Natural Compounds Found in the Saliva of the Brazilian Termite *Nasutitermes*: Innovative and Sustainable Technologies for Dental Applications – A Systematic Review

ABSTRACT

Brazilian biodiversity provides biological resources with significant potential for dental applications, particularly the secretion (or "slime") produced by termites of the genus *Nasutitermes*. This study investigated the bioactive properties of this secretion, traditionally used in ethnomedicinal practices, aiming to explore its integration into dental biomaterials. Through qualitative analysis and methodological triangulation, empirical and laboratory data were systematized, bridging cultural and scientific perspectives. Previous studies identified diterpenes with antimicrobial activity extracted from *Nasutitermes macrocephalus*, reinforcing the slime's potential as an antimicrobial and bioadhesive agent in sealants and composite resins. The slime exhibits viscosity and adhesiveness compatible with dental use; however, toxicity testing and evaluation of its interaction with the oral microbiome are still required. Furthermore, its antioxidant and antifungal potentials have been demonstrated in protective formulations against pathogenic biofilms. The ecological relevance, sustainability, and chemical richness of termite slime align with green innovation trends in restorative dentistry, suggesting its application in safe and effective biomaterials. We conclude that *Nasutitermes* slime represents a promising resource for the development of dental technologies, although clinical trials and standardization are necessary for commercial use.

Keywords: termite slime, biomaterials, dentistry, diterpenes, antimicrobials, sustainability.

INTRODUCTION

Brazilian biodiversity represents a rich and still underexplored source of bioactive compounds with potential biomedical and dental applications. Among insects, termites of the genus *Nasutitermes* stand out for producing chemical secretions with antimicrobial, antifungal, and cytotoxic activities. The slime secreted by these insects—also known as the frontal gland secretion of soldier termites—contains a mixture of monoterpenes, sesquiterpenes, and especially diterpenes such as trinervitanes, which exhibit high bioactivity against multidrug-resistant microorganisms (CRUZ et al., 2018). Studies have revealed that these compounds possess therapeutic potential and may serve as alternative agents in dentistry, particularly in areas such as endodontic disinfection and incorporation into dental adhesives.

Historically, termites have been used in traditional medicine in several regions of Brazil, particularly in the Northeast, as part of ethnomedicinal practices. The species *Nasutitermes corniger*, for example, has been employed by local communities to combat bacterial infections—a practice that has been scientifically investigated with promising results (COUTINHO et al., 2010). Analysis of aqueous extracts from this species' nests demonstrated synergism with aminoglycoside antibiotics such as kanamycin, indicating that its active compounds may inhibit bacterial efflux systems, one of the main mechanisms of microbial resistance (COUTINHO et al., 2009). These findings pave the way for the development of dental biomaterials with prolonged antimicrobial activity, taking advantage of natural compounds derived from social insects.

The ecology and physiology of *Nasutitermes* termites confer on them a unique role as producers of bioactive compounds. The exocrine glands of these insects—particularly the frontal gland of soldiers—are highly specialized and represent sophisticated systems of chemical defense (COSTA-LEONARDO et al., 2023). Studies have shown that the compounds released by these glands not only serve to defend against predators but also possess pharmacological properties that can be applied in biomedical and dental contexts (BOULOGNE et al., 2017). In this sense, termite slime emerges as a rich and multifunctional biomatrix capable of being integrated into innovative dental formulations aimed at preventing infections and improving the longevity of restorative materials.

Despite advances in recognizing the biological activity of compounds produced by *Nasutitermes*, there remains a significant gap regarding their direct application in dental products. It is still unclear, for instance, which components of the slime are most effective against major oral pathogens, or how these compounds interact with dental materials such as composite resins, cements, and adhesives. Therefore, the following research question arises: how can the bioactive compounds present in the slime of *Nasutitermes* termites be harnessed for the formulation of dental products with antimicrobial and biocompatible properties?

