

PROPOLIS IN ORAL HEALTH: THERAPEUTIC APPLICATIONS AND CLINICAL BENEFITS

Iustin Olariu¹ Andreea Mihaela Kiş^{2*}, Andreea Salcudean³ Laria Maria Trusculescu²,
Dana Emanuela Pitic⁴, Adina Feher⁴, Ramona Amina Popovici²

¹ Department of Dentistry, Faculty of Dentistry, "Vasile Goldiș" Western University of Arad, 94-96 Revoluției Blvd., 310025 Arad, Romania; olariu.iustin@uvvg.ro;

² Department of Management and Communication in Dental Medicine, Department I, Faculty of Dental Medicine, Victor Babes University of Medicine and Pharmacy of Timisoara, 300041 Timisoara, Romania; kis.andreea@umft.ro; ramona.popovici@umft.ro; laria.trusculescu@umft.ro

³ Department of Bioethics, Deontology and Medical Communication, George Emil Palade University of Medicine, Pharmacy, Science, and Technology of Targu Mures, 540142 Targu Mures, Romania; andreea.salcudean@umfst.ro

⁴ Doctoral School, "Victor Babes" University of Medicine and Pharmacy Timisoara, 300041 Timisoara, Romania; dana.pitic@umft.ro; adina.feher@umft.ro

Corresponding author; e-mail kis.andreea@umft.ro

ABSTRACT

Aim of the study There are a variety of natural products used today in biomedical application in treating a wide range of systemic diseases. Primarily composed of resins (55–60%), waxes and fatty acids (30–45%), and aromatic oil and pollen (10–5%) has a commercial availability of propolis is in the form of lozenges, topical creams, mouthwashes, and toothpastes **Materials and methods** The present work aimed to evaluate the effectiveness of using propolis-based products in oral health. Secondary objectives: verification of oral health habits in patients and oral assessment and screening of gingivitis, periodontitis and oral cancer in the two groups. **Results** Statistically significant improvements ($p < 0.05$) were observed only in Lot I (test group) for: gingivitis, gingival bleeding, halitosis. **Conclusions** Mouthwashes are used as commercial antiseptics and as home remedies for improved oral hygiene. Propolis is ranked among the few natural remedies that have still maintained their popularity over time due to its wide range of applications in both dentistry and medicine. Its extensive and wide variety of properties such as anti-inflammatory, antibacterial, antiviral and anti-fungal have also kept the attention of many researchers.

Key words: propolis, dental health, gingivitis, oral hygiene

INTRODUCTION

The health field has always emphasized the use of natural products for curing diseases, rather than relying on conventional allopathic medicine. There are a variety of natural products used today in biomedical application in treating a wide range of systemic diseases. These can include natural silk [1,2], chitosan [3,4], herbal tea [5] and miswak [6]. Propolis, a non-toxic natural resinous substance that exhibits antimicrobial [7,8], anticancer [9, 10], antifungal [11-14], antiviral [15- 18] and anti-inflammatory properties [19, 20], has gained attention in both the dental and medical fields. Propolis is one of the natural substances

produced by bees to build and maintain their hives. It kills pathogens, protects the honeycomb from rain, and, due to its adhesive nature, prevents foreign guests from entering the hive [21]. This natural substance has a wide range of overlooked benefits. It is classified into twelve different types based on its terrestrial location and physicochemical properties, however, only three different types of botanical origin have been identified [22]. Propolis is considered the core and powerhouse of nutrients [23]. It is made by a lipophilic resinous material with a sticky and soft consistence and flexible when exposed to heat, but at cold temperature it becomes hard

and brittle [22]. Propolis is primarily composed of resins (55–60%), waxes and fatty acids (30–45%), and aromatic oil and pollen (10–5%) [24]. Other substances may include minerals, vitamins, and flavonoids. The biological activity of propolis is largely related to flavonoids and hydroxycinnamic acid [25].

Research has shown that it is difficult to standardize the chemical constituents and flavonoid content of propolis because it is dependent on the environmental conditions of the collection site, origin, type of plant pollen and species of bees that produced it [24,26]. For the production of propolis, bees use secretions of different plants as well as substances discharged from plant wounds, i.e. lipophilic materials from leaves, leaf buds, resins, gums and matrices [27,28]. Therefore, there is a striking chemical variability in the composition of propolis, especially from tropical regions. Kujumgiev et al. compared the antibacterial, antiviral, antifungal and anti-inflammatory properties of propolis of different origins and concluded that all exhibited significant properties, including important antiviral properties [29]. Similarly, Popova et al. reported the same findings in comparison with the biological activity of propolis of geographical origin. [30].

The chemical constituents of propolis include chrysin, galangin, pinocembrin, pinobanksin, which are found in temperate climates. These are flavonoids without B-ring substituents. The major component of temperate propolis is caffeic acid phenethyl ester (CAPE) [27]. Similarly, the chemical composition of propolis originating from tropical regions includes prenylated phenylpropanoids (e.g., artemillin C), while propolis found in Pacific and African regions contains geranyl flavanones as characteristic compounds (Fig.1.) [27,31].

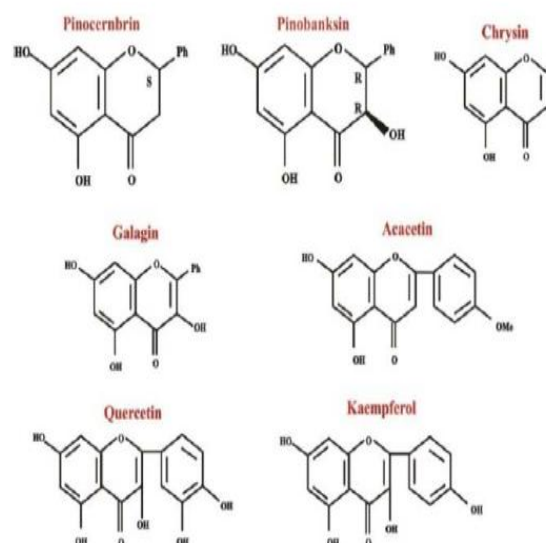


Figure 1. Nomenclature and chemical structures of the various constituents of propolis.

