# Evidence-Based Studies and Perspectives of the Use of Brazilian Green and Red Propolis in Dentistry

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## Abstract

This review analyzes the evidence and perspectives of dental use of the green and red propolis produced in Brazil by *Apis mellifera* L. Multiple applications of propolis were found considering its antibacterial, antifungal, anti-inflammatory, immunomodulatory, antiviral, and healing properties. Its therapeutic effects are mainly due to the presence of alcohols, aldehydes, aliphatic acids, aliphatic esters, amino acids, aromatic acids, aromatic esters, flavonoids, hydrocarbyl esters, ethers, fatty acids, ketones, terpenes, steroids, and sugars. Propolis has been mainly used in dentistry in the composition of dentifrices and mouthwashes. Studies have also demonstrated promising use against dentin hypersensitivity, root canal treatment, *Candida albicans,* and other microorganisms. Overall review of the literature presented here demonstrated that both Brazilian green and red propolis are effective for the problems of multiple etiologies that affect the oral cavity in different dental specialties.

**Keywords**
- green propolis
- red propolis
- antibacterial activity
- natural products

## Introduction

Propolis defines a dark, complex, and naturally occurring resinous substance that is obtained by bees from varied species of plants and transported into the hive where it is then mixed with beeswax, resulting in an adhesive substance. It has been widely used in folk medicine for centuries by different civilizations.[1] Due to the enormous Brazilian biodiversity, several kinds of propolis including brown and red, less common, which are classified based on the region of production and collection.[2] In the biodiversity of the flora in Brazil, 13 types of propolis are found.[3] Propolis collected in a hive not only contains mostly resins plant balms but also beeswax, essential oils, and pollen grains at lower concentrations. In its composition, it can be also found in organic acids and substantial quantities of minerals and vitamins.[4] Bees are known to use propolis to protect and strengthen hive from rain and pests such as insects and rodents. In this way, propolis maintains the aseptic conditions and the appropriate temperature of their hive.[5] The abundance of natural compounds found in the propolis favored it to have antibacterial, antiviral, antifungal, anti-inflammatory, analgesic, and other claims.[6] Propolis has been used as an active ingredient in various commercial products, including dental products. In this way, propolis is found in different commercial presentations and packing in liquid or powder forms.[7]

In this way, a broad spectrum of biological activities results from the complex and varied chemical composition of propolis. On the other hand, many factors affect the propolis therapeutic and medicinal properties such as the

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extraction methods and the area where the propolis was obtained.[8] Thus, the chemical composition of the propolis is determined by the pasture plant for the bees. Therefore, by comparing the chemical composition of propolis with the supposed origin plant would be the best way to find the plant from which the propolis was collected.[4] The determination of the geographic region where the propolis was obtained is extremely important for the quality control and for the standardization of propolis extracts to guarantee its therapeutic effects.[1] The color of propolis depends on its origin, ranging from dark brown to a greenish tinge and to reddish brown. It has a characteristic odor that also varies from one sample to another.[1] Several compounds are found in propolis. These compounds have been characterized using different methods that demonstrated that they belong to different classes: alcohols, aldehydes, aliphatic esters, acids (aliphatic, aromatic, fatty, and amino acids), esters (aromatic and hydrocarbyl esters), flavonoids, ethers, ketones, terpenes, and steroids.[6]

In spite of the need of more investigations, currently applications of propolis have evolved from folk and traditional medicine to modern medicine thanks to the results of most recently evidence-based research.[9] The broad applications of multitarget natural products, chemically rich in bioactive agents, such as propolis, have gained more and more attention of the clinicians due to some new and promising areas of use and the development of innovative propolis-containing products that have emerged recently.[10] Since contemporary dentistry is an area of medicine,[6] the use of propolis-based products in the different dental areas has increased as well. Common oral cavity diseases include dental caries, gingivitis, periodontitis, and other diseases of the oral mucosa such as angular cheilitis, oral herpes, oral candidiasis, exfoliative glossitis, prosthetic stomatitis (denture stomatitis), and aphthous ulcer, among others.[5]

Considering the enormous potential of propolis in terms of its varied activities evidenced in the literature, the purpose of this study is to review the literature in which both Brazilian green and red propolis uses in the different dental areas were scientifically demonstrated in evidence-based publications.

