot}011$) and between the 15th and 30th day (MIC – $P = 0{\cdot}018$; RC – $P = 0{\cdot}011$).

Table 1. Chi-squared test. Contingence table, with absolute frequency, of the elderly according to the experimental groups and the degree of DS observed initially

	Newton's criteria			
Groups	Type I	Type II	Type III	Total
MIC	3	5	2	10
NYS	3	3	4	10
RC	2	6	2	10
Total	8	14	8	30

Chi-squared test: $\chi^2 = 2{\cdot}25$; $P = 0{\cdot}69$.

The averages of cfu mL^{-1} (expressed as $\log_{10}$) obtained for the experimental groups in each assessment period are shown in Table 2. The analysis of these data showed no statistically significant difference in intragroup comparisons (Table 3).

Discussion

In this study, the antifungal activity of *Ricinus communis* against *Candida* spp. was qualitatively (clinical assessment) and quantitatively (cfu mL^{-1}) evaluated. *C. albicans* is currently the most abundant and important species of this genus and is known to be responsible for infections in humans, causing vulvovaginitis, oral thrush, nosocomial infections and candidiasis (20). Of the 150 institutionalised elderly patients, 20% showed clinical signs of DS with positive results in the mycological test. According to Aguirre *et al.* (6), the mycological test with swabs followed by culture

Table 2. Mean and standard deviation of cfu mL^{-1} ($\log_{10}$) according to the experimental groups and treatment periods

	Treatment periods		
Groups	1st day	15th day	30th day
MIC	4·36 ± 0·70	3·87 ± 0·71	3·96 ± 1·15
NYS	5·10 ± 0·98	4·39 ± 1·37	4·63 ± 1·52
RC	4·45 ± 0·74	4·29 ± 0·88	4·37 ± 0·94

[§]Daktarin; Janssen Pharmaceutica, Belgium.

[¶]Micostatin oral suspension; Bristol-Myers Squibb, Épernon, France.

**Castor Oil Polymer; Perioquil, Poliquil Araraquara Polímeros Químicos Ltda., Araraquara, SP, Brazil.

Table 3. Microbiologic analyses; *P* values of student's *t*-test for cfu mL^{-1} intragroup comparisons

	P values		
Comparisons	MIC	NYS	RC
1st vs. 15th day	0·09	0·08	0·44
1st vs. 30th day	0·46	0·23	0·83
15th vs. 30th day	0·79	0·44	0·74

of *Candida* is a good way to sample the denture-affected mucosa and to demonstrate the presence of *Candida*. These authors stated that the presence of *Candida* plays an important role in the development of DS only in some patients, and its role may be more related to the maintenance of the process than to its initiation. Regardless of the mycological analyses, there is a wide variation in the prevalence of DS. In a systematic review performed by Emami *et al.* (10), the prevalence of DS varies from 6·5% to 75·0%, according to the populations and characteristics of the studies.

The results of this study showed a greater frequency (46·67%) of DS type II (Newton's criteria), in agreement with the literature, which reports that DS type II is the most commonly found type of DS (6, 10). The null hypothesis was rejected based on the data from clinical evaluation when significant improvement in clinical features of DS after 30 was observed with MIC (Daktarin) and RC (Perioquil) treatment. Three and five patients treated with MIC and RC, respectively, showed clinical resolution of DS at this time. On the other hand, the use of NYS (Nystatin) did not reduce DS.

Many studies found clinical improvements with the use of NYS and MIC, drugs that have been used for a long time in DS treatment (19, 22). However, the absence of clinical resolution of DS with NYS treatment could mainly be attributed to two factors: (i) *C. albicans* resistance because NYS suspension is the first line therapy for management of candidiasis (33) and (ii) the elderly adherence to the treatment. RC and NYS have liquid forms, but with different application techniques; RC was used as a mouthwash, whereas NYS was applied over the tongue with an eyedropper, in less quantity. MIC was used in the form of a gel applied directly on the lesion, remaining in contact with all oral mucosa. According to Bakhshi *et al.* (18), NYS produces more side effects, such as a bitter taste, and less satisfaction for patients. Moreover, it was observed that RC promoted a greater adherence to the treatment among the patients because it seemed to encourage their independence.