The topic is both important and current, as it complements studies that have characterized the product from other areas of our country and creates the premises for the transfer of knowledge to economic agents that produce and market "over-the-counter" (OTC) beekeeping products. Commercial availability of propolis is in the form of lozenges, topical creams, mouthwashes, and toothpastes [32]

In the present literature there are numerous studies that investigated the effectiveness of various formulations of propolis for use in biofilm and dental caries control, including propolis-containing mouthwashes [33]

The present work aimed to evaluate the effectiveness of using propolis-based products in oral health.

The topic is both important and current, because it addresses a multidisciplinary topic that combines allopathic medicine with phytotherapy, which is gaining more and more ground in our country and increases the percentage of the population that consumes all kinds of food supplements and chemicals daily.

MATERIALS AND METHODS

The present work aimed to evaluate the effectiveness of using propolis-based products in oral health.

Secondary objectives:

- Verification of oral health habits in patients
- Oral assessment and screening of gingivitis, periodontitis and oral cancer in the two groups

DATA COLLECTION

To carry out this bachelor's thesis, we conducted a prospective observational study that took place between March and October 2025.

This study was carried out in 3 stages:

- First stage = formation of the target group, with the agreement to participate by completing the informed consent.
- Second stage = division of the target group into two, obtaining a test group and a control group. The test group - used propolis-based products and the control group used the same oral care products that they had been using until now. Evaluation of the patients' oral health status and completion of a questionnaire.

The patients were assessed by:

Silness-Löe Gingival Index (GI)

The gum surrounding the tooth at the neck is divided into 4 zones (V – the portion facing the lips or cheeks, M – facing the neighboring tooth closer to the midline, L – the surface facing the tongue or palate, D – the edge separating it from the neighboring tooth located more posteriorly), the gum is gently palpated with a periodontal probe and an index from 0 to 3 is assessed for each zone as follows: 0 = normal, pink, firm consistency;

1 = mild inflammation, little change in color and texture, no bleeding when pressed

with a periodontal probe;

2 = moderate inflammation, erythema, edema, and shiny gingiva, bleeding triggered by the probe;

3 = severe inflammation, red and edematous gums, spontaneous bleeding or even ulceration.

Papillary Bleeding Index (PBI).

0 = normal appearance, no bleeding on probing.

1 = spotting;

2 = linear or multiple bleeding;

3 = interdental papilla bleeding;

4 = one or more drops of blood are formed.

- Plaque Index

- Periodontal Screening Index.

- Decayed Teeth

- Filled Teeth

- Edentulous Teeth

- Third stage = oral re-evaluation and completion of the questionnaire.

The target group consisted of patients who presented to 3 individual dental clinics and who wanted to participate in the study. A total of 42 participants were selected, who, following the oral assessment, were divided into two equal groups of 21 patients each with approximately the same oral health status, in order to avoid random error.

DATA PROCESSING

The data obtained from completing the questionnaires and oral assessments were entered into a database in Excel 365, where they were descriptively processed, and the comparison test used was the online chi square Chi Square Calculator 2x2 (includes Yates correction) (socscistatistics.com). It was considered statistically significant at $p < 0.05$

RESULTS AND DISCUSSIONS

The study evaluated the effect of propolis mouthwashes by comparing plaque scores and gingival index at baseline and at a five-day interval.

In terms of demographic characteristics, the groups were relatively homogeneous, as can be seen in Table I, where we observe that the average age is similar, the subjects in terms of gender are evenly distributed, the highest percentage in both groups are from urban areas, and the subjects with higher education are the same in both groups.

Table 1. Demographic Characteristics of Study Groups

Variable	Category	Lot I – Test Group	Lot II – Control Group
Age (years)	Mean $\pm$ SD	32.6 $\pm$ 12.5	31.8 $\pm$ 12.7
	Minimum	19	19
	Maximum	54	53
Sex	Male	11 (52.38 %)	11 (52.38 %)
	Female	10 (47.61 %)	10 (47.61 %)
Place of Residence	Urban	18 (85.71 %)	16 (76.19 %)
Education	Secondary	6	7

n	Level	Lot I	Lot II
1	Primary school	9 (28.57 %)	8 (33.33 %)
2	High school	9 (42.85 %)	8 (38.09 %)
3	Higher education	6 (28.57 %)	6 (28.57 %)

Statistically significant improvements ($p < 0.05$) were observed only in Lot I (test group) for: Gingivitis, Gingival bleeding, Halitosis

No statistically significant changes were observed in Lot II (control group) for any parameter.

Results remain consistent after applying Yates' continuity correction, confirming robustness of findings. Propolis is ranked among the few natural remedies that have still maintained their popularity over time due to its wide range of applications in both dentistry and medicine.

Mouthwashes are used as commercial antiseptics and as home remedies for improved oral hygiene. These mouthwashes can be both cosmetic and therapeutic [33]. Therapeutic mouthwashes reduce bacterial counts, have antiplaque effects, act as an astringent, and help reduce gingivitis and carious lesions [34, 35].

Table 2. Results of applying mouthwashes of Favisan with propolis on the test group and control group.