## Review Method

Reviewers conducted a systematic search for relevant articles published in the English language between 2000 and 2019 indexed in the following databases: PubMed, ISI web of science, Cochrane Database of Systematic Reviews, CINAHL, Scopus, Science Direct, Conference Proceedings, Oral Health Journal Index, LILACS, and Medline. The keywords were in accordance with the DeCS—Health Sciences Descriptors (http://decs.bvs.br/I/decsweb2019.htm): propolis; dental; dentistry, operative; prosthodontics; preventive dentistry; pediatric dentistry; periodontics; surgery, oral; endodontics; orthodontics. Three reviewers independently assessed the methodological quality of selected studies using standardized critical inclusion criteria, which included local and systematic interventions in in vitro and in vivo studies, using animal models as well as in clinical trials describing the effectiveness of the use of green and red propolis in treating or preventing dental diseases in the different dental specialties.

### Brazilian Green Propolis

The green propolis of Southeastern Brazil is often referred to as “Brazilian Propolis,” but there are other types of Brazilian propolis. Five different types of propolis have been identified so far: two of red propolis from Northeast Brazil, one type of Southeast green propolis, and two types of brown propolis from the South. Each type of propolis has a different composition. The differences in color and composition in the propolis from the South and Southeast of Brazil are directly related to the geographical origins and to the predominant local vegetation.[11]

The therapeutic effects of the Brazilian green propolis can attributed to several phenolic compounds found in the plant *Baccharis dracunculifolia* D.C. (*B. dracunculifolia*), widely distributed in the plant kingdom in Brazil. One of the main phenolic compounds found in the Brazilian green propolis is flavonoids, but other compounds are also found such as phenolic acids and their esters, phenolic aldehydes, alcohols, and ketones. Flavonoids are phenolic compounds present antimicrobial action inhibiting cell division and growth of bacteria and increasing the membrane permeability by affecting the bacterial cell motility.[4] Although it is the most studied component of propolis, flavonoids are not only responsible for the pharmacological properties. However, in this type of Brazilian propolis, there are many aromatic acids and few flavonoids.[11]

The Africanized bees of the Southeast region are able to produce propolis from buds of leaves of *B. dracunculifolia* not yet expanded, guaranteeing a product with high concentrations of phenols and Artepillin C (3,5-diprenyl-4-hydroxycinnamic acid), a compound only found in propolis in the Southeast region on Brazil.[12] In this way, caffeic ferulic, *p*-coumaric acids, kaempferol, kaempferide, and Artepillin C are the main constituents of the Brazilian green propolis.[13] Artepillin C presents several activities such as antioxidant, antimicrobial, anti-inflammatory, antigenotoxic, antiangiogenic, and anticancer properties.[14] Other phenolic compounds, such as *p*-coumaric acid and 3-prenyl-4-hydroxycinnamic acid, are also found in this type of propolis extract. Other phenolic compounds, such as *p*-coumaric acid and 3-prenyl-4-hydroxycinnamic acid, are also found in this type of propolis extract. Green propolis also has an antiradical action against 1,1-diphenyl-2-picrylhydrazyl radicals. It also exhibits a wide spectrum of action, possibly related to the synergic effects of phenolic type compounds such as ferulic and caffeic acids and *p*-coumaric acid in the extract.[15]

Many biological properties have been reported for Brazilian green propolis, such as antibacterial activity,[16] anti-inflammatory,[17] antihypertensive,[18] antihyperlipidemic,[19] antioxidant,[20] and antitumor.[21] Recently, it has been used as a neuroprotectant in neurodegenerative diseases[22] and in the prevention of cognitive decline in the elderly.[23] ►**Table 1** demonstrates that the interest in Brazilian green propolis in dentistry is mainly due to its antimicrobial and anti-inflammatory activities.

