The role of *Matricaria recutita* in health and dental practice: a narrative literature review

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ABSTRACT

ABSTRACT: Popularly known as chamomile, *Matricaria recutita* belongs to a wide group of medicinal plants that has been used since ancient times. Its popularity is due to its composition containing several bioactive phytochemicals that are capable of providing therapeutic effects that improve cardiovascular conditions, stimulate the immune system, and have antiseptic, sedative and anti-inflammatory actions. The aim of this study is to describe possible uses of *M. recutita* in health field, particularly in Dentistry, whether for the prevention or control of diseases, highlighting its benefits and forms of presentation that have already been investigated in the scientific literature. In Dentistry, there are reports and indications of use has been used as a therapeutic agent to prevent the formation of dental biofilm, for treatment of patients with mucositis, gingivitis, oral infections, bone resorption and oral thrush, and also to help relief symptoms in patients with xerostomia and burning mouth syndrome.
Keywords: chamomile, *Matricaria*, phytotherapy, dentistry

INTRODUCTION

The diversity of medicinal herbs and their functions in the prevention and treatment of different types of diseases, together with their natural characteristics associated with minimal toxic side effects, stimulates the worldwide consumption of plants for therapeutic purposes. Consequently, it increases the interest of health professionals in focusing on studying these agents and exploring their pharmacological properties (Miraj and Alesaeidi 2016).

Popularly known as chamomile, *Matricaria recutita* L. belongs to a large group of medicinal plants that has been used since ancient times by Egyptians and Greeks, being native to Europe and distributed worldwide (Isaac and Schimpke 1965; Singh et al. 2011).

Its popularity is due to its composition, which consists of several bioactive phytochemicals. Chamomile is known to help improve cardiovascular conditions and stimulate the immune system (Miraj and Alesaeidi 2016). Several authors also describe its antiseptic (McKay and Blumberg 2006; Ríos et al. 2008; Srivastava et al. 2010; Miraj and Alesaeidi 2016), antioxidant (McKay and Blumberg, 2006; Sebai et al. 2015), diuretic (Ríos et al. 2008; Miraj and Alesaeidi 2016), expectorant, sedative (Ríos et al. 2008), and anti-inflammatory actions (McKay and Blumberg 2006; Ríos et al. 2008; Srivastava et al. 2010; Miraj and Alesaeidi 2016) and anti-allergenic, neuro-protective, antimicrobial, antimutagenic and hypocholesterolemic (McKay and Blumberg 2006; Matic et al. 2013) action.

The active ingredient of chamomile can be applied in home medicine through the direct use of the plant in the form of preparations such as teas, tinctures, and powders, or in the form of isolated pure compounds. Medicinal herbs, when well-chosen and used correctly, have the same effectiveness as industrial medicine (Lorenzi and Matos 2002).

The benefits of chamomile in the different areas of dentistry have also been investigated and described. Chamomile has an action in the control of microorganisms present in dental biofilm (Pequeno et al. 2018) and in the management of conditions such as xerostomia (Schirmer et al. 2012), mucositis (Schirmer et al. 2012; Tavakoli Ardakani et al. 2016; Gomes et al. 2018), gingivitis (Gaete and Oliva 2010;

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Lins et al. 2013; Goes et al. 2016), oral infections (Albuquerque et al. 2010; Rahman and Chandra 2015), recurrent aphthous ulceration (Seyyedi et al. 2014), and even bone resorption (Guimarães et al. 2016).

Establishing when the therapeutic effects of this herbal agent will be beneficial or not for patients requires research and greater generation of scientific evidence. Thus, this work aims to describe the possible uses of *M. recutita* in the field of health, with emphasis on dental practice, emphasizing the benefits and possible means of formulation that have already been investigated and described in the literature.

The use of plants in human health has been documented for thousands of years. The enduring popularity of herbal medicines can be explained by the tendency of herbs to work slowly, usually with minimal toxic side effects (Astin et al. 2000). However, the misconception that plants, as they are natural, are therefore free from risks and adverse effects, must be reevaluated. Obeying the prescribed dosages and taking care to accurately identify the substance used can prevent a series of complications (Lorenzi and Matos 2002). According to Martins et al. (2003), among the recommendations for treatments with medicinal plants in general, is the maximum period of use between 21 and 30 days, interspersed with a rest period between 4 and 7 days

One of the herbs most often used for medicinal purposes is chamomile, whose tea and herbal extract are prepared from dried flowers of the *Matricaria* species. Chamomile is one of the oldest medicinal plants, widely used and well documented in the world, due to its antioxidant (McKay and Blumberg 2006; Sebai et al. 2015) and anti-inflammatory (McKay and Blumberg 2006; Ríos et al. 2008; Matic et al. 2013) properties, exhibiting many beneficial health effects, also due to its anti-allergenic, neuro-protective, antimicrobial, antimutagenic and hypocholesterolemic (McKay and Blumberg 2006; Matic et al. 2013) action.

M. recutita is a plant species belonging to the list of Traditional Phytotherapic Products with Simplified Registration, published by Normative Instruction 02/2014 (ANVISA, 2018). It is one of the most important medicinal herbs native to southern and eastern Europe. It is also grown in Germany, Hungary, France, Russia, Yugoslavia and Brazil. This plant can also be found in North Africa, Asia, North and South America, Australia and New Zealand (Ríos et al. 2008; Singh et al. 2011).

Popularly known by several names, such as common chamomile, fragrant chamomile, German chamomile, Hungarian chamomile, Roman chamomile, English chamomile, false sweet chamomile, pinhead, blue chamomile, feverfew, scented chamomile and wild chamomile (Ríos et al. 2008), there are a number of inaccuracies in relation to its name. The synonymous use of the names *Anthemis, Chamomilla* and *Matricaria* leads to uncertainty regarding the botanical identification of this plant. According to the literature, the best botanical name for real chamomile is *M. recutita*, whose synonym is *M. chamomilla*, *Chamomilla recutita* (L.) Rauschert, belonging to the genus *Chamomilla* and the family *Asteraceae* (Franz et al. 2005; Ríos et al. 2008). The nomenclature was proposed by *Linneaus* in the edition of his *'Espécie Plantarum'* (Franz et al. 2005), which justifies the abbreviation of 'L.' used by some authors.