Parameter	Group	χ^2	p	Significant ($p < 0.05$)

Gingivitis	Lot I (Test)	9.72 22	0.001 821	Yes
	Lot II (Control)	1.00 27	0.316 670	No
Difficulty in Mastication	Lot I	0.14 14	0.706 879	No
	Lot II	0.12 32	0.725 625	No
Dental Pain	Lot I	0.46 67	0.494 525	No
	Lot II	0.42 86	0.512 691	No
Gingival Bleeding	Lot I	11.9 576	0.000 544	Yes
	Lot II	0.46 67	0.494 525	No
Halitosis (Bad Breath)	Lot I	6.03 52	0.014 023	Yes
	Lot II	0.52 50	0.468 717	No
Unexplained Oral Cavity Pain	Lot I	0.46 67	0.494 525	No
	Lot II	3.07 92	0.079 301	No

Mouthwashes are used as commercial

antiseptics and as home remedies for improved oral hygiene. These mouthwashes can be both cosmetic and therapeutic [36]. Therapeutic mouthwashes reduce bacterial counts, have antiplaque effects, act as an astringent, and help reduce gingivitis and carious lesions [37]. In Kiani S. *et al* study evaluated the effect of propolis mouthwashes by comparing plaque scores and gingival index at baseline and at five-day interval chlorhexidine mouthwashes were more effective compared to propolis extract mouthwashes [38]. In addition, the effect of propolis mouthwashes on gingival fibroblasts showed less cytotoxicity than chlorhexidine mouthwashes. Ozan *et al.* and Arsalan *et al.* concluded that propolis mouthwashes were not as effective as chlorhexidine mouthwashes in preventing caries [39,40]. Gram-negative bacteria in planktonic state and can be used as an alternative to chlorhexidine to avoid its side effects. Studies are needed to find the effects of propolis on biofilms [41].

Research has shown that mouthwashes containing propolis in an aqueous alcohol solution heal intra-oral surgical wounds; therefore, it plays a role in epithelial repair after tooth extraction and exerts an anti-inflammatory effect on orofacial pain [40]. Propolis-based toothpastes should be used as adjuncts to other substances in subjects at higher risk of developing periodontal problems [42].

Dental caries is considered one of the major and chronic dental public health problems. Personalized brushing techniques, dietary modification and fluoride use play a considerable role in preventing carious lesions [43,44]. Data suggest that the use of miswak together with an appropriate technique as an adjunct to tooth brushing is good. Similarly, evidence from various studies has evaluated the effect of propolis on *Streptococcus mutans* susceptibility, caries development and

glycosyl transferase activity in rats and found that propolis extract has cariostatic effects [45]. Similarly, the authors' largely uncontroversial results showed that propolis extracts limit plaque formation on the tooth surface, which indirectly reduces dental caries [46-49]. In addition, Durate *et al.* reported that fatty acids in propolis provide a cariostatic effect by decreasing the tolerance of microorganisms to a low pH and slowing down the production of acid [50, 51]. Furthermore, Nam *et al.* reported that Brazilian propolis possesses significant antimicrobial effects against *Streptococcus mutans* in the oral cavity by inhibiting enzymatic activity and cell division [52]. They also concluded that propolis could be used as an alternative and natural therapy against infectious conditions of the oral cavity, with no reported side effects [52,53]. A study by Cordoso *et al.* agrees with the findings of Nam *et al.* that ethanolic extract of propolis has no inhibitory action on the caries demineralization process [48]. The multiple and diverse effects of propolis on oral health have led to its use in periodontal diseases. Subgingival irrigation with propolis extracts during periodontal treatment has been shown to be more effective than root planning and scaling [54, 55]. In addition, propolis extracts, when used in gingival pockets, are beneficial for periodontal diseases [55,56]. A study on histological-morphological imaging has established that the application of propolis systematically prevents subsequent bone loss in periodontal conditions in rats [57]. In addition, Gebara *et al.* reported that the *in vitro* use of propolis extracts not only had antimicrobial activity against periodontopathic bacteria (*Capnocytophaga gingivalis*, *Prevotella intermedia*, *Fusobacterium nucleatum*, *Porphyromonas gingivalis*), but also against microorganisms that cause superinfection (*Staphylococcus aureus*, *Escherichia coli*, and *Candida albicans*) [58].

EFFECT OF PROPOLIS ON DENTIN HYPERSENSITIVENESS

Dental hypersensitivity is defined as a sudden and brief pain that occurs from tactile, osmotic, thermal or other stimuli from exposed dentin [59]. There are various theories for dental hypersensitivity. Among these theories, the hydrodynamic theory is considered the most acceptable and relevant. It is proposed that propolis reduces dentin hypersensitivity by decreasing the hydraulic conductance of dentin [60,61].

A recent study by Hussain *et al.* showed that propolis, when used in the treatment of dentin hypersensitivity at the chair level after bleaching, gave convincing results [61]. Similarly, another study by Hongal *et al.* showed contrasting results when Indian propolis was compared with RecaldentTM. RecaldentTM showed significant results in reducing dentin hypersensitivity [62]. Also, when 5% propolis extract was compared with potassium nitrate in reducing dentin hypersensitivity, no difference was observed between the two groups. Propolis used as a natural desensitizer is still a vague concept and requires further verification through research [63]

PROPOLIS USED AS A DISINFECTANT FOR CAVITIES IN VIVO

Good prognosis of caries is directly related to the removal of infected dentin. Due to the improved understanding of the caries process, there is a dramatic progress in the management of carious lesions. Cavity disinfection is an adjunct method to minimize or reduce the number of bacteria in the residual dentin after cavity preparation [64]. Propolis together with other cavity disinfectants, i.e., APF (acidified phosphate fluoride) gels, diode lasers, and 2%

chlorhexidine, was used against *S. mutans* and *L. bacilli* and it was observed that there was a significant decrease in the number of bacteria in all groups, however, APF gels showed the lowest reduction, while both Brazilian propolis and diode lasers were equally effective compared to the 2% chlorhexidine control group [41]. A randomized controlled trial by Prabha-kar *et al.* and evidence from others has demonstrated that, after minimally invasive manual excavation, both aloe vera and propolis can be used as a potential cavity disinfectant [65-67].