**Table 1** Uses of green propolis according to dental areas

| Dental area | Experimental aim | Activities and/or results | Experim. model | Ref. |
|---|---|---|---|---|
| Oral hygiene and caries pathogens | Cariogenic bacteria cytotoxicity | – All presented antimicrobial action against *Streptococcus mutans*, *S. sanguinis*, *S. salivarius*, and *Lactobacillus casei*<br>– Low cytotoxicity in osteoblasts in the three concentrations of varnishes | *In vitro* | 33 |
| | Evaluate adherence, appreciation, and acceptability of the mouthwash | Of 25 patients, 21 completed the study. Most reported unpleasant taste, but were satisfied and noted positive changes in oral health;<br>– Satisfactory adhesion (≥ 80%) | *In vivo* Human | 34 |
| | Plaque control and gingivitis | After 45 and 90 days of use, there were significant reductions ($p < 0.5$) in plaque index and gingival index (24 and 40%, respectively), when compared with control samples;<br>– There were no significant side effects in the soft and hard tissues of the mouth | *In vivo* Human | 35 |
| | Influence on oral cavity health | – Efficacy in hygiene preparations in two groups of patients: (1) without pathological changes at the periodontium boundaries and (2) in cases of risk of gingivitis caused by biofilm;<br>– Effective as a support for the removal of the plaque and to improve marginal periodontal status | *In vivo* Human | 36 |
| | Influence on oral cavity health | – It efficiently aided the removal of the biofilm and improved the state of the marginal periodontium;<br>– Antimicrobial activity against gram-positive bacteria, as *Candida albicans*;<br>– No activity against Escherichia coli was observed, but there was activity mainly against *S. mutans* and *L. casei* | *In vivo* Human | 37 |
| | Comparative evaluation of extracts of propolis and *Baccharis dracunculifolia* on cariogenic factors of *S. mutans* | – Both extracts produced a bacteriostatic effect;<br>– Similar inhibitory effect against acid production and the synthesis of insoluble and soluble glucans | *In vitro* | 38 |

(*continued*)

**Table 1** (*continued*)

| Dental area | Experimental aim | Activities and/or results | Experim. model | Ref. |
|---|---|---|---|---|
| Periodontics | Effect on oral epithelial dysplasia | – Important protective role during chemically induced lingual carcinogenesis in rats | *In vivo* Animal | 39 |
| | Efficacy against HSV-1 infection in rats | – Showed direct anti-HSV-1 activity and intradermal immune activity against HSV-1 | *In vivo* Animal | 40 |
| | Response in the lingual mucosa of hamsters submitted to experimental carcinogenesis | – There was no significant difference in the evaluation periods and the presence of squamous cell carcinoma was observed | *In vivo* Animal | 41 |
| | Treatment of periodontitis | – There was a 95% regression in gingivitis and suppuration in all the teeth irrigated with the gel, reduction in the probing depth of the pockets in all teeth not previously scraped and root planning;<br>– The reorganization of the alveolar bone was not observed;<br>– Increased gingival retraction and reduced mobility were noted. | *In vivo* Human | 42 |
| | Effectiveness against gingivitis | – After 21 days without oral hygiene, no significant difference was found for the measurements of papillary bleeding scores in the group that used the mouthwash compared with positive control group | In vivo Human | 43 |
| | Prevention of oral mucositis induced by radiation | – Of 24 patients, 20 did not develop mucositis, 2 developed in grade 1, and 2 developed in grade 2;<br>– No interruption of food intake and no report of pain;<br>– Candidiasis was not detected in any patient. | *In vivo* Human | 44 |
| | Antimicrobial activity against oral pathogens | – Inhibited all 15 microorganisms tested, showing greater zone of inhibition for *Actinomyces* spp.;<br>– Inhibition of cell adhesion and the formation of insoluble glucan in water | *In vitro* | 45 |
| | Antimicrobial activity against oral pathogens | – Activity against 8 strains of tested microorganisms, similar to propolis, with higher activity against strains of *E. salivarius*, *S. sanguinis*, *S. mitis*, and *C. albicans* | *In vitro* | 46 |
| | Susceptibility of oral pathogenic bacteria and fungi | – All 16 microorganisms tested were susceptible to the extract;<br>– None of the isolated fractions tested were more active than the extract | *In vitro* | 47 |
| | Effect on mechanisms of adherence of *C. albicans* | – Exerted influence on the cellular morphology of *C. albicans* and acted on the formation of the germinative tube;<br>– It has been shown to alter the cell wall of the microorganism | *In vitro* | 48 |
| | Oral pathogens and periodontal fibroblasts | – Inhibited the growth of *S. mutans* in low concentrations inhibited the growth of *S. sanguinis* or *Porphyromonas gingivalis*; but did not inhibit the growth of *Aggregatibacter actinomycetemcomitans*, even at the highest concentration;<br>– Low cytotoxicity to the periodontal tissue up to the highest concentration | *In vitro* | 49 |
| | Adhesive mucoresponsive system for the treatment of lesions caused by HSV-1 | – Inhibited the virus during the viral infection phase;<br>– Induced damage to the virion;<br>– Demonstrated ability to protect cells from viral infection | *In vitro* | 50 |

