นิพนธ์ต้นฉบับ

ฤทธิ์ทางชีวภาพของสมุนไพรไทยในการต่อต้านเชื้อสเตรปโตค็อกคัส มิวแทนส์ เพื่อสุขอนามัยช่องปาก

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บทคัดย่อ

โรคฟันผุซึ่งมีสาเหตุหลักจากเชื้อ *Streptococcus mutans* ยังคงเป็นปัญหาสุขภาพช่องปากระดับโลกที่สำคัญ ด้วยข้อจำกัดของสารต้านจุลชีพสังเคราะห์ เช่น ผลข้างเคียงและการดื้อยา ทำให้เกิดความสนใจในทางเลือกจากธรรมชาติเพิ่มขึ้น โดยเฉพาะสมุนไพรไทยที่มีการใช้ในด้านการดูแลช่องปากตามภูมิปัญญาแผนไทยมาอย่างยาวนาน การศึกษานี้มีวัตถุประสงค์เพื่อสังเคราะห์หลักฐานทางวิทยาศาสตร์เกี่ยวกับฤทธิ์ต้านแบคทีเรียของสารสกัดสมุนไพรไทยต่อเชื้อ *Streptococcus mutans* โดยเน้นค่าความเข้มข้นต่ำสุดที่ยับยั้งการเจริญ (MIC) และค่าความเข้มข้นต่ำสุดที่สามารถฆ่าเชื้อได้ (MBC) การทบทวนวรรณกรรมนี้ค้นคว้าจากข้อมูลจากฐานข้อมูล PubMed, ScienceDirect, Google Scholar และ ThaiJo สำหรับงานวิจัยที่เผยแพร่ระหว่างปี พ.ศ. 2553 ถึง พ.ศ. 2567 โดยมีเกณฑ์การคัดเลือกคือ งานวิจัยที่รายงานค่า MIC และ/หรือ MBC ของสารสกัดสมุนไพรไทยต่อเชื้อ *S. mutans* ด้วยวิธีการทดสอบต้านจุลชีพในหลอดทดลองมาตรฐาน ผลการทบทวนพบว่าสมุนไพรไทยหลายชนิดมีฤทธิ์ต้านแบคทีเรียต่อ *S. mutans* โดยเฉพาะ *Cinnamomum aromaticum*, *Syzygium aromaticum* และ *Ocimum basilicum* ซึ่งแสดงค่าการยับยั้งและฆ่าเชื้อในระดับต่ำ และมีอัตราส่วน MBC/MIC ที่บ่งชี้ถึงฤทธิ์ฆ่าเชื้อ อย่างไรก็ตาม พบความไม่สอดคล้องกันในวิธีวิจัยและข้อมูลทางคลินิกที่ยังมีจำกัดในแต่ละงานวิจัย โดยสรุป สารสกัดสมุนไพรไทยแสดงศักยภาพในการต้านเชื้อ *S. mutans* ในหลอดทดลอง ซึ่งสนับสนุนความเป็นไปได้ในการนำมาใช้เป็นส่วนประกอบในผลิตภัณฑ์ดูแลช่องปากจากธรรมชาติ ทั้งนี้ควรมีการวิจัยเพิ่มเติมเพื่อกำหนดมาตรฐานการทดสอบ ประเมินความปลอดภัย และพิสูจน์ประสิทธิผลทางคลินิกต่อไป

คำสำคัญ: สมุนไพรไทย สเตรปโตค็อกคัส มิวแทนส์ สุขอนามัยช่องปาก

Original Article

Bioactive Property of Thai Herbs Against *Streptococcus mutans* for Oral Hygiene

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Abstract

Dental caries, primarily caused by *Streptococcus mutans*, remains a major global oral health issue. Due to the limitations of synthetic antimicrobials, such as side effects and resistance, interest has grown in natural alternatives—particularly Thai herbs traditionally used in oral care. To synthesize scientific evidence on the antibacterial activity of Thai herbal extracts against *Streptococcus mutans*, focusing on minimum inhibitory concentration (MIC) and minimum bactericidal concentration (MBC) values. A literature review was conducted using databases including PubMed, ScienceDirect, Google Scholar, and ThaiJo for studies published between 2010 and 2024. Inclusion criteria required studies to report MIC and/or MBC values of Thai herbal extracts against *S. mutans* using standard in vitro antimicrobial assays. Numerous Thai herbs demonstrated antibacterial effects against *S. mutans*, with several showing low MIC and MBC values. Herbs such as *Cinnamomum aromaticum*, *Syzygium aromaticum*, and *Ocimum basilicum* exhibited potent activity and MBC/MIC ratios suggesting bactericidal action. However, inconsistencies in methodology and limited clinical data were observed across studies. Thai herbal extracts show promising in vitro antibacterial activity against *S. mutans*, supporting their potential use in natural oral care products. Further research is needed to standardize testing, evaluate safety, and validate clinical effectiveness.