EFFECT OF PROPOLIS AGAINST ENDODONTIC PATHOGENS

Endodontic infection is the infection of the dental canal system and the main etiological agent of apical periodontitis. Evidence clearly suggests that microorganisms are crucial for the advancement and continuation of various forms of apical periodontitis [68]. The rationale behind endodontic treatment is to eliminate the infection and prevent microorganisms from infecting or re-infecting the peri radicular tissue [69]. Ethanol-based propolis was tested as an endodontic disinfectant in comparison with conventional disinfectant (chlorhexidine and calcium hydroxide) against the gram-positive facultative anaerobe *Enterococcus faecalis* (*E. faecalis*) in vitro [70]. The results showed that the antimicrobial effect of propolis was found to be between chlorhexidine and calcium hydroxide. Chlorhexidine was the most effective endodontic antiseptic against *E. faecalis*. Propolis samples showed antimicrobial effects, but their efficacy did not exceed that of chlorhexidine. For propolis to be used as an endodontic irrigant, more human trials are needed to determine the cytotoxicity and tissue response of the material [70,71, 73]. Similarly, Ferreira *et al.* reported the effect of

propolis against various endodontic pathogens, reaching concluded that Brazilian Propolis was effective against all strains. *E. faecalis* was considered the least susceptible strain [74-76].

2.7. PROPOLIS AND DENTAL PULP INFLAMMATION

An in vitro and in vivo study showed that propolis has a strong anti-inflammatory effect and can be used as a pulp capping agent. Flavonoids and caffeic acid are the main ingredients in propolis, responsible for the anti-inflammatory response by inhibiting lipoxygenase and the arachidonic pathway [77,78]. In addition, flavonoids and caffeic acid provide acceleration of the immune system by enhancing phagocytic activity [8,72,79]. There are numerous studies over the years that have demonstrated the anti-inflammatory effects of propolis [56,60-63] Bachiega *et al* showed that cinnamic acid and coumaric acid in propolis inhibit IL-6 and IL-10 but encourage IL-8 production by macrophages.[78]

The anti-inflammatory effect of propolis depends on the potential dose and route of administration.

PROPOLIS AND DENTAL RESTORATIVE MATERIALS

Glass ionomer cement (GIC) is a fluoride-releasing material used for restorative purposes [79-81]. GIC is considered the only material of choice for atraumatic restorative treatment (ART). Favourable characteristics of this material may include biocompatibility, chemical bonding, constant fluoride release, inhibition of bacterial acid metabolism, and bactericidal potential [82].

Propolis, when added to GIC, has distinct antibacterial and anti-biofilm efficacy and may be used as a promising material in future

restorations [83]. In vitro propolis extracts were added to GIC to evaluate microhardness and microleakage. The results showed that GIC treated with propolis resulted in an increase in microhardness without changes or effects on microleakage [84]. Furthermore, when 1% ethanolic. Propolis extracts added to

GIC increased the fluoride release capacity of GIC without changing the shear bond strength [85]. Alternatively, a recent study by Subramaniam et al. suggests that the physicochemical properties of GIC tend to deteriorate when propolis is added [86-88].

CONCLUSIONS

1. It was observed that using Propolis-based products statistically significantly decreased the presence of gingival bleeding and bad breath. On organic causes such as toothache, it influenced an idea more than the classic products used in oral hygiene, but it was not statistically significant.
2. Propolis is ranked among the few natural remedies that have still maintained their popularity over time due to its wide range of applications in both dentistry and medicine. Its extensive and wide variety of properties such as anti-inflammatory, antibacterial, antiviral and anti-fungal have also kept the attention of many researchers.
3. Propolis is a natural biomaterial for oral health, which needs human clinical studies to obtain the best benefits from this natural

ingredient. There is a great need to outline algorithms for its use in dentistry and medical fields based on its biological properties.

4. Propolis and its phenolic and flavonoid constituents have many therapeutic uses in dentistry, oral health and medicine. Extensive therapeutic uses due to its antibacterial, antiviral, antifungal, anti-inflammatory and anticancer properties have been demonstrated in various in vitro, in vivo and ex vivo studies as well as in human clinical trials. However, there is a great need for standardization of the phenolic acid and flavonoid content of propolis to obtain the best therapies and medicines.

REFERENCES

- 1 Zafar M, Khurshid Z, Almas K. Oral tissue engineering progress and challenges. *Tissue Engineering and Regenerative Medicine* 2015;12:387-97. doi: 10.1007/s13770-015-0030-6.
- 2 Zafar MS, Al-Samadani KH. Potential use of natural silk for bio-dental applications. *Journal of Taibah University Medical Sciences* 2014;9:171-7. doi: 10.1016/j.jtumed.2014.01.003.
- 3 Husain S, Al-Samadani KH, Najeeb S, Zafar MS, Khurshid Z, Zohaib S, Qasim SB. Chitosan biomaterials for current and potential dental applications. *Materials* 2017;10:602. doi: 10.3390/ma10060602.
- 4 Qasim SB, Najeeb S, Delaine-Smith R, Rawlinson A, Reh-man IU. Potential of electrospun chitosan fibers as a surface layer in functionally graded GTR membrane for periodontal regeneration. *Dental Materials* 2017;33:71-83. doi: 10.1016/j.dental.2016.10.003.
- 5 Khurshid Z, Zafar MS, Zohaib S, Najeeb S, Naseem M. Green tea (camellia sinensis): Chemistry and oral health. *The Open Dentistry Journal* 2016;10:166-73. doi: 10.2174/1874210601610010166.
- 6 Niazi F, Naseem M, Khurshid Z, Zafar MS, Almas K. Role of salvadorapersica chewing stick (miswak): A natural toothbrush for holistic oral health. *European Journal of Dentistry* 2016;10:301-8. doi: 10.4103/1305-7456.178297.
- 7 Kalogeropoulos N, Konteles SJ, Troullidou E, Mourtzinis I, Karathanos VT. Chemical composition,