(*continued*)

**Table 1** (*continued*)

| Dental area | Experimental aim | Activities and/or results | Experim. model | Ref. |
|---|---|---|---|---|
| Oral and maxillofacial surgery | Effect of topical propolis and dexamethasone on the healing of oral surgical wounds | – It had a greater anti-inflammatory effect and reduced the healing time of surgical wounds compared with dexamethasone in Orabase gel | *In vivo* Animal | 51 |
| | Evaluation of oral microflora after maintenance hygiene after minor oral surgeries | – Affected gram-positive rods and bacilli, and gram-negative bacilli;<br>– Deep reduction in the amount of *Neisseria* spp. and strains of *Bifidobacterium* spp.;<br>– Eliminated 7 species of microorganisms | *In vivo* Human | 52 |
| | Influence on hygiene and buccal microbiota after mandibular fractures | – Pathogenic and opportunistic microorganisms were eliminated: in 16 patients there was a reduction of 54 strains of microorganisms to 48 after using the gel with an ethanolic extract;<br>– In the 15 patients who used gel without the EEP there was an increase from 41 to 57 strains. There was no harmful influence on physiological microflora | *In vivo* Human | 53 |
| | Biological activity in oral health after rehabilitation of implants supported | Acted effectively on the reduction in dental plaque and showed a local therapeutic effect on the marginal periodontium;<br>– Bacteria with pathogenic potential, particularly stems Enterobacteriaceae spp;<br>– Beneficial influence on the bacterial modification of the oral cavity;<br>– Little influence on *C. albicans* spp. | *In vivo* Human | 54 |
| Dentistry, operative | Effect on the physicomechanical properties of GIC | – Use of propolis combined with glass ionomer cements is promising<br>– Proposed as a resource against caries disease and prevention to secondary caries | *In vitro* | 55 |
| | Antidemineralizing and antibacterial effect against *S. mutans* dental biofilm | – Antibacterial against *S. mutans* biofilm;<br>– Low potential to inhibit the demineralization process | *In vitro* | 56 |
| | As a cavity disinfectant | – Action only bacteriostatic against *S. mutans* and *L. acidophilus*, having less efficacy than 2% chlorhexidine solution | *In vitro* | 57 |
| Orthodontics | Hygiene, gingival state, and oral microflora in cases of cleft palate treated with fixed orthodontic appliance | – Significant decrease in Plate Orthodontic Index, Gingival Index, and percentage of *Actinomyces* spp. and *Capnocytophaga* spp. | *In vivo* Human | 58 |

(*continued*)