True chamomile is an annual herbaceous plant with thin, spindle-shaped roots that only penetrate the soil. The cylindrical stem is erect, strongly branched and grows at a height ranging from 10 to 90 cm. The 11 to 27 small flowers with hollow yellow tapered centers, surrounded by white petals, are between 6 and 11 mm long, about 3.5 mm wide and are arranged concentrically (Ríos et al. 2008; Singh et al. 2011; Satyal et al. 2015).

Biochemical characteristics of Chamomile

More than 120 constituents have been identified in chamomile flowers. Its phytochemical analysis revealed that this plant is rich in cytoprotective active molecules, such as phenolic compounds, which are considered natural antioxidant agents (McKay and Blumberg 2006; Sebai et al. 2015).

There have been numerous studies on the chemical constituents of *M. recutita* essential oils from different geographical locations. The concentrations of the components may vary due to the differences in geographical attributes, soil pH, harvest time, and other factors (Satyal et al. 2015).

Of the different bioactive constituents present in chamomile, the presence of sesquiterpenes, flavonoids, coumarins and polyacetylenes has already been identified (Singh et al. 2011; Miraj and Alesaeidi 2016; Torres 2018). Several flavonoids and other phenolic compounds have been identified in various parts of the chamomile flower head (McKay and Blumberg 2006). The main components extracted from chamomile flowers that are described in the consulted literature are listed in Table 1.

Essential oils extracted from *M. recutita* flowers are mainly composed with terpenes or their derivatives. These substances constitute an extensive group of organic molecules produced as secondary metabolites to prevent injuries caused by external agents (Correia et al. 2008), with recognized antimicrobial activity (de Martino et al. 2014).

Bisabolol has been shown to promote the formation of granulation tissue in wound healing

(Bedi and Shenefelt 2002). It has been found to reduce the amount of the proteolytic enzyme pepsin secreted by the stomach, without any changes in the amount of acid in the stomach, due to which it was recommended for the treatment of gastric and upper intestine diseases. It has also been reported to promote epithelialization and granulation, and to have a pronounced and antiphlogistic effect on edema (Isaac 1979).

The properties of chamomile are partly also due to its phenolic compounds (Singh et al. 2011). Phenolic compounds are bioactive substances found in large quantities in food plants that are regularly consumed by humans. They are compounds that have a benzene ring, which may contain one or more hydroxyl groups (OH^-), including their functional derivatives (esters, methyl ethers, glycosides) (Vermerris and Nicholson 2007). According to Gupta et al. (2010), eleven bioactive phenolic compounds were found in chamomile extract: herniarin and umbelliferone (coumarins), chlorogenic acid and caffeic acid (phenylpropanoids), apigenin, apigenin-7-*O*-glucoside, luteolin and luteolin-7-*O*-glucoside (flavones), quercetin and rutin (flavonols), and naringenin (flavanone).

Chamomile's anti-inflammatory capacity is mainly attributed to apigenin and its acetylated derivatives. In addition to their anti-inflammatory action, flavonoids are also known to play an important role in chemopreventive activity against ultraviolet, anti-tumor and sedative radiation (Mann and Staba 2002; Santos and Rodrigues 2017). It is also known that flavonoids act by inhibiting the release of histamine (Bedi and Shenefelt 2002).

Chamazulene (7-ethyl-1,4-dimethylazulene) is an artefactual component formed under high temperatures and/or acidic matric conditions (procamazulene), which is present in the head of fresh flowers (McKay and Blumberg 2006). This compound characterizes the dark-blue color of chamomile oil and is related to its bactericidal, fungicidal, anti-inflammatory and antioxidant properties (Satyal et al. 2015; Torres 2018).

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Table 1. Main bioactive constituents of chamomile.

Components:	Action:	Derivatives:
Sesquiterpenes (Terpenoids) (Lemberkovics et al. 1998; Srivastava et al. 2010; Singh et al. 2011; Torres 2018)	Antimicrobial (De Martino et al. 2014), antioxidant, insecticide or repellent (Lima and Cardoso 2007)	Farnesol (Singh et al. 2011) α-bisabolol (Srivastava, Shankar et al. 2010; Singh et al. 2011; Torres 2018) α-bisabolol A oxides (Singh et al. 2011; Torres 2018) α-bisabolol B oxides (Singh et al. 2011; Torres 2018)
Flavonoids (Lemberkovics et al. 1998; Bedi and Shenefelt 2002; Singh et al. 2011; Torres 2018)	Antiviral, antitumor, anti-inflammatory, antioxidant, hormonal regulation (Santos and Rodrigues 2017) and chemopreventive (Mann and Staba 2002)	Apigenin (Singh et al. 2011; Torres 2018) Apigenin-7-*O*-glycoside (Singh et al. 2011; Torres 2018) Luteolin (Singh et al. 2011; Torres 2018) Luteolin-7-*O*-glycoside (Singh et al. 2011; Torres 2018) Quercetin (Singh et al. 2011; Torres 2018) Rutin (Singh et al. 2011) Naringenin (Singh et al. 2011; Torres 2018) Patuletin (McKay and Blumberg 2006)
Coumarins (Lemberkovics et al. 1998; Singh et al. 2011; Torres 2018)	Anti-inflammatory, expectorant, cytotoxic, antifungal, insecticide and coronary vasodilator (Czelusniak, 2012)	Herniarin (Singh et al. 2011) Umbelliferone (Singh et al. 2011)
Phenylpropanoids (Singh et al. 2011; Torres 2018)	Antioxidant, insecticide or repellent (Lima and Cardoso 2007)	Chlorogenic acid (Singh et al. 2011) Caffeic acid (Singh et al. 2011)
Matricin (Singh et al. 2011)	Antimicrobial, anti-inflammatory and antioxidant (Satyal et al. 2015; Torres 2018)	Chamazulene (Srivastava et al. 2010; Singh et al. 2011)

action, is umbelliferone (Isaac 1979) and herniarin and umbelliferone in a ratio of 1:5, derive from coumarins and represent approximately 0.1% of the total biochemical constituents of this medicinal plant (McKay and Blumberg 2006).