- antioxidant activity and antimicrobial properties of propolis extracts from greece and cyprus. *Food Chem*2009;116:452-61.
- 8 Inui S, Hatano A, Yoshino M, Hosoya T, Shimamura Y, Masuda S, Ahn MR, Tazawa S, Araki Y, Kumazawa S. Identification of the phenolic compounds contributing to an-tibacterial activity in ethanol extracts of brazilian red propo-lis. *Nat Prod Res* 2014;28:1293-6. doi: 10.1080/14786419.2014.898146.
 - 9 Kumar LS. Propolis in dentistry and oral cancer manage-ment. *North American journal of medical sciences* 2014;6:250-9. doi: 10.4103/1947-2714.134369.
 - 10 Kuo Y, Jim W, Su L, Chung C, Lin C, Huo C, Tseng J, Huang S, Lai C, Chen B. Caffeic acid phenethyl ester is a potential therapeutic agent for oral cancer. *International journal of molecular sciences* 2015;16:10748-66. doi: 10.3390/ijms160510748.
 - 11 Sokolonski AR, Fonseca MS, Machado BAS, Deegan KR, Araújo RPC, Umsza-Guez MA, Meyer R, Portela RW. Activity of antifungal drugs and Brazilian red and green propolis extracted with different methodologies against oral isolates of *Candida* spp. *BMC Complement Med Ther.* 2021 Nov 24;21(1):286. doi: 10.1186/s12906-021-03445-5. PMID: 34814913; PMCID: PMC8611924.
 - 12 Oliveira ACP, Shinobu CS, Longhini R, Franco SL, Svid-zinski TIE. Antifungal activity of propolis extract against yeasts isolated from onychomycosis lesions. *Memórias do Instituto Oswaldo Cruz* 2006;101:493-7. doi: 10.1590/S0074-02762006000500002.
 - 13 Dalben-Dota K, Faria MGI, Bruschi ML, Pelloso SM, Lopes-Consolaro M, Svidzinski TIE. Antifungal activity of propolis extract against yeasts isolated from vaginal ex-udates. *The Journal of Alternative and Complementary Medicine* 2010;16:285-90.
 - 14 Ota C, Unterkircher C, Fantinato V, Shimizu MT. Antifun-gal activity of propolis on different species of candida. *My-coses* 2001;44:375-8. doi: 10.1046/j.1439-0507.2001.00671.x.
 - 15 Schnitzler P, Neuner A, Nolkemper S, Zundel C, Nowack H, Sensch KH, Reichling J. Antiviral activity and mode of action of propolis extracts and selected compounds. *Phyto-therapy Research* 2010;24:S20-8.
 - 16 Sforcin JM, Bankova V. Propolis: Is there a potential for the development of new drugs? *J Ethnopharma-col*2011;133:253-60. doi: 10.1016/j.jep.2010.10.032.
 - 17 Gekker G, Hu S, Spivak M, Lokensgard JR, Peterson PK. Anti-HIV-1 activity of propolis in CD4+ lymphocyte and microglial cell cultures. *J Ethnopharmacol*2005;102:158-63. doi: 10.1016/j.jep.2005.05.045.
 - 18 Rivera-Yañez CR, Ruiz-Hurtado PA, Reyes-Realí J, Mendoza-Ramos MI, Vargas-Díaz ME, Hernández-Sánchez KM, Pozo-Molina G, Méndez-Catalá CF, García-Romo GS, Pedroza-González A, Méndez-Cruz AR, Nieto-Yañez O, Rivera-Yañez N. Antifungal Activity of Mexican Propolis on Clinical Isolates of *Candida* Species. *Molecules.* 2022 Sep 1;27(17):5651. doi: 10.3390/molecules27175651. PMID: 36080417; PMCID: PMC9457601.
 - 19 Yang J, Pi A, Yan L, Li J, Nan S, Zhang J, Hao Y. Research Progress on Therapeutic Effect and Mechanism of Propolis on Wound Healing. *Evid Based Complement Alternat Med.* 2022 Jul 21;2022:5798941. doi: 10.1155/2022/5798941. PMID: 35911156; PMCID: PMC9334088.
 - 20 Ripari N, Sartori AA, da Silva Honorio M, Conte FL, Tasca KI, Santiago KB, Sforcin JM. Propolis antiviral and immunomodulatory activity: a review and perspectives for COVID-19 treatment. *J Pharm Pharmacol.* 2021 Mar 6;73(3):281-299. doi: 10.1093/jpp/rgaa067. PMID: 33793885; PMCID: PMC7928728.
 - 21 Kalogeropoulos N, Konteles SJ, Troullidou E, Mourtzinis I, Karathanos VT. Chemical composition, antioxidant activity and antimicrobial properties of propolis extracts from greece and cyprus. *Food Chem*2009;116:452-61.
 - 22 Deswal H, Singh Y, Grover HS, Bhardwaj A. Healing effect of propolis in medicine and dentistry: A review. *Innovare Journal of Ayurvedic Sciences* 2016;1-4.
 - 23 Rathod S, Brahmkar R, Kolte A. Propolis-A natural re-medy. *Indian J Dent Res Rev* 2012;50:99-103.
 - 24 Toreti VC, Sato HH, Pastore GM, Park YK. Recent progress of propolis for its biological and chemical compo-sitions and its botanical origin. *Evidence-Based Comple-mentary and Alternative Medicine* 2013;2013:1-13. doi: 10.1155/2013/697390.