Keywords: Thai herb, *Streptococcus mutans*, Oral hygiene

Introduction

Dental caries, or tooth decay, is one of the most prevalent chronic diseases worldwide, affecting individuals across all age groups. The World Health Organization has reported dental caries as one of the most widespread non-communicable diseases, contributing to pain, impaired function, and reduced quality of life[1]. The pathogenesis of dental caries is multifactorial, involving poor oral hygiene, high sugar consumption, and the presence of cariogenic bacteria such as *Streptococcus mutans (S. mutans)*[2]. This bacterium is known for its ability to form biofilms, metabolize carbohydrates into lactic acid, and thrive in acidic environments—contributing to enamel demineralization and cavity formation[3].

Although conventional antimicrobial agents like chlorhexidine are effective against *S. mutans*, they are associated with adverse effects such as staining, altered taste, and mucosal irritation with long-term use[4]. These drawbacks have prompted researchers to explore alternative antimicrobial agents derived from natural sources, particularly medicinal plants.

Thai traditional medicine, an integral part of the national healthcare heritage, has long utilized herbal remedies for oral diseases. Ethnobotanical studies have documented over 30 herbal formulas traditionally used for managing dental problems such as toothache, inflammation, and halitosis[5]. These traditional practices provide a valuable foundation for identifying plant-based bioactive compounds with potential modern therapeutic applications.

Recent in vitro studies have demonstrated that several Thai herbs possess antimicrobial properties against *S. mutans*, as evidenced by their minimum inhibitory concentrations (MIC) and minimum bactericidal concentrations (MBC)[6,7]. However, a critical gap remains in synthesizing this data to identify the most potent herbs and assess their practical applications. Most existing studies are fragmented, lacking comparative analysis or discussion of limitations in methodologies, extract standardization, or translation to clinical settings.

This review aims to provide a comprehensive synthesis of current findings on the antibacterial activity of Thai herbal extracts against *S. mutans*. By comparing MIC and MBC values and identifying key candidates for further development, this review supports the potential integration of Thai herbs into evidence-based oral care solutions.

Study Methods

This review aimed to synthesize current scientific evidence on the antibacterial activity of Thai herbal extracts against *Streptococcus mutans*, focusing on minimum inhibitory concentration (MIC) and minimum bactericidal concentration (MBC) values. A literature search was conducted using PubMed, Google Scholar, ScienceDirect, and ThaiJo for studies published between 2010 and 2024. Keywords included “Thai herbs,” “*Streptococcus mutans*,” “MIC,” “MBC,” “oral hygiene,” and "herbal extract." Studies were included if they investigated Thai herbs, reported MIC and/or MBC values against *S. mutans*, used standard in vitro antimicrobial assays, and were published in peer-reviewed journals. Articles were excluded if they lacked quantitative data, focused on non-Thai herbs, or were non-original studies. For each included article, data on the herb name, plant part, extraction method, MIC and MBC values, and assay type were extracted. These data were analyzed to compare antibacterial potency, and MBC/MIC ratios were interpreted to distinguish between bacteriostatic and bactericidal activity.

Streptococcus mutans in oral health problems

The oral cavity hosts over 700 microbial species, forming one of the most diverse microbiomes in the human body[8]. Among these, *Streptococcus mutans* is a key pathogen in dental caries development due to its strong cariogenic potential. While typically a part of the normal flora, *S. mutans* can dominate when conditions favor its growth—particularly in high-sugar diets—shifting the oral microbiome from a balanced to a disease-prone state.

S. mutans adheres strongly to tooth enamel through extracellular polysaccharides, initiating biofilm formation. Within these biofilms, the bacteria are protected, communicate through quorum sensing, and can exchange genetic material, including resistance genes[9]. Its ability to metabolize carbohydrates into lactic acid, thrive in acidic environments, and form resilient biofilms enables it to persist and cause tooth decay[3].