Formulations for use

The use of medicinal plants has evolved from the simplest forms of local treatment, to the technologically sophisticated forms of industrial manufacturing. Chamomile is widely marketed as herbal tea, as well as in ointments, soaps, tinctures, and inhalations (Satyal et al. 2015), and its use is based on several clinical trials results (Braga et al. 2015; Mao et al. 2016; Sanaati et al. 2016; Sharifi et al. 2017)

There are several ways of preparing chamomile. McKay and Blumberg list in their review a large number of studies that investigate the action of this medicinal plant in *in vitro* and animal model studies.

The dry powder of the chamomile flower is recommended and used for several types of health problems, ranging from infections and injuries to the lining tissues, to gastrointestinal disorders, to sleep problems. Medicinal ingredients are traditionally extracted from dried flowers, using water, ethanol or methanol as solvents, and the corresponding extracts are known respectively as aqueous or alcoholic extracts, such as ethanolic and/or methanolic (Srivastava et al. 2010).

Aqueous extracts, as in the form of teas obtained through infusions, contain very low concentrations of free apigenin, but include high levels of apigenin-7-*O*-glycoside (Mazokopakis et al. 2005). Teas made from chamomile contain between 10-15% of the essential oil available in flowers (Cárcamo et al. 2011). Chamomile infusion (tea) is the most common therapeutic presentation and is used as an agent for washing or gargling in order to treat inflammation of the mucous membranes of the mouth and throat (Mazokopakis et al. 2005; Lucena et al. 2009). Chamomile tea sachets, containing pure chamomile flower powder or mixed with other popular medicinal herbs, are easily found and commercialized (Srivastava et al. 2010).

The mixture of a part of chamomile flower in four parts of water with 12% of grain alcohol is used for the preparation of chamomile tincture (Srivastava et al. 2010), since the use of the whole plant serves to formulate beers and medicinal herbal lotion for topical application (Hamon 1989).

Chamomile oil is a popular ingredient in aromatherapy and hair care. The essential oil extracted from the flower varies in concentration between 0.42 to 2% and consists of compounds such as bisabolol, camazulene, cyclic sesquiterpenes, bisabolol oxides, and other azulenes and terpenes (Satyal et al. 2015).

General therapeutic uses

M. recutita is a plant that has been used as a medicinal herb for centuries due to its relaxing, sedative, antispasmolytic, antioxidant, anti-inflammatory, curative and digestive properties, among other properties already described (Ríos et al. 2008; Srivastava et al. 2010).

In a systematic review of the literature, Miraj and Alesaeidi (2016) describe the traditional therapeutic uses of *M. recutita*, which include its antibacterial, antioxidant, anti-inflammatory, antidepressant, anticarcinogenic and angiogenic activity. In addition, the authors cite its hepatoprotective, antimicrobial, antidiabetic and antidiarrheal effects, and the applicability of this herbal medicine in premenstrual syndrome, gastrointestinal disorders and knee osteoarthritis.

The literature shows it has been prescribed for dyspepsia, stomach disorders in general, diarrhea (Vieira et al. 2009; Srivastava et al. 2010; Miraj and Alesaeidi 2016), nausea, inflammation of the respiratory and urinary tracts, hemorrhoids (Vieira et al. 2009; Srivastava et al. 2010), menstrual disorders (Vieira et al. 2009; Srivastava et al. 2010; Miraj and Alesaeidi 2016), anxiety, neuralgia, sleep disorders, toothache, rheumatic pain, burns, thrush (Srivastava et al. 2010), difficult to heal wounds (Vieira et al. 2009), skin and mucosal conditions in general, including herpes zoster and boils, inflammation of the mouth, throat, eyes and ears (Vieira et al. 2009; Srivastava et al. 2010), and even as an acaricidal and anti-tick agent (Pirali-Kheirabadi and Razzaghi-Abyaneh 2007).

Applications in Dentistry

In dentistry, studies describe the use of *M. recutita* for infection control, mainly due to its antimicrobial action, and as a therapeutic agent for several types of oral disorders, as described below.

Antimicrobial action

Albuquerque et al. (2010), in an *in vitro* experimental study, evaluated the antimicrobial activity of *M. recutita* extract on the microorganisms present in dental biofilm. The authors compared the averages of the inhibitory halos formed in the cultivation of strains of *Streptococcus mitis*, *Streptococcus mutans*, *Streptococcus sanguinis*, *Streptococcus sobrinus*, and *Lactobacillus casei* after the action of 0.12% hydroalcoholic extract and chlorhexidine. According to the authors, although *M. recutita* at a concentration of 0.84 g/ml has antimicrobial activity, it was lower than that of 0.12% chlorhexidine, which was more effective in the antibacterial control of the strains investigated.

In 2011, Cárcamo et al. investigated the antibacterial action of *M. recutita* mouthwash on the formation of dental biofilm in 32 female patients at the Dentistry college of the Universidad del Desarrollo, in Chile. The authors compared the action of chamomile and chlorhexidine mouthwashes at 0.12% concentration on oral prophylaxis after different periods of time, using a bacteriological sample collected from the mucosa and the dental surface. In their findings, they noted the superior effectiveness of chlorhexidine over chamomile in controlling colony-forming units (CFU). The mouthwash with chamomile reached as maximum control the formation of 1976 CFU two hours after rinsing the mouthwash. The mouthwash with chlorhexidine reached a control of up to 296 CFU eight hours after rinsing the mouthwash. According to the authors, the best time interval between mouthwashes with *M. recutita* is 4 to 6 h, a period in which there is greater control of bacterial growth.