- 25 Santos LM, Fonseca MS, Sokolonski AR, Deegan KR, Araújo RP, Umsza-Guez MA, Barbosa JD, Portela RD, Machado BA. Propolis: types, composition, biological activities, and veterinary product patent prospecting. *J Sci Food Agric*. 2020 Mar 15;100(4):1369-1382. doi: 10.1002/jsfa.10024. Epub 2019 Dec 14. PMID: 31487405.
- 26 Huang S, Zhang C, Wang K, Li GQ, Hu F. Recent advances in the chemical composition of propolis. *Molecules* 2014;19:19610-32. doi: 10.3390/molecules191219610.
- 27 Bankova V. Recent trends and important developments in propolis research. *Evidence-based complementary and alternative medicine* 2005;2:29-32.
- 28 Kujumgiev A, Tsvetkova I, Serkedjieva Y, Bankova V, Christov R, Popov S. Antibacterial, antifungal and antiviral activity of propolis of different geographic origin. *J Ethno-pharmacol* 1999;64:235-40. doi: 10.1016/S0378-8741(98)00131-7.
- 29 Popova M, Bankova V, Naydensky C, Tsvetkova I, Kujum-giev A. Comparative study of the biological activity of propolis from different geographic origin: A statistical ap-proach. *Macedonian Pharmaceutical Bulletin* 2004;50:9-14.
- 30 Sforcin JM, Fernandes A, Lopes C, Bankova V, Funari S. Seasonal effect on brazilian propolis antibacterial activity. *J Ethnopharmacol* 2000;73:243-9.
- 31 Lotfy M. Biological activity of bee propolis in health and disease. *Asian Pac J Cancer Prev* 2006;7:22-31.
- 32 Alghutaimel H, Matoug-Elwerfelli M, Alhaji M, Albawardi F, Nagendrababu V, Dummer PMH. Propolis Use in Dentistry: A Narrative Review of Its Preventive and Therapeutic Applications. *Int Dent J*. 2024 Jun;74(3):365-386. doi: 10.1016/j.identj.2024.01.018. Epub 2024 Feb 19. PMID: 38378400; PMCID: PMC11123522.
- 33 Akca AE, Akca G, Topçu FT, Macit E, Pıkdöken L, Özgen Ş. The comparative evaluation of the antimicrobial effect of propolis with chlorhexidine against oral pathogens: An in vitro study. *BioMed research international* 2016;2016:1-8. doi: 10.1155/2016/3627463.
- 34 Halboub E, Al-Maweri SA, Al-Wesabi M, Al-Kamel A, Shamala A, Al-Sharani A, Koppolu P. Efficacy of propolis-based mouthwashes on dental plaque and gingival inflammation: a systematic review. *BMC Oral Health*. 2020 Jul 10;20(1):198. doi: 10.1186/s12903-020-01185-5. PMID: 32650754; PMCID: PMC7350560.
- 35 Prasad KR, John S, Deepika V, Dwijendra KS, Reddy BR, Chincholi S. Anti-plaque efficacy of herbal and 0.2% chlor-hexidine gluconate mouthwash: A comparative study. *Jour-nal of international oral health: JIOH* 2015;7:98.
- 36 Radzki D, Wilhelm-Węglarz M, Pruska K, Kusiak A, Ordyniec-Kwaśnica I. A Fresh Look at Mouthwashes-What Is Inside and What Is It For? *Int J Environ Res Public Health*. 2022 Mar 25;19(7):3926. doi: 10.3390/ijerph19073926. PMID: 35409608; PMCID: PMC8997378
- 37 Alghutaimel H, Matoug-Elwerfelli M, Alhaji M, Albawardi F, Nagendrababu V, Dummer PMH. Propolis Use in Dentistry: A Narrative Review of Its Preventive and Therapeutic Applications. *Int Dent J*. 2024 Jun;74(3):365-386. doi: 10.1016/j.identj.2024.01.018. Epub 2024 Feb 19. PMID: 38378400; PMCID: PMC11123522.
- 38 Kiani S, Birang R, Jamshidian N. Effect of Propolis mouthwash on clinical periodontal parameters in patients with gingivitis: A double-blinded randomized clinical trial. *Int J Dent Hyg*. 2022 May;20(2):434-440. doi: 10.1111/idh.12550. Epub 2021 Nov 14. PMID: 34431213.
- 39 Ozan F, Sümer Z, Polat Z, Er K, Ozan U, Deger O. Effect of mouthrinse containing propolis on oral microorganisms and human gingival fibroblasts. *Eur J Dent* 2007;1:195-201.
- 40 Arslan S, Silici S, Percin D, Ko AN, Er Ö. Antimicrobial activity of poplar propolis on mutans streptococci and caries development in rats. *Turkish Journal of Biology* 2012;36:65-73. doi: 10.3906/biy-1101-180.
- 41 Saeed MA, Khabeer A, Faridi MA, Makhdoom G. Effectiveness of propolis in maintaining oral health: a scoping review. *Can J Dent Hyg*. 2021 Oct 1;55(3):167-176. PMID: 34925517; PMCID: PMC8641552.
- 42 Morawiec T, Dziedzic A, Niedzielska I, Mertas A, Tana-siewicz M, Skaba D, Kasperski J, Machorowska-Pieniążek A, Kucharzewski M, Szaniawska K. The bio-logical activity of propolis-containing toothpaste on oral health environment in patients who underwent implant-supported