Genome analyses have further revealed the bacterium's adaptability and virulence, including the production of mutacins and mutanobactins—antimicrobial compounds that suppress competing microbes[10]. Notably, the extensive use of fluoride has led to fluoride-resistant *S. mutans* strains, raising concerns about long-term reliance on standard anti-caries agents[11].

While chemical antimicrobials like chlorhexidine are effective, their drawbacks—such as tooth staining, altered taste, and potential for resistance—highlight the need for safer, natural alternatives[4]. This has driven interest in plant-based therapies, including Thai herbs, for their antimicrobial, antioxidant, and biocompatible properties.

Antibacterial property of Thai Herbs Against *Streptococcus mutans*

Thai traditional medicine offers a rich repository of herbal knowledge, with over 30 herbal formulas historically used in oral care[5]. Recent studies have validated many of these herbs for their inhibitory effects against *S. mutans*, positioning them as promising candidates for modern dental applications.

The efficacy of these herbal extracts varies based on plant species, plant part used, and extraction method—commonly ethanol extraction or hydrodistillation. Minimum inhibitory concentration (MIC) and minimum bactericidal concentration (MBC) values are key indicators of their antimicrobial potency. As summarized in Table 1, several herbs show strong antibacterial activity. For instance, *Cinnamomum aromaticum* essential oil demonstrates both MIC and MBC at 0.039%, while *Albizia myriophylla* has a MIC of 3.9 µg/ml. Additionally, *Streblus asper* shows both MIC and MBC at 1.93 mg/ml, indicating strong bactericidal action.

To critically interpret these results, MBC/MIC ratios were used to differentiate bacteriostatic from bactericidal effects. Most herbs fell within the ratio range of 1–4, suggesting bactericidal properties. Notably, herbs like *Cinnamomum*, *Syzygium aromaticum*, and *Ocimum basilicum* consistently demonstrated low MIC/MBC values across studies, marking them as top candidates for further development.

However, some studies reported less potent activity or lacked consistency in experimental design, including differences in bacterial strain, extract preparation, or assay technique. This highlights the need for standardized testing methods to ensure comparability.

Moreover, safety profiles, toxicity, and stability of herbal compounds remain underexplored. Few studies address potential side effects, long-term oral exposure, or formulation challenges—critical factors for commercial translation.

Overall, while numerous Thai herbs exhibit promising in vitro activity against *S. mutans*, their clinical application will depend on further validation through standardized assays, safety evaluations, and formulation research. Their integration into oral care products, such as mouthwashes and herbal toothpastes, offers a natural, culturally relevant, and potentially safer alternative to synthetic antimicrobials.

Discussion

This review highlights the antimicrobial potential of Thai herbal extracts against *Streptococcus mutans*, a key contributor to dental caries. The findings demonstrate that several herbs traditionally used in Thai medicine exhibit strong antibacterial effects, with low minimum inhibitory concentration (MIC) and minimum bactericidal concentration (MBC) values. These results support the therapeutic relevance of traditional knowledge and align with growing global interest in plant-based oral care solutions(5,6).

Particulary, herbs such as Cinnamomum aromaticum, Syzygium aromaticum, and Ocimum basilicum consistently showed potent activity, with MIC and MBC values comparable to or better than some conventional agents(7). The MBC/MIC ratio for many herbs ranged between 1 and 4, suggesting a primarily bactericidal mode of action. These properties make them promising candidates for integration into oral hygiene products such as herbal toothpastes, mouthwashes, and gels.

However, the comparison of studies also discloses key challenges. Variability in extraction methods, plant parts used, and assay conditions affects the reproducibility and comparability of results[5,6]. For instance, ethanol extraction and hydrodistillation yielded different concentrations and bioactivities, underscoring the need for standardized extraction protocols to ensure consistency. Moreover, limited information on the active phytochemical constituents and mechanisms of action further complicates direct comparisons.