**Table 1** (*continued*)

| Dental area | Experimental aim | Activities and/or results | Experim. model | Ref. |
|---|---|---|---|---|
| Endodontics | Pulpal repair after pulpotomy | – Inflammatory response consisting of neutrophils was observed; necrosis was observed, and its extension increased with time;<br>– Vascular congestion, edema and hemorrhage were observed | *In vivo* Animal | 59 |
| | Inflammatory response of three cell lines | – Suppresses the LPS-induced inflammatory response of cells within the root canals | *In vitro* | 60 |
| | Development of a propolis-based irrigant solution and its effect on the bonding of fiber-glass posts to the root canal dentin | – Propolis-based irrigation protocols do not interfere in the bonding performance of posts cemented to root canal dentin | *In vitro* | 61 |
| | Decontamination ability when associated with calcium hydroxide paste | – Associated with calcium hydroxide paste as vehicle and addictive<br>– Increased the antimicrobial effect of the calcium hydroxide paste | *In vitro* | 62 |
| | Proliferation and apoptosis of periodontal ligament fibroblasts | – Decreased apoptosis and increased metabolic activity and proliferation of periodontal ligament cells | *In vitro* | 63 |
| Prosthodontics | Treatment of oral candidiasis | – All patients treated with the extract had lesion regression similar to that observed in patients treated with nystatin | *In vivo* Human | 64 |
| | Efficacy for the treatment of prosthetic stomatitis | – All patients treated with the gel had complete clinical remission of edema and palmar erythema, which also occurred in the positive control | *In vivo* Human | 65 |
| | Comparison with miconazole gel in the treatment of *C. albicans* associated with prosthetic stomatitis | – Significant reduction or complete remission of prosthetic stomatitis and significant decrease of *C. albicans* colonies;<br>– Effect similar to that of miconazole gel | *In vivo* Human | 66 |

Abbreviations: EEP, ethanolic extract of propolis; GIC, glass ionomer cement; HSV-1, herpes simplex virus type 1; LPS, lipopolysaccharide; SEM, scanning electron microscope.

**Brazilian Red Propolis**

Brazilian red propolis is obtained by bees from the species *Apis mellifera* mainly from the sap of *Dalbergia ecastophyllum*, which is a leguminous plant found in the northeastern mangroves of Brazil.[12] One of its botanical origin is a legume identified as *D. ecastophyllum* L., found in a region of tropical coastal climate, specifically the mangrove region. Its stem is reddish, so the product of propolis accompanies the coloration.[4] Red propolis presents an intense red color and other characteristics that makes it different from other types of propolis found in Brazil[24] and throughout the world.[3] The main secondary metabolites present in the red propolis are isoflavonoids, propolones/guttiferones, terpenes, chalcones, and phenolic compounds.[25] It also has chemical substances such as vestitol, neovestitol, C-glycoside, liquiritigenin, isoliquiritigenin, formononetin, and medicarpin that are not found in other types of propolis.[26] Compounds such as daidzein, biochanin A,[27] pinocembrin, and quercetin[24] are considered biomarkers of Brazilian red propolis. Brazilian red propolis presents antimicrobial, anti-inflammatory and immunomodulatory, antioxidant, and antiproliferative activities due to a distinctive chemical composition, mainly isoflavone that is important against numerous diseases.[28] Other actions of ethanolic extracts of red propolis such as antioxidant, antimicrobial, antipyretic, and cytotoxic properties of Brazilian red propolis were also found.[29] Only red propolis extract was able to inhibit the growth of tumor cells. In addition, red propolis showed the highest anti-*Trypanosoma cruzi* Y activity and a potential therapeutic action against Chagas disease,[29] both of which are endemic diseases in Brazil and Latin America. Red propolis extracts was also found to be able to inhibit gram-positive bacteria, and other kinds of cancer. These findings demonstrated a strong biological activity of red propolis extracts, possibly favoring a wider use in different application forms.

►**Table 2** shows the interest in Brazilian red propolis in dentistry. ►**Table 3** shows the synergistic use of both green and red propolis.

## Discussion

As previously exposed, it is a fact that with the development of modern methods of phytochemical analysis associated with different methods to extract a variety of bioactive agents, deeper knowledge of propolis properties has allowed an increase in its general use considering its antibacterial, antiviral, antifungal, anti-inflammatory, antioxidant, and chemopreventive actions. Overall action of the chemical compounds found in the different categories of propolis is still being investigated, which will certainly allow the development of new products for healthcare.[5] In this way, the benefits of propolis have been widely explored by the nutraceutical and pharmaceutical industry with a view to application in the different areas of medicine in the prevention and treatment of oral and systemic disorders.[28] The use of natural products may significantly reduce the use of conventional treatments and antibiotics, shifting toward the usage of propolis in the management of oral cavity conditions.[5] Thanks to the multiple bioactive components found in extracts of propolis, it seems to play a synergic role in terms of therapeutic action that is comparatively greater than that when using a drug alone.[9] In this way, a trend exists in which therapeutic modes using "multi-drugs and multi-targets" are associated.[9]