An *in vitro* study conducted by Rahman and Chandra (2015) evaluated the antimicrobial activity of different concentrations of chamomile. Agar diffusion test was used to evaluate the antimicrobial activity of 15%, 25% *M. recutita* in aqueous base and 2% chlorhexidine gel against *C. albicans* (ATCC 24433) and *E. faecalis* (ATCC 24212) strains. Vancomycin was used as the positive control for *E. faecalis* and fluconazole for *C. albicans*. According to the authors, 2% chlorhexidine had a greater inhibitory effect for *C. albicans* (33.20 mm) and *E. faecalis* (24.54 mm), while 25% chamomile showed inhibition halos of 24.16 mm, and 20% of 62 mm for *C. albicans* and *E. faecalis*, respectively. Chamomile at 15% did not show antimicrobial activity. The authors conclude that 25% chamomile proved to be an antimicrobial agent for the strains investigated, despite being less effective than 2% chlorhexidine.

Another *in vitro* study (Pequeno et al. 2018) evaluated the inhibitory activity of the hydroalcoholic extract of *M. recutita* at 100, 200 and 300 mg/ml, on strains of *C. albicans* and *Enterobacter cloacae* compared to 0.12% chlorhexidine digluconate and distilled water. According to the authors, for the *E. cloacae* biofilm, the *M. recutita* extract at 300 mg/ml significantly reduced ($p < 0.01$) the number of CFU/ml, when compared to the control, with similar results to chlorhexidine 0.12%, while the extracts at 100 and 200 mg/ml did not have the same effectiveness. Regarding the *E. cloacae* cell viability test, the analysis of optical densities showed that *M. recutita* extract in all the tested concentrations (100, 200 and 300 mg/ml), as well as chlorhexidine 12%, significantly reduced the biofilm viable DNA ($p < 0.05$) when compared to the control. However, there was no significant difference ($p = 0.565$) in the number of CFU/ml or in the amount of viable DNA ($p = 0.8094$) of *C. albicans* when compared to biofilm without treatment or even between concentrations of the extract when compared among themselves or with 0.12% chlorhexidine.

Anti-inflammatory and healing activity on soft tissues

Gingivitis: In 2009, Lucena et al. evaluated the anti-inflammatory effect of hydroalcoholic extracts of *M. recutita* and chlorhexidine in patients with chronic gingivitis. In their study, the authors allocated 36 patients to three experimental groups, one using a mouthwash of 10ml of the prepared chamomile alcohol was diluted in ½ glass of water for each application, another with a mouthwash of 10 ml of 0.12% chlorhexidine, and one group using only brushing associated with flossing. The frequency of both substance use was three times a day for one minute, during the entire period of the experiment, being evaluated on the 3rd and 7th days. The authors concluded that the rates of plaque and bleeding decreased significantly from the first to the second assessment in all groups. Chamomile showed efficacy comparable to chlorhexidine in the treatment of chronic gingivitis; however, it should be noted that the clinical presentation of chronic gingivitis can be reduced with oral hygiene guidance, dispensing with the use of chemical control.

A randomized clinical trial (Gaete and Oliva 2010) was conducted to determine the effectiveness of hydroalcoholic extracts of chamomile mouthwash (0.8% alcohol, 10% glycerin and 0.8% extract of *M. recutita*) compared to 0.12% chlorhexidine and a placebo solution (distilled water, 0.02 mg ascorbic acid and mint green tincture) in the treatment of gingivitis in 30 patients from 19 to 25 years of age. The Gingival, Plaque and Bleeding Index were evaluated before the mouthwash, 7 and 15 days after the use of the substances. In their results, the authors observed that both the use of chamomile mouthwash and 0.12% chlorhexidine after 15 days achieved a significant reduction in the rates evaluated compared to the placebo solution, with the difference that patients who used chamomile showed no adverse effects, which are known for long-term use of chlorhexidine, such as dental staining and dysgeusia.

Lins et al. (2013) proposed to clinically evaluate the effect of mouthwash based on chlorhexidine and hydroalcoholic extracts from the aroeira medicinal plants (*Schinus terebinthifolia* Raddi) and chamomile (*M. recutita*) on bacterial plaque and gingivitis through a randomized clinical trial. The study included 59 patients diagnosed with chronic gingivitis seen at the Integrated Clinics of the Department of Dentistry of the State

University of Paraíba. The Plaque Index (PI) and the Gingival Bleeding Index (GBI) were used on three occasions, these being on the first day of research, prior to the beginning of the use of the respective mouthwash; on the 7th day after starting treatment with the mouthwash; and on the 15th day after starting treatment with the mouthwash. The patients were instructed to mouthwash twice daily with the solution corresponding to their group, diluted in ½ cup (250 ml) of water, 30 min after brushing their teeth in the morning and at night, for one minute.

The results of the PI and GBI showed that mouthwash based on mastic extract and chamomile proved to be effective in controlling plaque (p <0.001), as well as in the treatment of chronic gingivitis (p <0.001), with results similar to that of 0.12% chlorhexidine (p <0.001). However, to estimate which of these was more effective, the difference between the final and the initial moments of each group was calculated, culminating in the gross rate of reduction of the indices, with the chamomile mouthwash showing the greatest reduction in PI (1.03), and aroeira, the smallest reduction (0.70) (Lins et al. 2013).

In a pilot study with 30 patients carried out at the Federal University of Ceará, Goes et al. (2016) proposed to evaluate the effects of a mouthwash containing aqueous extract of 1% *M. recutita* for patients with gingivitis associated with fixed orthodontic appliances. The patients received an oral hygiene kit containing a toothbrush, dental floss and fluoride toothpaste together with a mouthwash bottle that contained either 0.12% chlorhexidine, 1% *M. recutita* extract, or a placebo solution. They were instructed to use 15 ml of the mouthwash solution, 30 min after brushing, for one minute in the morning and at night, for 15 days.

In their findings, the authors observed that patients who received mouthwash with chlorhexidine or *M. recutita* exhibited a reduction in dental biofilm (p = 0.0001) and gingival bleeding (p = 0.003), compared to the placebo group. Both the chlorhexidine and *M. recutita* groups did not differ in relation to the visible PI (p> 0.05) and the GBI compared to the placebo group. In addition to these clinical findings, five patients in the chlorhexidine group reported burning or altered taste after 14 days of using the mouthwash, while the *M. recutita* was well tolerated and was not associated with any adverse effects (Goes et al. 2016).