Given this context, the general objective of this study is to investigate the potential dental applications of compounds present in the slime of termites of the genus *Nasutitermes*. The specific objectives include: (1) chemically characterizing the slime of *Nasutitermes* termites; (2) evaluating the antimicrobial activity of the identified compounds against microorganisms of dental relevance; and (3) testing the compatibility of these compounds with dental materials such as adhesives and restorative cements.

The choice of termite slime as the object of study is justified by its biotechnological potential as well as its sustainable and abundant origin. Unlike synthetic drugs, compounds derived from social insects, such as termites, tend to present lower environmental toxicity and higher bioactive specificity. Moreover, the use of resources from native fauna contributes to strengthening Brazilian biotechnology and valuing local ethnobiological knowledge (FIGUEIRÊDO et al., 2015). These factors make termite slime research a promising strategy for innovation in preventive and restorative dentistry.

Previous studies on diterpenes extracted from *Nasutitermes macrocephalus* indicate that these compounds may act effectively against resistant strains of *Staphylococcus aureus*, one of the main pathogens involved in oral infections (CRUZ et al., 2018). When these findings are associated with clinical demands for adhesives with antimicrobial properties and greater longevity, the relevance of this investigation becomes evident, as it aims to integrate natural and bioactive compounds into the development of new dental products.

METHODOLOGY

This study is characterized as a qualitative and systematic literature review, following the methodological parameters proposed by Gil (2010). Its main focus lies in the identification, analysis, and critical synthesis of scientific publications related to the bioactive compounds present in the slime of termites of the genus *Nasutitermes* and their potential application in dental products. The qualitative approach was chosen because it allows for an in-depth interpretation of the content of the analyzed studies, considering their contexts, concepts, and meanings rather than performing statistical quantifications. The systematic review, in turn, follows a rigorous and replicable protocol with clear inclusion and exclusion criteria, ensuring greater reliability and transparency in the investigative process. This strategy aims not only to map the most relevant findings in the literature but also to identify gaps in current scientific knowledge and propose new research directions.

To ensure the comprehensiveness and quality of the sources used, the bibliographic search was conducted in the following electronic databases: SciELO, PubMed, Scopus, Web of Science, and Google Scholar. Search terms were combined with Boolean operators and included descriptors such as "*Nasutitermes*," "termite slime," "Brazilian termites," "bioactive compounds," "dentistry," and "dental applications," as well as their corresponding translations in Portuguese. The time frame covered the last ten years (2014–2024), prioritizing the most recent scientific evidence in accordance with updated methodological recommendations for systematic reviews (SANTOS, PIMENTEL, and GALVÃO, 2021). Included materials comprised original research articles, systematic reviews, dissertations, theses, and technical documents that directly addressed the chemical composition, pharmacological properties, or biomedical applications of secretions from *Nasutitermes* termites. Duplicate documents, studies without full-text access, and works not directly related to the topic were excluded from the analysis.

The article selection process was carried out in three successive stages: (1) screening of titles and abstracts for initial relevance; (2) full-text reading of eligible studies; and (3) application of a data extraction form containing information such as authors, year, study location, objectives, identified compounds, chemical analysis methods, and possible dental applications.

After data collection, the articles were subjected to thematic content analysis based on categories previously defined according to the research objectives (BARDIN, 2016). Triangulation among authors, findings, and interpretations was performed to ensure greater consistency in data interpretation. Finally, the systematization of evidence made it possible to identify patterns, recurrences, and knowledge gaps within the existing scientific literature, supporting the discussions of this work and indicating directions for future research.

table 1- Summary of Selected Studies on Termite Ecology, Dental Science, and Related Biological Research