- prosthodontic rehabilitation. Evidence-based complementary and alternative medicine 2013;2013:1-12. doi: 10.1155/2013/704947.
- 43 Niaz MO, Naseem M, Siddiqui SN, Khurshid Z. An outline of the oral health challenges in “Pakistani” population and a discussion of approaches to these challenges. JPDA 2013;21:219-26.
- 44 Gooch BF, Griffin SO, Gray SK, Kohn WG, Rozier RG, Siegal M, Fontana M, Brunson D, Carter N, Curtis DK. Preventing dental caries through school-based sealant pro-grams: Updated recommendations and reviews of evidence. J Am Dent Assoc2009;140:1356-65. doi: 10.14219/jada.archive.2009.0070.
- 45 Hayacibara MF, Koo H, Rosalen PL, Duarte S, Franco EM, Bowen WH, Ikegaki M, Cury JA. In vitro and in vivo ef-fects of isolated fractions of brazilian propolis on caries de-velopment. J Ethnopharmacol2005;101:110-5. doi: 10.1016/j.jep.2005.04.001.
- 46 Stähli A, Schröter H, Bullitta S, Serralutzu F, Dore A, Nietzsche S, Milia E, Sculean A, Eick S. In Vitro Activity of Propolis on Oral Microorganisms and Biofilms. Antibiotics (Basel). 2021 Aug 26;10(9):1045. doi: 10.3390/antibiotics10091045. PMID: 34572627; PMCID: PMC8472590.
- 47 Ophori EA, Eriagbonye BN, Ugbo-daga P. Antimicrobial activity of propolis against streptococcus mutans. African Journal of Biotechnology 2010;9:4966-9.
- 48 Cardoso JG, Iorio NLP, Rodrigues LF, Couri MLB, Farah A, Maia LC, Antonio AG. Influence of a brazilian wild green propolis on the enamel mineral loss and streptococcus mutans,Ä count in dental biofilm. Arch Oral Bi-ol2016;65:77-81. doi: 10.1016/j.archoralbio.2016.02.001.
- 49 Tanasiewicz M, Skucha-Nowak M, Dawiec M, Król W, Skaba D, Twardawa H. Influence of hygienic preparations with a 3% content of ethanol extract of brazilian propolis on the state of the oral cavity. Advances in Clinical and Expe-rimental Medicine 2012;21:81-92.
- 50 Yuan J, Yuan W, Guo Y, Wu Q, Wang F, Xuan H. Anti-Biofilm Activities of Chinese Poplar Propolis Essential Oil against Streptococcus mutans. Nutrients. 2022 Aug 11;14(16):3290. doi: 10.3390/nu14163290. PMID: 36014799; PMCID: PMC9412247.
- 51 Libério S,A., Pereira A, A., Araújo MJ,A.M., Dutra RP, Nascimento FRF, Monteiro-Neto V, Ribeiro MNS, Gonçalves A,G., Guerra RNM. The potential use of propolis as a cariostatic agent and its actions on mutans group strep-tococci. J Ethnopharmacol2009;125:1-9. doi: 10.1016/j.jep.2009.04.047.
- 52 Nam S, Choi Y, Jang S, Shim Y, Han G. Antimicrobial ac-tivity of propolis on different oral bacteria. Indian Journal of Science and Technology 2016;9:1-4. doi: 10.17485/ijst/2016/v9i15/89174.
- 53 Choi Y, Nam S, Jiang HB, Jang S, and Shim Y. Antimi-crobial activity of propolis on different oral bacteria. Inter-national Conference on Convergence Technology 2015; 5: 1040-1041.
- 54 Seth TA, Kale TA, Lendhey SS, Bhalerao PV. Comparative evaluation of subgingival irrigation with propolis extract versus chlorhexidine as an adjunct to scaling and root planing for the treatment of chronic periodontitis: A randomized controlled trial. J Indian Soc Periodontol. 2022 Mar-Apr;26(2):151-156. doi: 10.4103/jisp.jisp_613_20. Epub 2022 Mar 1. PMID: 35321296; PMCID: PMC8936014.
- 55 Parolia A, Thomas MS, Kundabala M, Mohan M. Propolis and its potential uses in oral health. International Journal of Medicine and Medical Science 2010;2:210-5.
- 56 Wifôckiewicz W, Miernik M, Wifôckiewicz M, Morawiec T. Does propolis help to maintain oral health? Evidence-Based Complementary and Alternative Medicine 2013;2013:1-8. doi: 10.1155/2013/351062.
- 57 Silveira, G.R.C.; Ganzaroli, V.F.; Toro, L.F.; da Costa, L.L.; Pereira, R.I.L.; da Silva, A.B.; Ferreira, I.R.S.; de Mello-Neto, J.M.; Garcia, V.G.; Theodoro, L.H.; et al. Brazilian Green Propolis Carried in Lipid-Based Nanostructures: A Potent Adjuvant Therapy to Non-Surgical Periodontal Treatment in the Management of Experimental Periodontitis. Biomedicines 2025, 13, 1643. <https://doi.org/10.3390/biomedicines13071643>
- 58 Seth, Tejashvi Ashok; Kale, Triveni Ashok; Lendhey, Shruti Shankarrao; Bhalerao, Pallavi Vilas. Comparative evaluation of subgingival irrigation with propolis extract versus chlorhexidine as an adjunct to scaling and root planing for the treatment of chronic periodontitis: A randomized controlled trial. Journal of Indian Society of Periodontology 26(2):p 151-156, Mar–Apr 2022. | DOI: 10.4103/jisp.jisp_613_20
- 59 Kripal K, Chandrasekaran K, Chandrasekaran S, Kumar VR, Chavan SKD, Dileep A. Treatment of