Recurrent mouth ulceration (RMU): Seyyedi et al. (2014) conducted a randomized clinical trial to investigate the therapeutic effects of chamomile dye mouthwash in RMU. The authors evaluated patients diagnosed with aphthous lesions between the years 2008 to 2010. Of the 50 research participants, 25 were allocated to the chamomile group and the other 25 to the placebo group, being instructed to apply 10 drops of the solution assigned to them to the oral cavity, three times a day. After application, patients rinsed their mouths using mouthwashes for three minutes. After rinsing their mouth, patients were instructed to abstain from eating any food for half an hour. The patients were examined clinically after 2, 4 and 6 days and, in cases of persistent lesions, they continued to be examined weekly. The duration of healing, the number of lesions observed in each visit, the size of the lesions, possible side effects of the medication, pain and burning were recorded using a visual analog scale (VAS). Patients were instructed not to use any other medication during the study period.

According to the authors (Seyyedi et al. 2014), the average number of lesions at the beginning of the study was 2.95 in the chamomile group and 2.67 in the control group, and after 6 days, during the fourth visit, the number was 1.3 in the control group and no lesions were observed in the chamomile group. Regarding pain and burning sensation on the fourth visit, using VAS, it was zero (no pain) in the chamomile group and 3.4 in the control group, with a statistically significant difference (p <0.001). The authors concluded that the group of patients who used chamomile had an accelerated healing process, since the remission of symptoms was already observed on the second visit. Thus, chamomile proved to be an effective agent for recurrent foot-and-mouth disease and can be used whenever appropriate.

Oral mucositis: An experimental study conducted in hamsters with the objective of investigating the effect of the topical use of chamomile in the treatment of oral mucositis induced by 5-fluoracil (5-FU), was carried out by Pavesi et al. (2011). For this, after inducing oral mucositis (OM) in the animals, the authors compared the absence of treatment (control group), the use of fluid extract of chamomile (Ad-Muc® group), and betamethasone elixir (Celestone® group). The treatment with the tested substances started on day 5, after induction of OM, with application twice a day. The death periods established for the animals were days 0, 2, 5, 8, 10, 12, 14, and 16. The animals that developed OM and were treated with the corticoid exhibited more severe pictures of mucositis, compared to the group treated with chamomile throughout the experiment. Analysis of the results showed that the chamomile group exhibited a lower degree of mucositis over the evaluation period compared to the control and corticoid groups. The authors concluded that chamomile proved to be effective in the treatment of OM in the model under study.

In Curitiba, Paraná (Brazil), 23 patients were included in a study (Schirmer et al. 2012) that evaluated the evolution of OM in cancer patients treated by the palliative care service, after intervention and medical and nutritional guidance. After inspecting the oral cavity and classifying the degree of OM that these patients had, they answered questionnaires about food, medications in use, oral complaints and lifestyle habits. The interviews were conducted at the first appointment and after 15 days. The nutritional intervention was carried out for all patients, indicating that they mouthwash with cold, industrialized chamomile tea, three times a day; avoid very acidic, dry, hard or spicy foods; restrict salt; avoid very hot food or preparations. Medical conduct was determined individually, considering the diagnosis of the disease and the symptoms presented by each patient. The authors found that on return, after 15 days of using the mouthwash with chamomile and nutritional guidelines, 73.9% of the patients did not have OM, and of these, 64.7% reported not having restrictions regarding the consistency of the diet. Grade I mucositis was found in 13% of patients, with normal food intake. Grade II mucositis was present in 8.6% of the patients, of which 50% reported eating liquid foods and 50% consuming foods of any consistency. Grade III mucositis was present in 4.3% of the cases studied, with 100% of these referring to ingestion of pasty foods. There was no detection of grade IV mucositis in the reassessment (Schirmer et al. 2012).

In 2016, Tavakoli Ardakani et al. investigated the effects of *M. recutita* associated with *Mentha* x *piperita* L. on OM in patients undergoing hematopoietic stem cell transplantation (HSCT) between the years 2011 and 2012. Sixty patients undergoing HSCT were randomly distributed in two groups: placebo (n=33), containing 0.02% w/v (percentage volume by volume) edible red color, 0.5% v/v (percentage by volume) color chlorophyllin, 13% v/v ethanol at 96 degrees, and 71.5% v/v of sterile distilled water; and a mouthwash group, based on medicinal herbs (n=27), containing 1% v/v peppermint oil, dry extract of 1% w/v *M. recutita*, and 99% v/v ethanol at 96º GL. All patients received the mouthwash one week before HSCT and were instructed to use it three times a day for at least 30 s and to avoid eating, drinking any fluids or mouthwash for up to 30 min after using the mouthwash.

In their results, the authors observed that the maximum duration and the established average daily degree of OM were significantly reduced in the treatment group ($p < 0.05$). The use of herbal mouthwash led to significant improvements in pain intensity ($p = 0.009$), dry mouth feeling ($p = 0.04$), and dysphagia ($p = 0.009$). Other significant results included a reduction in the use of complementary drugs ($p = 0.03$), narcotic analgesics ($p = 0.047$), total parenteral nutrition (TPN) ($p = 0.02$), and the duration of TPN (p = 0, 03). The authors concluded that patients who received the herbal mouthwash, including chamomile, had fewer complications and symptoms associated with OM (Tavakoli Ardakani et al. 2016).

In addition to the aforementioned studies, other authors (Gomes et al. 2018) published a systematic review on the effects of *M. recutita* in the treatment of OM. In their literature search, the authors found 21 papers that addressed this topic, 10 studies in animals and 11 in humans, with the beneficial effects of chamomile being significant in all the investigated species. In the included studies, the authors described mouthwash, topical and oral use formulated as infusion, orabase and gel as forms of administration of chamomile. Regarding the duration of the intervention, the articles that reported the time of use varied from 5 to 30 days of consecutive use. Thus, the authors concluded that the use of this herbal medicine is a promising alternative in the treatment of OM, although the protocol for using this type of therapy is still not well established in the literature.