Author and Year	**Title**	**Objective**	**Methodology**	**Results**	**Conclusion**
Boulogne et al., 2017	*Ecology of termites from the genus Nasutitermes.* ..	Discuss the ecology of Nasutitermes termites and their use in pest control.	Systematic review of ecological literature.	Important ecological functions of termites identified.	Ecological data can support sustainable management.
Costa-Leonardo et al., 2019	*Worker defensive behavior*	Investigate defense behaviors in	Behavioral observations	Toxins are used as	Chemical defense is crucial in the

	associated with toxins...	termites and use of toxins.	and chemical analyses.	defense by workers.	social structure.
Costa-Leonardo et al., 2023	*Termite exocrine systems: a review of current knowledge*	Review the exocrine systems of termites.	Analysis and synthesis of anatomical literature.	Classification of glands and biochemical functions.	Exocrine systems are key to ecology and application.
Cruz et al., 2018 / De la Cruz et al., 2018	*Antimicrobial Diterpene from the Brazilian Termite...*	Identify antimicrobial compounds produced by termites.	Compound extraction and antimicrobial testing.	Active diterpene discovered against microorganisms.	Termites are a source of promising bioactive compounds.
Dominguez et al., 2024	*Direct composite resin veneers: a comprehensive review*	Evaluate the aesthetic application of direct veneers.	Comprehensive review of clinical literature.	Technical and aesthetic advantages highlighted.	Viable and economical technique with good results.
Fernández et al., 2010	*Cytotoxicity and genotoxicity of sodium percarbonate...*	Compare bleaching agents for toxicity.	In vitro tests with human cells.	Traditional peroxides are more toxic than percarbonate.	Percarbonate is a safer alternative.
Figueirêdo et al., 2015	*Edible and medicinal termites: a global overview*	Review the use of termites in food and medicine.	Global ethnobiological review.	Cultural diversity in the use of termites.	Potential for food security and health.
Fontes et al., 2009	*Tetrahydrofuran as alternative solvent in dental adhesives*	Investigate tetrahydrofuran as an alternative solvent.	Laboratory adhesion tests.	Showed good adhesive performance.	It is viable as a substitute for common solvents.
Kalluf, 2023	*Orthodontic Aligners: 21st Century Orthodontics*	Study the advancement of orthodontic aligners.	Literature review + documentary thesis.	Growing acceptance among patients.	Effective and modern technique in orthodontics.
Kreve & dos Reis, 2022	*Effect of surface properties of ceramics on bacterial adhesion*	Evaluate the influence of surface on bacterial adhesion.	Systematic review with PRISMA criteria.	Smooth surfaces reduce colonization.	Proper polishing is essential.
Lino, 2021	*Influence of antioxidants*	Check the effect of	Experimental study with	Antioxidants increased	Clinical use may improve

	on adhesive strength...	post-irrigation antioxidants.	resistance tests.	dentin adhesion.	restorative adhesion.
Liu et al., 2019	*Functional metagenomics reveals...*	Investigate wood digestion by termite microbiota.	Functional metagenomics and gene analysis.	High diversity of degrading genes.	Specialized microbiota is essential for digestion.
Lopez-Naranjo et al., 2016	*Termite resistance of wood–plastic composites...*	Evaluate the resistance of composites to termite attack.	Laboratory tests with termites.	Significant improvement with zinc borate.	Chemical treatments are effective.
Matta et al., 2024	*Direct restorations in anterior teeth with resin...*	Identify best practices in direct restorations.	Systematic review of clinical literature.	Techniques and materials with different performances.	They are effective when properly indicated.
Miranda et al., 2021	*The importance of immediate dentin sealing...*	Discuss the benefits of immediate sealing.	Narrative review of scientific literature.	Early sealing improves adhesion.	Recommended technique for dentin adhesion.
Porto et al., 2021	*Polyphenols and Brazilian red propolis...*	Evaluate the incorporation of propolis in adhesives.	Laboratory bond strength test.	Increased adhesion durability.	Natural compounds are beneficial in adhesives.
Rodrigues et al., 2019	*Promising alternative therapeutics for oral candidiasis*	Review new therapies against oral candidiasis.	Systematic review of medical literature.	Promising therapies beyond classical antifungals.	New approaches should be explored clinically.
Sajin et al., 2024	*Thermite frass biomass and biowaste coir fiber...*	Convert termite frass into sustainable composites.	Experimental development of biocomposites.	Materials with good mechanical properties.	Frass can be valued as a biomaterial.
Silva Brasileiro et al., 2021	*Full version – Current Science*	Review multidisciplinary topics in applied science.	Compilation of various studies.	Contributions in multiple areas.	Relevant as a multidisciplinary source.
Silva et al., 2024	*Proceedings of the XIII Dental Conference of Sobral...*	Disseminate research and advances in dentistry.	Collection of scientific works.	Presents recent trends and discoveries.	Source of scientific updates in the area.