In contrast to the clinical data, none of the treatments showed a significant reduction in number of cfu mL^{-1}. Abaci *et al.* (9) have shown that in the vast majority of cases, DS lesions are associated with positive cultures of *Candida* spp.; however, the diagnosis of DS does not depend on the performance of mycological tests because *C. albicans* is a microorganism found in the oral flora of healthy individuals with or without teeth (9). According to Farah *et al.* (4), normal *Candida* spp. carriage in 50% of the population is less than 1000 cfu mL^{-1}, whereas in infected individuals, counts range from 4000 to 20 000 cfu mL^{-1}, and from a mycological point of view, successful treatment would be expected to result in a decrease in fungal colonies from 10 000/20 000 cfu mL^{-1} to a few hundred. Banting & Hill (2001) (34) argue that noninvasive *Candida* forms may grow in the culture medium, so even a positive culture, with a high number of microorganisms, may not necessarily indicate the presence of the pathogenic form. These findings may be a possible explanation for the remission of DS signs without simultaneous decrease in the values of cfu mL^{-1} observed in this study.

The search for an alternative treatment for DS has focused on attractive properties of herbs that lack the toxic effects of traditional medicines (24, 26). While the toxicity of *Ricinus communis* seeds had been recognised for years (35), the process used for obtaining castor oil used in Perioquil removes toxic (ricin) and allergenic proteins. Then RC is a viable herbal alternative with advantages, such as low-cost and antimicrobial activity against gram-positive bacteria and yeasts (30), in addition to its powerful detergent action with no unpleasant odour or colour (27).

Although there is no scientific study regarding the use of RC for DS treatment, some possible explanations for it action against bacteria and yeasts can be found in the literature. The main compound of Perioquil (RC) is the sodium ricinoleate. It is obtained from a saponification of the ricinoleic acid, which is extracted from *Ricinus Communis* seeds (36). According to Mordenti *et al.* (1982) (37) sodium ricinoleate may change biofilm formation by decreasing its acid production. Moreover, other possible mechanism against

fungi is related to the action over chitin, a long-chain polymer of N-acetylglucosamine, and the main component of the cell walls of *Candida albicans* (38).

It is known that biofilm formation and microbial adhesion to the complete denture had some differential mechanisms. The presence of bacteria on the surface of complete denture favours the adhesion of blastopores by co-aggregation (39). Considering that RC can act against fungi and bacteria, its use, probably, decreases the microflora virulence by synergistic interaction, which could explain improvements of DS signs without simultaneous decrease of cfu mL^{-1}.

This study had some limitations, mainly attributed to the studied population. It is know that DS treatment can include beyond therapeutic agents, a strict oral hygiene and good quality prosthesis. However, institutionally elderly often exhibit poorer oral hygiene caused by motor difficulties and limited attendance by the nursing home staff (17). Moreover, it is expected that better results could be obtained if the performance of institutional staff was improved by controlling the factors that contribute to the development and maintenance of DS. Although all patients were given the same initial instructions, is of little value to institute drug treatment if factors such as oral and prosthesis hygiene were not supervised.

Our results suggest the importance of the association between drugs treatments and the motivation/understanding for a correct adjustment of DS risk factors in institutionalised elderly. In the light of the mycological and clinical outcomes associated with the limitations inherent to this study, there is an evident need to develop preventative programs to diminish local risks of infections by *Candida* yeast. Further studies should be performed with institutionalised patients, and new formulations of RC should be tested to reduce yeast of the genus *Candida* quantitatively.

Conclusion

Within the limitations of this study, it was concluded that *Ricinus communis* is an effective treatment for reducing the clinical signs of DS. Its effectiveness was similar to that of the treatment with Miconazole, and it can be considered a viable alternative to conventional treatments in institutionalised elderly.