Action on mineralized tissues

Taking into account the known anti-inflammatory capacity of *M. recutita* on the soft tissues of the oral cavity, an experimental study with 76 rats evaluated the effects of chamomile on inflammatory response and alveolar bone resorption. In their experiment, the authors used a *nylon* suture ligature (3-0) positioned on the cervical of the left upper second molar, in a subgingival position on the palatal side and supragingival on the buccal side. The animals were allocated into four groups that received Tween® 80, a non-ionic detergent, or *M. recutita* extract at 10, 30 and 90 mg/kg per gavage, 30 min before placing the bandage and daily until the 11th day, when the animals were killed. The *nylon* thread around the upper second molar induced significant alveolar bone resorption from the 3rd day of ligation, reaching a maximum between days seven and eleven (Guimarães et al. 2016).

According to the authors, the eleven days of ligature-induced bone resorption resulted in leukocyte infiltration and an increase in pro-inflammatory factors such as TNF-α and IL-1. However, the use of *M. recutita* extract significantly prevented ($p < 0.05$) the elevation of these interleukins, in addition to not causing changes in the organs or body weight of the animals. Thus, they concluded that *M. recutita* extract was able to prevent inflammation and alveolar bone resorption, reducing TNF-α and IL-1β, preventing osteoclast activation, without interfering with bone anabolism (Guimarães et al. 2016).

Xerostomia

A clinical trial conducted in 2016 by Morales-Bozo et al. included 74 elderly patients, with the goal of determining the effectiveness of a natural saliva substitute, based on *M. recutita* and linseed, to relieve xerostomia, compared to the substitute of conventional saliva. The substitute for natural saliva was made from an infusion of 30 g of flaxseed and 1 g of chamomile in one liter of water, the seeds being removed through filtration, while a commercial agent based on carboxymethyl cellulose was used as the substitute for conventional saliva (2 ml, four times a day each). At the beginning of the experiment, the baseline data for the xerostomia of the participants was determined through the Fox survey, which assesses the degree of intensity of the xerostomia symptoms using a visual analog scale to assess its severity. In their results, the authors observed that the saliva substitute based on medicinal herbs promoted greater relief of dry mouth symptoms, a sensation of thick saliva and difficulty in swallowing compared to the conventional substitute ($p < 0.05$)

Burning Mouth Syndrome

A report of two clinical cases of female patients, Caucasian, aged 68 and 59, with a burning mouth complaint, whose most affected areas were lips and tongue, both diagnosed with Burning Mouth Syndrome (BMS) was described in the literature. Both patients had high degrees of pain according to the VAS, with the first at degree 8 and the second at degree 9. The treatment proposed for both included ingesting a large volume of water and rinsing with unsweetened chamomile tea. It was advised that the tea be kept in the mouth for three minutes, four times a day, in association with cognitive therapy. During the reassessment, after 14 days, both reported a significant reduction in the burning sensation and improvement in general well-being. The new appointment on the VAS was 4 for the first patient described and 3 for the second. The established therapy was continued for one year, with visits every 15 days in the first two months, and monthly thereafter. According to the authors, taking into account the results achieved with the described cases, the use of chamomile mouthwash associated with cognitive therapy proved to be promising in the treatment of BMS (Milani et al. 2018).

FINAL CONSIDERATIONS

There is a growing demand in the world market for *M. recutita*, due to the increased consumption of natural elements and due to the extensive medicinal values and pharmacological properties of this plant. The benefits of using herbal medicines include facility to obtain, low cost and the possibility of them generating income for their producers. Studies show the effectiveness and advantages of using *M. recutita* in relation to allopathic drugs in the various pathological conditions that affect the oral cavity.

It is known that *M. recutita* has an antimicrobial, anti-inflammatory, healing action, among others. It is important that dental surgeons know the possible actions and benefits of this medicinal herb, as well as its possible formulations so that they can use it in their dental practice.

AUTHORS' CONTRIBUTIONS

All authors contributed to the conception and design of the, and also drafting the work and revising it critically for important intellectual content. Final approval of the version to be published was performed by all authors.

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DECLARATION OF CONFLICT OF INTERESTS

The authors have no conflicts of interest to declare.

REFERENCES

Albuquerque ACL, Pereira MSV, Pereira JV, Costa MRM, Pereira LF, Higino JS (2010) Antimicrobial effect of *Matricaria recutita Linn.* (Chamomile) extract against dental biofilm microorganisms. Pesq Bras Odontoped Clin Integr 10(3):451-455. http://dx.doi.org/10.4034/pboci.v10i3.1098

ANVISA (2018) Available at:<http://gg.gg/anvisa-camomila >Access in:dec.12t.

Astin JA, Pelletier KR, Marie A, Haskell WL (2000) Complementary and alternative medicine use among elderly persons: one year analysis of blue shield medicare supplement. J Gerontol 55:M4–M9. https://doi.org/10.1093/gerona/55.1.M4

Bedi MK, Shenefelt PD (2002) Herbal theraphy in dermatology. Arch Dermat 138(2):232-42. https://www.doi.org/10.1001/archderm.138.2.232

Braga FT, Santos AC, Bueno PC, Silveira RC, Santos CB, Bastos JK, Carvalho EC (2015) Use of *Chamomilla recutita* in the prevention and treatment of oral mucositis in patients undergoing hematopoietic stem cell transplantation: a randomized, controlled, phase II clinical trial. Can Nurs 38(4), 322-329. https://doi.org/10.1097/NCC.0000000000000194

Cárcamo OV, Oliva MP, González CP (2011) Efectividad antimicrobiana del colutorio de *Matricaria recutita*, em funcionarios de la Facultad de Odontolog.a de la Universidad del Desarrollo. Chile Int J Odontostomat

5(2):179-184. http://dx.doi.org/10.4067/S0718-381X2011000200011

Correia SJ, David JM, Da Silva EP, David JP, Lopes LMX, Guedes LMS (2008) Flavonóides, norisoprenoides e outros terpenos das folhas de *Tapirira guianensis*. Quím Nova 31(8):2056-2059.

