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YST028 - PIPERPURE: HERBAL ANTIMICROBIAL MOUTHWASH POWERED BY *PIPER BETLE* L.

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ABSTRACT

Oral diseases, driven by bacterial and fungal pathogens, continue to affect millions worldwide, leading to tooth decay, gum inflammation, and oral infections. While conventional mouthwashes such as chlorhexidine and chemical antiseptics are widely used, they often cause side effects, including tooth staining, altered taste, and mucosal irritation. In response, there is a growing global demand for safe, effective, and sustainable herbal alternatives. PIPERPURE is a novel herbal antimicrobial mouthwash formulated from ethanolic extract of *Piper betle* L., a plant long valued in traditional medicine for its potent antimicrobial and antioxidant properties. In this study, fresh *Piper betle* leaves were extracted via maceration using 95% ethanol, followed by qualitative phytochemical screening, which confirmed the presence of flavonoids, tannins, saponins, and steroids. Antimicrobial activity was evaluated using the disc-diffusion method against *Staphylococcus aureus*, *Pseudomonas aeruginosa*, and *Candida albicans*. The extract demonstrated moderate to significant inhibitory effects against all pathogens, with the 250 mg/mL concentration producing the largest inhibition zones, remarkably surpassing Fluconazole in antifungal activity against *C. albicans*. Two alcohol-free mouthwash formulations with varying extract concentrations were developed and tested for pH, foamability, appearance, stability, and sensory acceptability. Both maintained an optimal pH, clear physical appearance, and stability over time, while preserving antimicrobial potency. Taste and aroma evaluations confirmed strong user acceptability. PIPERPURE bridges traditional herbal wisdom and modern formulation science to deliver an effective, chemical-free oral care solution. With proven laboratory efficacy, stability, and consumer appeal, it addresses unmet needs in preventive dentistry while supporting sustainability and cultural heritage. The product holds strong commercialization potential in both domestic and international herbal oral care markets, offering health-conscious consumers a safe and innovative alternative to conventional mouthwashes.

Keywords – *Piper betle* L., herbal mouthwash, antimicrobial activity, oral pathogens, natural oral care, antifungal efficacy

INTRODUCTION

Oral diseases such as dental caries, gingivitis, and oral candidiasis remain among the most common health problems worldwide, affecting individuals across all age groups. These conditions are primarily caused by bacterial and fungal pathogens that colonize the

oral cavity, leading to pain, discomfort, and reduced quality of life. While conventional mouthwashes containing synthetic antiseptics like chlorhexidine are effective, their prolonged use is often associated with adverse effects, including tooth staining, altered taste, and mucosal irritation.

Driven by growing consumer demand for safer, plant-based, and eco-friendly alternatives, PIPERPURE was developed as a herbal antimicrobial mouthwash formulated from *Piper betle* L., a medicinal plant widely recognized in Southeast Asian traditional medicine for its potent antimicrobial, antioxidant, and anti-inflammatory properties. The motivation behind this innovation stems from the need to provide an effective, chemical-free oral hygiene product that not only addresses microbial control but also aligns with sustainability and cultural heritage.

By integrating traditional herbal knowledge with modern formulation science, PIPERPURE aims to deliver a safe, effective, and market-ready solution for maintaining oral health.

OBJECTIVE

The primary objective of this innovation is to develop and evaluate PIPERPURE, a herbal antimicrobial mouthwash derived from *Piper betle* L., as a safe and effective natural alternative to conventional chemical-based oral care products. Specifically, this project aims to:

- i. **Formulate** an alcohol-free mouthwash incorporating *Piper betle* ethanolic extract with optimal pH, stability, and sensory acceptability.
- ii. **Evaluate** the antimicrobial efficacy of the formulation against selected oral pathogens, including *Staphylococcus aureus*, *Pseudomonas aeruginosa*, and *Candida albicans*.
- iii. **Establish** the product's potential for commercialization as a sustainable, culturally rooted, and consumer-friendly oral hygiene solution.

DESCRIPTION OF THE PROJECT

PIPERPURE is an innovative herbal antimicrobial mouthwash developed from the ethanolic extract of *Piper betle* L. leaves, a medicinal plant well-known in Southeast Asian traditional medicine for its potent antimicrobial, antioxidant, and anti-inflammatory properties. Fresh leaves were extracted through maceration using 95% ethanol, and qualitative phytochemical screening confirmed the presence of bioactive compounds such as flavonoids, tannins, saponins, and steroids. The antimicrobial efficacy of the extract was evaluated using the disc-diffusion method against *Staphylococcus aureus*, *Pseudomonas aeruginosa*, and *Candida albicans*, revealing moderate to significant inhibitory effects, with the 250 mg/mL concentration demonstrating the largest inhibition zones and surpassing Fluconazole in antifungal activity. Two alcohol-free formulations with varying extract concentrations were then developed and assessed for pH, foamability, clarity, stability, and sensory acceptability. Both maintained optimal pH levels, stability over time, and pleasant taste and aroma while retaining strong antimicrobial activity. By integrating traditional herbal knowledge with modern formulation techniques, PIPERPURE offers an effective, chemical-free, and culturally relevant oral hygiene solution that meets growing consumer demand for safe, natural, and sustainable personal care products, with strong potential for commercialization in local and global markets.

NOVELTY

PIPERPURE introduces a unique integration of traditional herbal knowledge and modern formulation science to create an effective, chemical-free mouthwash that addresses current gaps in oral care. While *Piper betle* L. has been traditionally chewed for its medicinal benefits, its application as a scientifically validated, alcohol-free mouthwash is a novel approach in the oral hygiene market. The originality of this product lies in three main aspects:

- **Innovative Use of *Piper betle* L. Extract** - Unlike existing herbal mouthwashes that rely on common plant extracts such as tea tree or peppermint, PIPERPURE harnesses the potent antimicrobial and antifungal properties of *Piper betle*, with laboratory evidence showing superior activity against *Candida albicans* compared to Fluconazole.
- **Optimized Alcohol-Free Formulation** - Many conventional and herbal mouthwashes contain alcohol, which can cause oral dryness and irritation. PIPERPURE is formulated without alcohol while maintaining stability, clarity, palatability, and high antimicrobial efficacy, making it suitable for sensitive users and long-term use.
- **Cultural and Sustainable Value** - This product revives a culturally significant Southeast Asian medicinal plant and transforms it into a standardized, market-ready product that aligns with global trends toward sustainable, eco-friendly, and culturally inspired health solutions.

By combining a less-explored yet highly potent plant extract with a consumer-friendly, safe, and effective delivery system, PIPERPURE stands out as a distinctive and innovative oral care solution with strong potential for both niche and mainstream markets.

CONCLUSION

PIPERPURE demonstrates that *Piper betle* L. ethanolic extract possesses strong antimicrobial and antifungal properties, making it a viable natural alternative to conventional chemical-based mouthwashes. Laboratory testing confirmed significant inhibitory effects against key oral pathogens, with superior antifungal performance compared to Fluconazole, while formulation studies ensured stability, optimal pH, and consumer acceptability. By delivering effective oral microbial control without alcohol or synthetic antiseptics, PIPERPURE addresses growing consumer demand for safe, sustainable, and culturally rooted health products. Its integration of traditional herbal knowledge with modern formulation science offers a competitive advantage in the expanding herbal oral care market. With proven efficacy, pleasant sensory qualities, and scalability in production, PIPERPURE holds strong potential for commercialization as a chemical-free oral hygiene solution for both local and global markets.