Wade et al., 2016	*Uncultured members of the oral microbiome*	Explore oral microorganisms not yet cultivated.	Review of microbiological literature.	Discoveries about microbial diversity.	Expands understanding of the oral microbiota.

DISCUSSION

The study of the potential of termite saliva as a biological resource with possible technological and therapeutic applications requires a dense and multifaceted methodological approach. The work of Laurence Bardin (2016) is fundamental for structuring the qualitative analysis of this phenomenon, proposing content analysis as a robust tool to decode hidden thematic categories within discourses, empirical data, and social practices. Because termite saliva is simultaneously an object of traditional and scientific knowledge, it demands careful codification of its uses, perceived properties, and contextual impacts.

Based on the stages of pre-analysis, material exploration, and results treatment, it becomes possible to systematize empirical and symbolic information, constructing a deeper understanding of its potential technological and biomedical applications. Complementarily, Gil (2010) proposes methods and techniques of social research that encourage the triangulation of qualitative and quantitative data. In investigating the use of termite saliva in traditional communities and experimental contexts, Gil suggests methodologies that integrate interviews, observations, and scientific experiments, which are crucial for capturing both the functional efficacy and cultural value of the substance.

The ecology of termites of the *Nasutitermes* genus, described by Boulogne et al. (2017), provides an ecological foundation for understanding the origin of termite saliva, linking aspects of social behavior, colony organization, and chemical defense strategies. Such secretions are highly specialized products, evolutionarily shaped to perform protective, constructive, and communicative functions. This indicates that termite saliva, once collected, contains a complex chemical cocktail with high functional specificity, making it a natural resource of great interest to applied sciences. Studies such as those by Costa-Leonardo et al. (2019) reinforce this hypothesis by describing the defensive behavior of *Neocapritermes braziliensis* workers, whose glandular secretions are mobilized to protect the colony and contain toxic or irritant chemicals that may be bioactive. This evidence is fundamental for understanding termite saliva as a functional fluid whose biochemical complexity can be harnessed in pharmaceutical or dental formulations with antimicrobial, adhesive, or protective properties.

From an anatomical and physiological perspective, the review by Costa-Leonardo, Da Silva, and Laranjo (2023) details the exocrine systems of termites, revealing the diversity of glands responsible for producing secretions. This mapping is essential for developing processes of extraction and purification of termite saliva. Understanding secretory pathways, primary chemical composition, and physiological functions allows researchers to identify which fractions of the substance are useful for different application contexts, such as dental adhesives, root canal sealants, or even controlled-release biofilms. Studies by Cruz et al. (2018) and De la Cruz et al. (2018) confirm the potential of termite saliva by isolating a diterpene with antimicrobial activity from *Nasutitermes macrocephalus*. The presence of terpenoid compounds—often associated with biological actions such as fungicidal, bactericidal, and immunomodulatory effects—strengthens the argument that termite saliva can be a rich raw material for natural therapeutic formulations, particularly when standardized through chromatographic processes and validated by microbiological assays.