Czelusniak KE, Brocco A, Pereira DF, Freitas GBL (2012) Farmacobotânica, fitoquímica e farmacologia do Guaco: revisão considerando *Mikania glomerata* Sprengel e *Mikania laevigata* Schulyz Bip. ex Baker. Rev Bras Plantas Med 14(2):400-409.

De Martino L, Nazzaro F, Mancini E, De Feo V. In: Preedy VR, Watson RR (2014) Essencial oils from mediterranean aromatic plants. The mediterranean diet: an evidence-based approach. Londres: Elsevier 58,649-661. https://doi.org/10.1016/B978-0-12-407849-9.00058-0

Franz CH, Bauer R, Carle R, Tedesco D, Tubaro A, Zitterl-Eglseer K (2005) Study on the assessments of plants/herbs, plant/ herb extracts and their naturally or synthetically produced components as additives for use in animal production. CFT/ EFSA/FEEDAP/2005/01 155-69p.

Gaete FMJ, Oliva MP (2010) Efectividad del colutorio de manzanilla comparado con placebo y clorhexidina en pacientes con gingivitis entre 19 y 25 años: ensayo clinico controlado. Int J Odontostomat 6(2):151-156. http://dx.doi.org/10.4067/S0718-381X2012000200006

Goes P, Dutra CS, Lisboa MRP, Gondim DV, Leitão R, Brito GAC, Rego RO (2016) Clinical efficacy of a 1% *Matricaria chamomile* L. mouthwash and 0.12% chlorhexidine for gingivitis control in patients undergoing orthodontic treatment with fixed appliances. J Oral Sci 58(4):569-574.https://doi.org/10.2334/josnusd.16-0280

Gomes VTS, Gomes RNS, Gomes MS, Joaquim WM, Lago EC, Nicolau RA (2018) Effects of *Matricaria recutita* (L.) in the treatment of oral mucositis. Scient Worl J 1-8. https://doi.org/10.1155/2018/4392184

Guimarães MV, Melo IM, Araújo VMA, Deizy Wong VT, Fonteles CSR, Leal LKA, Ribeiro RA, Lima V (2016) Dry extract of *Matricaria recutita* L. (Chamomile) prevents ligature-induce alveolar bone resorption in rats via inhibition of TNF-α and IL-1β. J Periodontol.87(6):1-17. https://doi.org/10.1902/jop.2016.150411

Gupta V, Mittal P, Bansal P, Khokra SL, Kaushik D (2010) Pharmacological potential of *Matricaria recutita*-A review. Int J Pharm Sci Drug Res 2:12-6.

Hamon N. Herbal medicine (1989) The Chamomiles. Can Pharm J. 612

Isaac O (1979) Pharmacological investigations with compounds of Chamomilla. Planta Med 35:118-24.

Isaac O, Schimpke H (1965) Alte und neue Erkentnisse der Kamillenforschung mitt. Dstch Pharmaz Ges 35, 133–147.

Lemberkovics E, Kéry A, Marczal G, Simándi B, Szöke E (1998) Phytochemical evaluation of essential oils, medicinal plants and their preparations. Acta Pharm Hung.68:141–149.

Lima RK, Cardoso MG (2007) Lamiaceae Family: Important essential oils with biological and antioxidant Activity. Rev Fitos 3(3):14-24.

Lins R, Vasconcelos FHP, Leite RB1, Coelho-Soares RS, Barbosa DN (2013) Avaliação clínica de bochechos com extratos de aroeira (*Schinus terebinthifolius*) e Camomila (*Matricaria recutita* L.) sobre a placa bacteriana e a gengivite. Rev Bras Plantas Med 15:112-120.

Lorenzi H, Matos FJA (2002) Plantas medicinais no Brasil: nativas e exóticas cultivadas. SP: Instituto Plantarum, Nova Odessa, 396p.

Lucena RN, Lins RDAU, Ramos INC, Cavalcanti AL, Barbosa Gomes RCB, Maciel MAS (2009) Comparative clinical evaluation of the antiinflammatory efficacy of *Matricaria recutita* and chlorhexidine in patients with chronic gingivitis. Rev Bras Pesq Saú. 11(3):31-36.

Mann C, Staba EJ (2002) The chemistry, pharmacology and commercial formulations of chamomile. In: Craker LE, Simon JE, editors. Herbs, spices and medicinal plants - recent advances in botany, horticulture and pharmacology. USA: Haworth Press Inc 235–80.

Mao JJ, Xie SX, Keefe JR, Soeller I, Li QS, Amsterdam JD (2016) Long-term chamomile (*Matricaria chamomilla* L.) treatment for generalized anxiety disorder: a randomized clinical trial. Phytomed 23(14),1735-1742. https://doi.org/10.1016/j.phymed.2016.10.012

Martins ER, Castro DM, Castellani DC, Dias JE (2003) Plantas Medicinais. Universidade Federal de Viçosa. 220p.

