PROPOLIS IN ORAL HEALTH: THERAPEUTIC APPLICATIONS AND CLINICAL BENEFITS

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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

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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, pinobaskin, 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., artepillin C), while propolis found in Pacific and African regions contains geranyl flavanones as characteristic compounds (Fig.1.) [27,31].

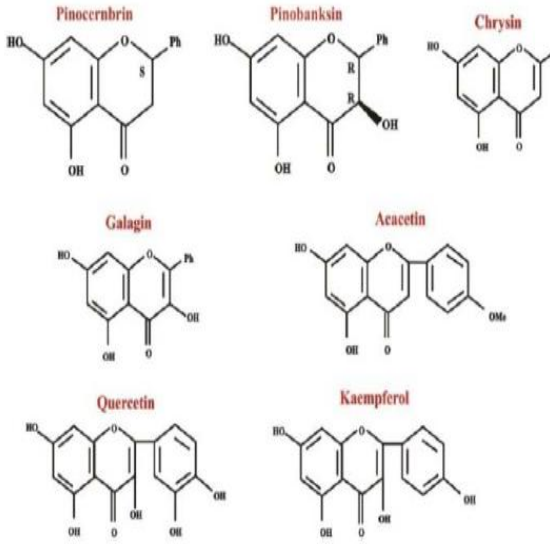

Figure 1. Nomenclature and chemical structures of the various constituents of propolis.

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.

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MATHERIALS 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 $p< 0.05$

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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 ± SD	32.6 ± 12.5	31.8 ± 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 Level	Secondary school	6 (28.57 %)	7 (33.33 %)
	High school	9 (42.85 %)	8 (38.09 %)
	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 ($p<0.05$)

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Gingivitis	**Lot I (Test)**	**9.7222**	**0.001821**	**Yes**
	Lot II (Control)	**1.0027**	**0.316670**	**No**
Difficulty in Mastication	**Lot I**	**0.1414**	**0.706879**	**No**
	Lot II	**0.1232**	**0.725625**	**No**
Dental Pain	**Lot I**	**0.4667**	**0.494525**	**No**
	Lot II	**0.4286**	**0.512691**	**No**
Gingival Bleeding	**Lot I**	**11.9576**	**0.000544**	**Yes**
	Lot II	**0.4667**	**0.494525**	**No**
Halitosis (Bad Breath)	**Lot I**	**6.0352**	**0.014023**	**Yes**
	Lot II	**0.5250**	**0.468717**	**No**
Unexplained Oral Cavity Pain	**Lot I**	**0.4667**	**0.494525**	**No**
	Lot II	**3.0792**	**0.079301**	**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

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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 Steptococcus 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 neucleatum, 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%

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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 reinfecting the peri radicular tissue [69]. Ethanol-based propolis was tested as an endodontic disinfectant in comparison with conventional disinfectant (chlorohexidine 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. Chlorohexidine 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 irrigate, 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

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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.

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