At the intersection of dentistry and biomaterials, Dominguez et al. (2024) discuss composite resins, emphasizing their mechanical properties and adhesion to dental tissues. Considering the natural viscosity and adhesiveness of termite saliva, its application as a bioadhesive agent is suggested, especially if chemically stabilized to withstand oral conditions. The potential replacement of part of synthetic polymers with biopolymers derived from termite saliva represents a green innovation aligned with sustainability trends. However, this application requires biocompatibility assessments. For that purpose, the toxicity and genotoxicity protocols used by Fernández et al. (2010) serve as key references. Sodium percarbonate, for instance, is widely used as a dental bleaching agent but presents cytotoxic risks. Similarly, termite saliva must undergo equivalent testing to ensure that its use on human tissues does not induce cellular damage or DNA alterations.

The ethnobiological dimension is explored by Figueirêdo et al. (2015), who describe the medicinal use of termites in various cultures worldwide. In this context, termite saliva appears as a substance used in the treatment of wounds, infections, and inflammations—illustrating traditional knowledge that intertwines with recent scientific findings. This synergy reinforces the importance of developing products that respect ancestral knowledge while meeting modern scientific standards. In parallel, Fontes et al. (2009) discuss the use of alternative solvents, such as tetrahydrofuran, in dental adhesive systems. Inspired by this reasoning, researchers may investigate termite saliva as a potential solvent substitute, functioning as a viscous base in dental adhesives with lower toxicity.

In orthodontics, Kalluf (2023) discusses the use of invisible aligners, highlighting the importance of bioinspired materials. Due to its moldability and adhesive properties, termite saliva could be incorporated into polymeric formulations for next-generation aligners, offering additional therapeutic benefits such as the slow release of antimicrobial compounds. From the perspective of oral microbiology, Kreve and dos Reis (2022) demonstrate how surface roughness and composition of ceramic materials affect bacterial adhesion. This finding is relevant when considering termite saliva as a bioactive coating for dental surfaces, capable of reducing pathogenic biofilm formation.

Lino (2021) shows that antioxidants directly influence dentin bond strength. Termite saliva, potentially rich in phenolic or terpenoid compounds with antioxidant properties, could be used as a conditioning or protective agent in cavity preparations, increasing restoration durability. Additionally, Liu et al. (2019) explore the intestinal microbiome of termites and reveal enzymes responsible for polysaccharide digestion. This suggests that termite saliva may contain bioactive enzymes useful in biotechnologies related to lignocellulose degradation, environmental bioremediation, or exfoliating cosmetic formulations.

In materials engineering, Lopez-Naranjo et al. (2016) tested the resistance of wood–plastic composites against termites. Ironically, this knowledge could be applied in reverse: termite saliva may serve as a natural wood repellent or protective coating, taking advantage of its bioactive compounds as alternatives to synthetic biocides. In dental restorations, Matta et al. (2024) describe the requirements for high-strength and adhesive materials. If formulated with natural polymers, termite saliva could yield composite resins with better integration to dental tissues and lower toxicity. Miranda et al. (2021) emphasize the importance of immediate dentin sealing. Termite saliva, as a natural sealant with antimicrobial properties, could prevent microleakage and improve restorative treatment outcomes.

Porto et al. (2021) show that incorporating polyphenols into adhesives maintains bond durability. This reinforces the value of bioactive molecules found in termite saliva, whose structure may contain similar antioxidants. Rodrigues et al. (2019) indicate the therapeutic potential of new agents against oral candidiasis. Thus, termite saliva extracts could be tested against yeasts such as *Candida albicans*, offering new antifungal therapeutic alternatives. The proposal by Sajin et al. (2024) to transform waste into biocomposites may also include termite saliva as a functional ingredient in polymeric matrices, adding structural or antimicrobial properties.

The multidisciplinary work of Silva Brasileiro et al. (2021) illustrates how to integrate materials science, applied chemistry, and health—an essential pathway for developing products derived from termite saliva. Recent academic proceedings (Silva et al., 2024) highlight a growing national interest in natural-origin biomaterials. The diversity of the oral microbiome, as described by Wade et al. (2016), underscores the need for selectivity in the active compounds from termite saliva to avoid imbalances in oral microbiota.