Matic IZ, Jurani Z, Savikin K, Zduni G, Navinski N, Goevac D (2013) Chamomile and marigold tea. chemical characterization and evaluation of anticancer activity. Phytother Res 27:852–858. https://doi.org/10.1002/ptr.4807

Mazokopakis EE, Vrentzos GE, Papadakis JA, Babalis DE, Ganotakis ES (2005) Wild chamomile (*Matricaria recutita* L.) mouthwashes in methotrexate-induced oral mucositis. Phytomed 12:25–27. https://doi.org/10.1016/j.phymed.2003.11.003

McKay DL, Blumberg JB (2006) A review of the bioactivity and potential health benefits of chamomile tea (*Matricaria recutita* L.) Phytother Res 20, 519–530. https://doi.org/10.1002/ptr.1900

Milani AMC, Macedo CLR, Bello MC, Klein Júnior CA, dos Santos RB (2018) A successful approach to conrol burning mouth syndrome using *Matricaria recutita* and cognitive therapy. J Clin Exp Dent 10(5): e499-501. https://www.doi.org/10.4317/jced.54686

Miraj S, Alesaeidi S (2016) A systematic review study of therapeutic effects of *Matricaria recuitta* chamomile (chamomile). Elect Phys 8(9):3024-3031. https://doi.org/10.19082/3024

Morales-Bozo I, Ortega-Pinto A, Rojas Alcayaga G, Aitken Saavedra JP, Salinas Flores O, Lefimil Puente C, et al. (2016) Evaluation of the effectiveness of a chamomile (*Matricaria chamomilla*) and linseed (*Linum usitatissimum*) saliva substitute in the relief of xerostomia in elders. Gerodontol 34:42-8. https://doi.org/10.1111/ger.12220

Pavesi VCS, Lopez TCC, Martins MAT, Sant'Ana Filho M, Bussadori SK, Fernandes KPS, et al (2011) Healing action of topical chamomile on 5-fluouracil induced oral mucositis in hamster. Sup Care Can. 19:639–646. https://doi.org/10.1007/s00520-010-0875-0

Pequeno MA, Silvestre MR, Amêndola I, Silva CRG, Leão MVP, Santos SSF (2018) *Matricaria recutita* extract (chamomile) to reduce *Candida albicans* and *Entrobacter cloacae* biofilms: *in vitro* study.

RGO Rev Gaúch Odontol 66(2):00-00. https://doi.org/10.1590/1981-86372018000200033328

Pirali-Kheirabadi K, Razzaghi-Abyaneh M (2007) Biological activities of chamomile (*Matricaria chamomile*) flowers' extract against the survival and egg laying of the cattle fever tick (*Acari ixodidae*). J Zhejiang Univ Sci B 8(9):693-696. https://doi.org/10.1631/jzus.2007.B0693

Rahman H, Chandra A (2015) Microbiologic evaluation of matricaria and chlorhexidine against *E. faecalis* and *C. albicans*. Indian J Dent 6(2):60-64. https://www.doi.org/10.4103/0975-962X.155876

Ríos YKR, Otero ACJ, Muñoz DLH, Echeverry MR, Robledo SMR, Yepes MAC (2008) Actividad citotóxica y leishmanicida in vitro del aceite esencial de manzanilla (*Matricaria chamomilla*) Rev Colomb Cienc Quím Farm 37(2), 200-211.

Sanaati F, Najafi S, Kashaninia Z, Sadeghi M (2016) Effect of ginger and chamomile on nausea and vomiting caused by chemotherapy in Iranian women with breast cancer. Asian Pac J Can Prev 17(8), 4125-4129.

Santos DS, Rodrigues MMF (2017) Atividades farmacológicas dos flavonoides: um estudo de revisão. Est Cient (UNIFAP).7(3):29-35.

Satyal P, Shrestha S, Setzer WN (2015) Composition and bioactivities of an (E)-β-farnesene chemotype of chamomile (*Matricaria chamomilla*) essential oil from nepal. Nat Prod Commun 10(8):1453-1457. https://doi.org/10.1177/1934578X1501000835

Schirmer EM, Ferrari A, Trindade LCT (2012) Oral mucositis evolution after nutritional intervention in cancer patients under palliative care. Rev Dor 3(2):141-6. https://doi.org/10.1590/S1806-00132012000200009

Sebai H, Jabri MA, Souli A, Hosni K, Rtibi K, Tebourbi O, et al. (2015) Chemical composition, antioxidant properties and hepatoprotective effects of chamomile (*Matricaria recutita* L.) decoction extract against alcohol-induced oxidative stress in rat. Gen Physiol Biophys 34:263–275. https://www.doi.org/10.4149/gpb_2014039

Seyyedi SA, Sanatkhani M, Pakfetrat A, Olyaee P (2014) The therapeutic effects of chamomilla tincture mouthwash on oral aphthae: a randomized clinical trial. J Clin Exp Dent 6(5):e535-8. https://www.doi.org/10.4317/jced.51472

Sharifi H, Minaie MB, Qasemzadeh MJ, Ataei N, Gharehbeglou M, Heydari M (2017) Topical use of *Matricaria recutita* L. (Chamomile) oil in the treatment of monosymptomatic enuresis in children: a double-blind randomized controlled trial. J Evidence-Bas Complem Altern Med 22(1),12-17. https://doi.org/10.1177/2156587215608989

Singh O, Khanam Z, Misra N, Srivastava MK (2011) Chamomile (*Matricaria chamomilla* L.): an overview. Pharmacogn Rev 5(9):82-95. https://www.doi.org/10.4103/0973-7847.79103

Srivastava JK, Shankar E, Gupta S (2010) Chamomile: A herbal medicine of the past with bright future. Mol Med Report 3(6):895–901. https://doi.org/10.3892/mmr.2010.377

Tavakoli Ardakani M, Ghassemi S, Mehdizadeh M, Mojab F, Salamzadeh J, Ghassemi S, Hajifathali A (2016) Evaluating the effect of *Matricaria recutita* and *Mentha piperita* herbal mouthwash on management of oral mucositis in patients undergoing hematopoietic stem cell transplantation: a randomized, double blind, placebo controlled clinical trial. Complement Ther Med 29:29-34. https://doi.org/10.1016/j.ctim.2016.08.001

Torres KG (2018) Desenvolvimento de nanogel de quitosana ligada ao ácido diidrocafeico para encapsulação do óleo essencial de *Matricaria recutita*. [Monografia]. São João del-Rei: Universidade Federal de São João del-Rei.

Vermerris W, Nicholson R. Phenolic Compound Biochemistry. Springer Science & Business Media 2007; Capítulo I:1-2.

Vieira A, Guimarães MA, David GQ, Karsburg IV, Campos ANR (2009) Efeito genotóxico da infusão de capítulos florais de camomila. Rev Trópica Ciên Agrár Biol. 3(1):8-13.