In spite of the evolving technology in terms of phytochemical properties, factors such as limited investment and incomplete or inconsistent information from preclinical and clinical testing impact the production of derivatives of natural products in the healthcare industry.[30] Although a vast literature evaluating the biological effects propolis in in vitro and in vivo studies exists, only a small part of them reaches the clinical phase and becomes commercially available. In addition, a lack of clinical trials is also observed in the dental area.[3] Thus, it is imperative for the development of more clinical trials to explore the benefits of propolis. Thus, it is imperative that more clinical studies need to be performed to explore the benefits of propolis. In this way, in vivo studies are also important for refining the dosages and formulations focused on drug development.[31]

Other issues seem to affect the use of propolis for healthcare. For instance, the time at which propolis and its botanical sources are collected interfere in the composition of propolis, thus resulting in variations in its antibacterial activity.[32] Another important issue to consider is the predisposition to allergies when consuming products derived from bees, especially toward pollen and honey, as well as by individuals with atopy or asthma.[5] Other issues include the need of an appropriate processing and dose regulation, to improving the drug efficacy and reducing the drug toxicity.[9] Although these issues, there is a promising research area aiming to deepen the knowledge in the following areas such as drug-like activity, physicochemical and biochemical properties, pharmacokinetic, and also toxicological characteristics of natural products. The benefits are numerous advantages over other forms of medicine discovery of lead compounds and drug candidates, favoring the development of new drugs, thereby resulting in many benefits, such as significant cost reductions.

Among the several pharmacological properties of propolis, the main purpose of its use in the different dental specialties seems to be mainly related to its antimicrobial (bacteriostatic and bactericidal) actions, identified against different species of gram-positive bacteria.[14] In this way, according to the findings in the present study, the main application of green and red propolis in the dental specialties is as antimicrobial agent. Oral and maxillofacial surgery (in postoperative control of infections), periodontics (also controlling postoperative infections after gum surgery), endodontics (as a root canal irrigant), oral hygiene (against caries pathogens, hindering *S. mutans* biofilms), and orthodontics (minimizing enamel demineralization) were the dental specialties that stood out regarding the use of propolis. To a lesser extent, propolis can be also used due to its antioxidant activities and also as an

**Table 2** Uses of red propolis according to dental areas

| Dental area | Experimental aim | Activities and/or results | Experim. Model | Ref. |
|---|---|---|---|---|
| Oral hygiene and caries pathogens | In vitro biofilm accumulation and in vivo caries development | – It hindered the accumulation of Streptococcus mutans biofilms;<br>– As effective as fluoride (positive control) in reducing the development of caries. | *In vitro/In vivo* Animal | 26 |
| | Antimicrobial and anti-inflammatory evaluation | – Consistent bioactive compounds that exhibit anti-inflammatory and antimicrobial activities that can act strongly at low dose and concentration. | *In vitro* | 67 |
| | Antimicrobial activity against cariogenic bacteria | 3% RP reduced *S. mutans* colonization, decreased concentration of extracellular polysaccharides and reduced dental enamel demineralization | *In vitro* | 68 |
| Periodontics | Fungicidal action against *Candida spp*. | – Isoflavone formononetin acts as a fungicide against *Candida* spp. | *In vitro* | 69 |
| | Anti-inflammatory action | – It attenuates the inflammatory cascade induced by LPS in macrophages and decreases the formation of chemical mediators related to inflammation | *In vitro* | 70 |
| | Antifungal activity against *Candida spp*. isolated from patients with chronic periodontitis | – Good fungistatic and fungicidal action against most samples of *Candida* species | *In vitro* | 71 |
| | Antifungal action in *Candida spp.* oral | – The lower concentration of the extract had greater antifungal action | *In vitro* | 72 |
| | Antifungal activity and synergism of propolis with the use of antifungals on *Candida spp*. | – There was synergism with fluconazole: a therapeutic strategy for the treatment of *Candida* spp. resistant | *In vitro* | 73 |
| | Antifungal potential of Brazilian red propolis against Candida spp | Presented strong anti-*Candida* activity: should be considered to treat oral and systemic candidiasis | *In vitro* | 74 |
| | Inhibition of the growth of oral squamous cell carcinoma induced | – Preventive chemopreventive activity on the progression of induced epithelial dysplasia in an experimental model of lip carcinogenesis | *In vivo* Animal | 75 |
| | Antimicrobial effects on multispecies biofilms | – Decreased biofilm metabolic activity by 45%, with no significant difference from chlorhexidine-treated samples | *In vitro* | 76 |
| | Biological activity | – antimicrobial action against *S. aureus* and *S. mutans* and against tumor cells;<br>– Fractions were more active than the EEP: nonsynergistic effect among the various compounds, suggesting isolation and identification of the various compounds responsible for antioxidant, antimicrobial and anticancer activities | *In vitro* | 77 |
| Dentistry, operative | Desensitization of the dentinal tubules | – Demonstrated occlusion action on the dentinal tubules. | *In vitro* | 78 |
| | Cavity cleanser | – Demonstrated no influence in the aesthetics or on the bond strength of the dentin/resin interface | *In vitro* | 3 |