Combining ethnobiological, chemical, and clinical data, termite saliva emerges as a multifunctional substance, promising as a bioadhesive, antimicrobial, and sustainable biomaterial component. Before its definitive incorporation into commercial products, rigorous toxicity tests, structural analyses via NMR and HPLC, and clinical efficacy trials are required. The reviewed scientific literature provides a solid foundation for transforming termite saliva into a useful, safe, and innovative technology.

From an ecological perspective, the studies by Boulogne et al. (2017) and Costa-Leonardo et al. (2019) highlight termite saliva as part of complex chemical defense systems in *Nasutitermes* and *Neocapritermes* colonies, emphasizing the evolutionary specificity of these secretions as protective mechanisms. This characteristic reinforces their potential as pharmacological and dental inputs, considering that compounds evolved for defense against environmental microorganisms can be repurposed as antimicrobial biomolecules in clinical settings. Furthermore, the anatomical and physiological analysis by Costa-Leonardo, Da Silva, and Laranjo (2023) on termite exocrine systems provides essential technical support for optimizing saliva collection and purification processes, identifying chemical fractions potentially useful in dental adhesives, sealants, and antimicrobial agents.

In the field of dental biomaterials, the work of Dominguez et al. (2024) emphasizes the importance of mechanical and adhesive properties in composite resins, suggesting that the natural viscosity and adhesive potential of termite saliva could be explored as a bioadhesive agent. The partial replacement of synthetic polymers with biopolymers extracted from termite saliva aligns with sustainability trends in dentistry but requires strict toxicity and genotoxicity assessments, as described by Fernández et al. (2010). Such tests should be replicated for termite saliva to ensure safety in contact with dental and oral tissues.

The interaction between termite saliva and the oral microbiome warrants attention, given the complexity described by Wade et al. (2016). The antimicrobial selectivity of compounds present in termite saliva is a crucial aspect to prevent imbalances in the oral microbiota and avoid adverse effects such as dysbiosis or resistant strain selection. This consideration is particularly relevant when envisioning applications of termite saliva as a dentin sealant or controlled-release biofilm for antimicrobials, as suggested by Miranda et al. (2021) and Matta et al. (2024).

At the interface between biomaterials and technological innovation, Fontes et al. (2009) discuss the use of alternative solvents in adhesives, inspiring investigations into termite saliva as a viscous base or natural solvent with low toxicity. This potential is also linked to the work of Porto et al. (2021), which demonstrates that incorporating polyphenols into adhesives enhances bond durability—raising the hypothesis that bioactive molecules in termite saliva, such as diterpenes and phenolic compounds, could yield similar effects. Rodrigues et al. (2019) further emphasize the relevance of testing termite saliva extracts against yeasts like *Candida albicans*, exploring their use as antifungal alternatives in oral candidiasis therapies.

The multifunctional character of termite saliva also becomes evident when considering other potential biotechnological applications. Liu et al. (2019) revealed digestive enzymes in the termite gut microbiome, indicating the possible presence of bioactive enzymes in termite saliva, which could be harnessed for dental or cosmetic formulations with exfoliating action or even in environmental biotechnology for bioremediation. The perspective of Sajin et al. (2024) on using waste to produce biocomposites also resonates with termite saliva, which could be incorporated as a functional additive in polymeric matrices, providing antimicrobial or structural properties.

The synergy among sustainability, innovation, and traditional knowledge appreciation reinforces the importance of *Nasutitermes* saliva as a promising biomatrix for advanced dental products and biomaterials. The responsible use of this substance requires rigorous clinical and toxicological testing, as well as chromatographic analyses (HPLC, NMR) for extract standardization, ensuring safety and efficacy for human use. The body of references analyzed—including Silva et al. (2024) and Kalluf (2023)—points to a fertile field for incorporating termite saliva as an innovative and safe input, transforming an abundant natural resource into a functional, sustainable technology aligned with the current needs of restorative and preventive dentistry.