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References

1. Uludamar A, Ozyesil AG, Ozkan YK. Clinical and microbiological efficacy of three different treatment methods in the management of denture stomatitis. Gerodontology. 2011;28:104–110.
2. Samaranayake LP, McFarlane TW. Oral candidosis. Cambridge: Wright, 1990.
3. Pires-Goncalves RH, Miranda ET, Baeza LC, Matsumoto MT, Zaia JE, Mendes-Giannini MJ. Genetic relatedness of commensal strains of Candida albicans carried in the oral cavity of patients' dental prosthesis users in Brazil. Mycopathologia. 2007;164:255–263.
4. Farah CS, Ashman RB, Challacombe SJ. Oral candidosis. Clin Dermatol. 2000;18:553–562.
5. Dar-Odeh NS, Shehabi AA. Oral candidosis in patients with removable dentures. Mycoses. 2003;46:187–191.
6. Aguirre JM, Verdugo F, Zamacona JM, Quindos G, Ponton J. Cytological changes in oral mucosa in denture stomatitis. Gerodontology. 1996;13:63–67.
7. Webb BC, Thomas CJ, Willcox MD, Harty DW, Knox KW. Candida-associated denture stomatitis. Aetiology and management: a review. Part 1. Factors influencing distribution of Candida species in the oral cavity. Aust Dent J. 1998;43:45–50.
8. Dorocka-Bobkowska B, Zozulinska-Ziolkiewicz D, Wieruszewska B, Hedzelek W, Szumala-Kakol A, Budtz-Jorgensen E. Candida-associated denture stomatitis in type 2 diabetes mellitus. Diabetes Res Clin Pract. 2010;90:81–86.
9. Abaci O, Haliki-Uztan A, Ozturk B, Toksavul S, Ulusoy M, Boyacioglu H. Determining Candida spp. incidence in denture wearers. Mycopathologia. 2010;169:365–372.
10. Emami E, Taraf H, de Grandmont P, Gauthier G, de Koninck L, Lamarche C *et al.* The association of denture stomatitis and partial removable dental prostheses: a systematic review. Int J Prosthodont. 2012;25:113–119.
11. Budtz-Jorgensen E. Etiology, pathogenesis, therapy, and prophylaxis of oral yeast infections. Acta Odontol Scand. 1990;48:61–69.
12. Narhi TO, Ainamo A, Meurman JH. Salivary yeasts, saliva, and oral mucosa in the elderly. J Dent Res. 1993;72:1009–1014.
13. Barbeau J, Seguin J, Goulet JP, de Koninck L, Avon SL, Lalonde B *et al.* Reassessing the presence of Candida albicans in denture-related stomatitis. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2003;95:51–59.
14. de Resende MA, de Sousa LV, de Oliveira RC, Koga-Ito CY, Lyon JP. Prevalence and antifungal susceptibility of yeasts