Abbreviations: EEP, ethanolic extract of propolis; LPS, lipopolysaccharide.

**Table 3** Associated use of red and green propolis according to dental areas

| Dentistry area | Experimental aim | Activities and/or results | Experim. Model | Ref. |
|---|---|---|---|---|
| Oral hygiene and caries pathogens | Synergistic effect on *Streptococcus mutans* and *S. sanguinis* | All extracts inhibit the growth of both microorganisms; • The isolated red propolis extract or associated with green were more effective than other | *In vitro* | 79 |
| | Antimicrobial activity against cariogenic bacteria | • 3% red propolis reduced *S. mutans* colonization, decreased concentration of extracellular polysaccharides and reduced dental enamel demineralization | *In vitro* | 68 |

anti-inflammatory agent. Propolis was also proven to be useful as part of a novel targeted therapy for some types of cancer in some studies. The main uses of propolis are in the form of extracts or powders, mostly associated with other vehicles or additives in healthcare products. Propolis can also be taken orally in the form of tablets, liquid extracts, and capsule form, or can be used as a mouthwash or local application to areas of affected mucosa.

Overall review of the literature presented here demonstrated that both Brazilian green and red propolis are effective for the problems of multiple etiologies that affect the oral cavity in the different dental specialties. The in vitro and in vivo studies also demonstrated that the green and red propolis could be associated with conventional treatments of the diseases in the oral cavity, possibly reducing the dosage and consequently the side effects of drugs, such as antibiotics and anti-inflammatory medicaments.[5] In this way, there should be a plea for the development of multidisciplinary collaborative research with a view for innovative ideas, to deepen the knowledge of the synergism of natural products and of the traditional medicine to obtain new drugs and effective treatments.[9]

## Conclusions

Research with natural products has increased in the dental area in the recent years, searching for new healthcare products with lower toxicity, greater biocompatibility, and improved pharmacological activities, associated with more affordable costs to the population. Herbal medicine is widely and popularly accepted with excellent acceptance by the dental clinicians and patients. In this way, a lot of natural products have been developed and marketed by the dental industries supported by specific laboratory and clinical studies and after improving the quality control. Although the literature evidences a significant number of studies using green propolis, the evaluation of Brazilian red propolis by researchers has increased, demonstrating to be a substance of great value in the different areas of dentistry. Natural products and traditional medicines present incomparable advantages due to their unique diversity in terms of chemical structures and biological activities, which allow them to be used to develop new drugs. On the other hand, some issues described in this literature review still need to be solved but with promising results, considering that some of them still need clinical evaluations. In this way, propolis remains as an interesting research area considering its application in biomedical and dentistry areas.

**Conflict of Interest**
None declared.

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