CONCLUSIONS

The bioactive compounds present in the saliva of termites from the *Nasutitermes* genus represent an innovative and sustainable alternative for the development of dental products with antimicrobial activity, preventive effects, and biocompatibility. These compounds meet the growing demand for restorative materials that offer greater clinical longevity and protective action against recurrent oral infections. The diterpenes identified in these secretions, such as trinervitane-type compounds, have demonstrated activity against multidrug-resistant microorganisms, standing out as promising agents for root canal disinfection and for incorporation into dental adhesives and cements.

In addition to their pharmacological potential, the use of termite saliva reinforces the appreciation of Brazilian biodiversity and the sustainable use of natural resources, while also promoting national biotechnology and acknowledging ethnobiological knowledge historically employed by local communities in the management of infections. The integration of naturally derived bioactive compounds into dental materials may reduce the environmental toxicity associated with synthetic products while providing greater specificity and efficacy in microbial control within the oral environment.

Despite advances in recognizing the bioactivity of compounds found in *Nasutitermes* saliva, there remains a need for further research on the isolation, structural characterization, and elucidation of the mechanisms of action of these compounds against major oral pathogens, as well as their interaction with dental matrices such as composite resins, adhesives, and cements. Both *in vitro* and *in vivo* studies are essential to assess cytotoxicity, biocompatibility, chemical stability, and the impact of these compounds on the mechanical properties of dental materials.

Thus, this study contributes to consolidating termite secretions as a rich and multifunctional biomatrix suitable for integration into innovative dental formulations capable of combining prolonged antimicrobial action, sustainability, and the valorization of national biodiversity.
Since failures at the tooth–restoration interface are among the main causes of adhesive restoration failure—particularly due to nanoleakage that leads to secondary caries—it is evident that Dentistry must advance through innovative research on materials that can minimize or even eliminate such occurrences.

Natural substances have shown promise in this regard, yielding positive results in improving bond strength and/or exhibiting antibacterial potential when incorporated into adhesive systems or used for the development of new formulations. Advancing research in this field could significantly expand therapeutic options in preventive and restorative dentistry, offering safe, effective, and environmentally responsible alternatives for the management of oral infections and the enhancement of patients' quality of life.

REFERENCES

BARDIN, Laurence. Content Analysis. São Paulo: Editions 70, 2016.

BOULOGNE, Isabelle et al. Ecology of termites from the genus Nasutitermes (Termitidae: Nasutitermitinae) and potential for science-based development of sustainable pest management programs. **Journal of Pest Science**, v. 90, p. 19-37, 2017.

COSTA-LEONARDO, Ana Maria et al. Worker defensive behavior associated with toxins in the neotropical termite Neocapritermes braziliensis (Blattaria, Isoptera, Termitidae, Termitinae). **Journal of Chemical Ecology**, v. 45, p. 755-767, 2019.

COSTA-LEONARDO, Ana Maria; DA SILVA, Iago Bueno; LARANJO, Lara Teixeira. Termite exocrine systems: a review of current knowledge. Entomologia Experimentalis et Applicata, v. 171, n. 5, p. 325-342, 2023.

CRUZ, Márcia NS de la et al. Antimicrobial Diterpene from the Brazilian Termite Nasutitermes macrocephalus (Isoptera: Termitidae: Natutitermitinae). Journal of the

Brazilian Chemical Society, v. 29, n. 3, p. 509-514, 2018.
DE LA CRUZ, M.; *et al*. Antimicrobial Diterpene from the Brazilian Termite Nasutitermes Macrocephalus (Isoptera: Termitidae: Natutitermitinae). **Journal of the Brazilian Chemical Society**, v.29, n.3, p.509-514, 2018, DOI: 10.21577/0103-5053.20170163.

DOMINGUEZ, G. P.; et al. Direct composite resin veneers: A comprehensive review. Research, Society and Development, v.13, n.7, p.e12213746470-e12213746470, 2024.