- dentinal hypersensitivity using propolis varnish: a scanning electron microscope study. *Indian J Dent Res.* 2019;30(2):249–253.
- 60 Lin P, Cheng Y, Chu C, Chien K, Lin C, Tu Y. In-office treatment for dentin hypersensitivity: A systematic review and network meta-analysis. *J ClinPeriodontol*2013;40:53-64. doi: 10.1111/jcpe.12011.
- 61 Hussain RA, Dannan A, Al-Ahmad M. Propolis treatment for dental sensitivity after tooth bleaching. *Imperial Journal of Interdisciplinary Research* 2017;2:1436-9.
- 62 Hongal S, Torwane NA, Goel P, Chandrashekar B. The effect of 30% ethanolic extract of indian propolis on replica of human dentin compared against commercially available de-sensitizing agent: A methodological SEM study in vitro. *Pharmacognosy research* 2014;6:113-9. doi: 10.4103/0974-8490.129026.
- 63 Purra AR, Mushtaq M, Acharya SR, Saraswati V. A comparative evaluation of propolis and 5.0% potassium nitrate as a dentine desensitizer: A clinical study. *Journal of Indian Society of Periodontology* 2014;18:466-71. doi: 10.4103/0972-124X.138695.
- 64 Niculescu O, Nica P, Badarau G, et al. Experimental investigations of polymer plasma laser ablation. *Mater Plast.* 2009;46(3):336-338.
- 65 Matochek MHM, Tomaz PLS, Oliveira TS, Polassi MR, Alonso RCB, Scremin FM, Sauro S, Marcucci MC, D'Alpino PHP. Influence of a propolis-based irrigant solution on gap formation and bond strength of posts bonded to root canal dentin using different resin cements. *Dent Mater J.* 2020 Jun 5;39(3):490-499. doi: 10.4012/dmj.2019-111. Epub 2020 Feb 29. PMID: 32115490.
- Prabhakar AR, Karuna YM, Yavagal C, Deepak BM. Cavity disinfection in minimally invasive dentistry-comparative evaluation of aloe vera and propolis: A randomized clinical trial. *Contemporary clinical dentistry* 2015;6:S24-31. doi: 10.4103/0976-237X.152933.
- 66 Mangaiyarkarasi SP, Manigandan T, Elumalai M, Cholan PK, Kaur RP. Benefits of aloe vera in dentistry. *Journal of pharmacy & bioallied sciences* 2015;7:S255-9. doi: 10.4103/0975-7406.155943.
- 67 Sardana D, InduShekar KR, Manchanda S, Saraf BG, Sheoran N. Role of propolis in dentistry: Review of the literature. *Focus on Alternative and Complementary Therapies* 2013;18:118-25. doi: 10.1111/fct.12034.
- 68 Narayanan LL, Vaishnavi C. Endodontic microbiology. *Journal of Conservative Dentistry* 2010;13:233.
- 69 Almadi KH, Ahmed MA, Ghazal T, Jouhar R, Alkahtany MF, Abduljabbar T, Vohra F. Antimicrobial efficacy of propolis in comparison to chlorhexidine against *Enterococcus faecalis*: A systematic review and meta-analysis. *Appl Sci.* 2021;11(8):3469. doi:10.3390/app11083469.
- 70 Kayaoglu G, Ömürlü H, Akca G, Mügem, Gürel Ö, Sorkun K, Salih B. Antibacterial activity of propolis versus conventional endodontic disinfectants against *enterococcus faecalis* in infected dentinal tubules. *J Endod*2011;37:376-81. doi: 10.1016/j.joen.2010.11.024.
- 71 Mattigatti S, Ratnakar P, Moturi S, Varma S, Rairam S. Antimicrobial effect of conventional root canal medicaments vs propolis against *enterococcus faecalis*, *staphylococcus aureus* and *candida albicans*. *J Contemp Dent Pract*2012;13:305-9.
- 72 de AF, Torres SA, da SR, Ferreira CM, Garcia RB, Marcucci MC, Gomes BPFA. Antimicrobial effect of propolis and other substances against selected endodontic pathogens. *Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology, and Endodontology*2007;104:709-16. doi: 10.1016/j.tripleo.2007.05.019.
- 73 Sabir A. The healing actions of propolis on direct pulp capping treatment: A review. *Journal of Dentomaxillofacial Science* 2016;1:186. doi: 10.15562/jdmfs.v1i1.145.
- 74 Popescu V, Vasluianu E, Bercu E, et al. Comparative study of the FTIR analysis and the performances of N,N,N-trimethyl chitosan as wrinkle-proofing agent. *Rev Chim (Bucharest).* 2013;64(11):1284-1294.
- 75 Ramos A, Miranda J. Propolis: A review of its anti-inflammatory and healing actions. *Journal of Venomous Animals and Toxins Including Tropical Diseases* 2007;13:697-710. doi: 10.1590/S1678-91992007000400002.
- 76 Inflamed Rat Dental Pulp Tissue Following Propolis Application (An Immunohistochemistry Study). The 3rd ASEAN Plus And Tokushima Joint International Conference, Program And Proceeding

- Book. 2014.
- 77 Costan A, Dima A, Agop M, et al. Thermal properties of a Ti-6Al-4V alloy used as dental implant material. *Optoelectron Adv Mater Rapid Commun*. 2011;5(1-2):92-95.
- 78 Ardo Sabir D. Using propolis as A therapeutic agent in den-tistry. *Cakradonya Dental Journal* 2012;4:480-6.
- 79 Sabir A. The healing actions of propolis on direct pulp cap-ping treatment: A review. *Journal of Dentomaxillofacial Science* 2016;1:186. doi: 10.15562/jdmfs.v1i1.145.
- 80 Bachiega TF, Orsatti CL, Pagliarone AC, Sforcin JM. The effects of propolis and its isolated compounds on cytokine production by murine macrophages. *Phytotherapy Res* 2012;26:1308-13.
- 81 Zafar MS, Ahmed N. Therapeutic roles of fluoride released from restorative dental materials. *Fluoride* 2015;48:184-94. doi:http://www.fluorideresearch.org/483/files/FJ2015_v48_n3_p184-194_pq.pdf.
- 82 Zafar MS. Effects of surface pre-reacted glass particles on fluoride release of dental restorative materials. *World Ap-plied Sciences Journal* 2013;28:457-62. doi: 10.5829/idosi.wasj.2013.28.04.1869.
- 83 Najeeb S, Khurshid Z, Zafar MS, Khan AS, Zohaib S, Martí JMN, Sauro S, Matinlinna JP, Rehman IU. Modifications in glass ionomer cements: Nano-sized fillers and bioactive na-noceramics. *International Journal of Molecular Sciences* 2016;17:1134. doi: 10.3390/ijms17071134.
- 84 Altunsoy M, Tanriver M, Türkan U, Uslu ME, Silici S. In vitro evaluation of microleakage and microhardness of ethanolic extracts of propolis in different proportions added to glass ionomer cement. *J ClinPediatr Dent* 2016;40:136-40. doi: 10.17796/1053-4628-40.2.136.
- 85 Topcuoglu N, Ozan F, Ozyurt M, Kulekci G. In vitro anti-bacterial effects of glass-ionomer cement containing etha-nolic extract of propolis on streptococcus mutans. *Eur J Dent* 2012;6:428-33.
- 86 Prabhakar AR, Balehosur DV, Basappa N. Comparative evaluation of shear bond strength and fluoride release of conventional glass ionomer with 1% ethanolic extract of propolis incorporated glass ionomer cement-in vitro study. 2016;10:ZC88-91. doi: 10.7860/JCDR/2016/17056.7818.
- 87 Solomon S, Ursarescu I, Forna NC, et al. Photo-activated Toluidine Blue O as adjunctive periodontal treatment. *Rev Chim (Bucharest)*. 2015;66(8):1166-1168.
- 88 Subramaniam P, Girish Babu K, Neeraja G, Pillai S. Does addition of propolis to glass ionomer cement alter its physi-comechanical properties? an in vitro study. *J ClinPediatr Dent* 2016;40:400-3. doi: 10.17796/1053-4628-40.5.400.