obtained from the oral cavity of elderly individuals. Mycopathologia. 2006;162:39–44.
15. Oksala E. Factors predisposing to oral yeast infections. Acta Odontol Scand. 1990;48:71–74.
16. Epstein JB, Polsky B. Oropharyngeal candidiasis: a review of its clinical spectrum and current therapies. Clin Ther. 1998;20:40–57.
17. Coleman P, Watson NM. Oral care provided by certified nursing assistants in nursing homes. J Am Geriatr Soc. 2006;54:138–143.
18. Bakhshi M, Taheri JB, Basir Shabestari S, Tanik A, Pahlevan R. Comparison of therapeutic effect of aqueous extract of garlic and nystatin mouthwash in denture stomatitis. Gerodontology. 2012;29:e680–e684.
19. Budtz-Jorgensen E, Mojon P, Rentsch A, Deslauriers N. Effects of an oral health program on the occurrence of oral candidosis in a long-term care facility. Community Dent Oral Epidemiol. 2000;28:141–149.
20. Sangetha S, Zuraini Z, Sasidharan S, Suryani S. Fungicidal effect and oral acute toxicity of Cassia spectabilis leaf extract. Nihon Ishinkin Gakkai Zasshi. 2008;49:299–304.
21. Kovac M, Mitic G, Kovac Z. Miconazole and nystatin used as topical antifungal drugs interact equally strongly with warfarin. J Clin Pharm Ther. 2012;37:45–48.
22. Neppelenbroek KH, Pavarina AC, Palomari Spolidorio DM, Sgavioli Massucato EM, Spolidorio LC, Vergani CE. Effectiveness of microwave disinfection of complete dentures on the treatment of Candida-related denture stomatitis. J Oral Rehabil. 2008;35:836–846.
23. Gonzales PF, Tim M. Photodynamic inactivation for controlling *Candida albicans* infections. Fungal Biol. 2012;116:1–10.
24. Catalan A, Pacheco JG, Martinez A, Mondaca MA. In vitro and in vivo activity of Melaleuca alternifolia mixed with tissue conditioner on Candida albicans. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2008;105:327–332.
25. Liu X, Han Y, Peng K, Liu Y, Li J, Liu H. Effect of traditional Chinese medicinal herbs on Candida spp. from patients with HIV/AIDS. Adv Dent Res. 2011;23:56–60.
26. Santos VR, Pimenta FJ, Aguiar MC, do Carmo MA, Naves MD, Mesquita RA. Oral candidiasis treatment with Brazilian ethanol propolis extract. Phytother Res. 2005;19:652–654.
27. Pisani MX, da Silva CH, Paranhos HF, Souza RF, Macedo AP. Evaluation of experimental cleanser solution of Ricinus communis: effect on soft denture liner properties. Gerodontology. 2012;29:e179–185.
28. Panghal M, Kaushal V, Yadav JP. In vitro antimicrobial activity of ten medicinal plants against clinical isolates of oral cancer cases. Ann Clin Microbiol Antimicrob. 2011;10:21.
29. Ito IY, Froner IC, Mian H, Chierici GO. Castor oil: antimicrobial activity of detergent derived from ricinoleic acid. J Dent Res. 1999;78:344.
30. Ferreira CM, Bonifacio KC, Froner IC, Ito IY. Evaluation of the antimicrobial activity of three irrigating solutions in teeth with pulpal necrosis. Braz Dent J. 1999;10:15–21.
31. Newton AV. Denture sore mouth, a possible aetiology. Br Dent J. 1962;112:357–360.
32. Samaranayake LP, Cheung LK, Samaranayake YH. Candidiasis and other fungal diseases of the mouth. Dermatol Ther. 2002;15:19.
33. Lalla RV, Latortue MC, Hong CH, Ariyawardana A, D'Amato-Palumb S, Fischer DJ *et al.* A systematic review of oral fungal infections in patients receiving cancer therapy. Support Care Cancer. 2010;18:985–992.
34. Banting DW, Hill SA. Microwave disinfection of dentures for the treatment of oral candidiasis. Spec Care Dentist. 2001;21:4–8.
35. Fernandes KV, Deus-de-Oliveira N, Godoy MG, Guimaraes ZA, Nascimento VV, Melo EJ *et al.* Simultaneous allergen inactivation and detoxification of castor bean cake by treatment with calcium compounds. Braz J Med Biol Res. 2012;45:1002–1010.
36. Burdock GA, Carabin IG, Griffiths JC. Toxicology and pharmacology of sodium ricinoleate. Food Chem Toxicol. 2006;44:1689–1698.
37. Mordenti JJ, Lindstrom RE, Tanzer JM. Activity of sodium ricinoleate against in vitro plaque. J Pharm Sci. 1982;71:1419–1421.
38. Selitrennikoff CP. Antifungal proteins. Appl Environ Microbiol. 2001;67:2883–2894.
39. Sato M, Tsuchiya H, Akagiri M, Takagi N, Iinuma M. Growth inhibition of oral bacteria related to denture stomatitis by anti-candidal chalcones. Aust Dent J. 1997;42:343–346.

Correspondence: Lígia Antunes Pereira Pinelli, Department of Dental Materials and Prosthodontics, Araraquara Dental School - Univ Estadual Paulista-UNESP, Rua Humaitá, no. 1680, Araraquara – SP, CEP: 14801-903, Brazil. E-mail: ligia@foar.unesp.br