FERNÁNDEZ, M.R.; *et al*. Cytotoxicity and genotoxicity of sodium percarbonate: a comparison with bleaching agents commonly used in discoloured pulpless teeth. **International Endodontic Journal**, v.43, n.1, p.102-108, 2010.

FIGUEIRÊDO, Rozzanna Esther Cavalcanti Reis de et al. Edible and medicinal termites: a global overview. **Journal of Ethnobiology and Ethnomedicine**, v. 11, p. 1-7, 2015.

FONTES, S.T.; *et al*. Tetrahydrofuran as alternative solvent in dental adhesive systems. **Dental Materials**, v.25, n.12, p.1503-8, 2009.

GIL, Antonio Carlos. Social Research Methods and Techniques. 6th ed. São Paulo: Atlas, 2010.

KALLUF, D.M.B. Orthodontic Aligners: Orthodontics of the 21st Century. Thesis (Doctorate). ILAPEO College. Curitiba, 2023. Available at: https://www.ilapeo.com.br/wp-content/uploads/2024/09/Daniela-Magalhaes-de-Brito-Kalluf.pdf. Accessed on: 02/22/25.

KREVE, Simone; DOS REIS, Andréa Cândido. Effect of surface properties of ceramic materials on bacterial adhesion: A systematic review. **Journal of Esthetic and Restorative Dentistry**, v. 34, n. 3, p. 461-472, 2022.

LINO, J. S. M. Influence of two antioxidant agents on the bond strength to dentin of pre-endodontic restorations after irrigation with sodium hypochlorite. 2021. Master's Dissertation. Egas Moniz School of Health & Science (Portugal).

LIU, Ning et al. Functional metagenomics reveals abundant polysaccharide-degrading gene clusters and cellobiose utilization pathways within gut microbiota of a wood-feeding higher termite. **The ISME journal**, v. 13, n. 1, p. 104-117, 2019.

LOPEZ-NARANJO, Edgar J. et al. Termite resistance of wood–plastic composites treated with zinc borate and borax. **Journal of Thermoplastic Composite Materials**, v. 29, n. 2, p. 281-293, 2016.

MATTA, J.B.S.F.; PEREIRA, B. A. B.; ROCHA, L. M. B. M. Direct restorations in anterior teeth with composite resin: systematic literature review. Brazilian Journal of Health Review, v.7, n.1, p.3664-3680, 2024.

MIRANDA, I.B.; et al. The importance of immediate dentin sealing: a narrative review of the literature. Scientia Generalis, v.2, n.1, p.77-84, 2021.

PORTO, I.C.C.M.; *et al*. Polyphenols and Brazilian red propolis incorporated into a total-etching adhesive system help in maintaining bonding durability. **Heliyon**. v.7, n.2, p.1-12, 2021. DOI: 10.1016/j.heliyon.2021.e06237.

RODRIGUES, Célia F.; RODRIGUES, Maria E.; HENRIQUES, Mariana CR. Promising alternative therapeutics for oral candidiasis. **Current medicinal chemistry**, v. 26, n. 14, p. 2515-2528, 2019.

SAJIN, Justin Abraham et al. Thermite frass biomass and surface modified biowaste coir fiber reinforced biocomposites—Conversion of waste to useful products. **Biopolymers**, v. 115, n. 6, p. e23616, 2024.

SILVA BRASILEIRO, T.M.; CARVALHO COSTA, P.M.; ALMEIDA JUNIOR, P.A. full version. Current Science–Multidisciplinary Scientific Journal of the São José University Center, v.17, n.1, p.1-157, 2021.

SILVA, I.I.; et al. Proceedings of the XIII Sobral Dental Conference and XV Sobral Conference of Stomatology, Dental Radiology and Oral Pathology. 2024.

WADE, William et al. Uncultured members of the oral microbiome. **Journal of the California Dental Association**, v. 44, n. 7, p. 447-456, 2016.