Beyond antimicrobial potency, practical considerations for clinical application remain underexplored. Few studies address the safety, toxicity, or irritation potential of these herbal extracts when used regularly in the oral cavity. Additionally, the stability of active compounds, potential allergenicity, and formulation compatibility with commercial products are critical factors for translation from bench to consumer products[4]. The emergence of fluoride-resistant *S. mutans* strains also reinforces the need for alternative agents, yet the risk of microbial resistance developing against herbal compounds has not been well studied[11]. Moreover, future research should explore optimal formulation approaches and delivery systems, such as incorporation into toothpaste, mouthwash, gels, or slow-release vehicles, along with comprehensive safety and toxicity assessments in both preclinical and clinical settings.

While in vitro data are encouraging, clinical evidence remains limited. No studies included in this review conducted randomized controlled trials or in vivo assessments to evaluate effectiveness in human populations. Thus, future research should focus on well-designed preclinical and clinical studies, formulation development, and comprehensive safety testing.

Finally, the integration of Thai herbs into evidence-based oral care could promote culturally relevant and sustainable health solutions in Thailand and beyond. By bridging traditional knowledge with modern science, these herbs offer a natural and accessible approach to caries prevention. However, to realize this potential, further interdisciplinary research is essential—combining microbiology, pharmacognosy, dentistry, and public health perspectives[3,9,10,12].

Conclusion

This review synthesized evidence on the antibacterial activity of Thai herbal extracts against *Streptococcus mutans*, focusing on MIC and MBC values. Several herbs, including Cinnamomum aromaticum and Syzygium aromaticum, demonstrated strong bactericidal effects, highlighting their potential as natural ingredients in oral care products. However, variations in methods and limited clinical data underscore the need for standardized testing and further research to support their safe and effective use.

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Table Figure and Diagram

Table 1 Antibacterial property of some Thai herbs against *Streptococcus mutans*

Herb	Part	Extraction	MIC	MBC	Reference
Acmella oleracea	Whole plant	Ethanol extraction	1 mg/ml	-	(1)
Albizia myriophylla	Wood	Ethanol extraction	3.9 µg/ml	-	(1)
Alpinia galanga	Rhizome	Ethanol extraction	0.5 mg/ml	-	(1)
Avicennia marina	Leaf	Ethanol extraction	62.5 µg/ml	-	(1)
Cinnamomum aromaticum	Stem bark	Hydrodistillation	0.039%	0.039%	(7)
Cinnamomum zeylanicum	Stem bark	Hydrodistillation	0.08%	0.08%	(13)
Citrus hystrix	Leaf	Hydrodistillation	2.50%	2.50%	(13)
	Fruit peel	Hydrodistillation	2.50%	2.50%	(13)
Etlingera pavieana	Rhizome	Hydrodistillation	>1.6%	>1.6%	(14)
Foeniculum vulgare	Seed	Hydrodistillation	1.25%	2.50%	(13)
Glycyrrhiza glabra	Leaf	Ethanol extraction	<12.5 mg/ml	25 mg/ml	(15)
	Rhizome	Ethanol extraction	0.195 mg/ml	3.125 mg/ml	(16)
Illicium verum	Fruit	Hydrodistillation	1.250%	>5.000%	(7)
Mitragyna speciosa	Leaf	Ethanol extraction	3.125 mg/ml	100 mg/ml	(17)
Momordica cochinchinensis	Seed	Ethanol extraction	6.25 mg/ml	>12.5 mg/ml	(16)
Ocimum basilicum	Leaf	Hydrodistillation	0.31%	0.31%	(13)
Ocimum sanctum	Whole plant	Ethanol extraction	1 mg/ml	-	(1)
Phyllanthus niruri	Leaf	Ethanol extraction	100 mg/ml	200 mg/ml	(18)
Piper betle	Leaf	Ethanol extraction	1.56 mg/ml	3.17 mg/ml	(19)
Piper nigrum	Seed	Hydrodistillation	1.25%	2.50%	(13)

Herb	Part	Extraction	MIC	MBC	Reference
Plectranthus amboinicus	Leaf	Ethanol extraction	1 mg/ml	-	(1)
Pouzolzia pentandra	Leaf	Ethanol extraction	1 mg/ml	-	(1)
Psidium guajava	Leaf	Ethanol extraction	1.56 mg/ml	>12.5 mg/ml	(16)
Solanum nigrum	Leaf	Ethanol extraction	100 mg/ml	200 mg/ml	(18)
Streblus asper	Leaf	Ethanol extraction	1.93 mg/ml	1.93 mg/ml	(20)
Syzygium aromaticum	Flower buds	Hydrodistillation	0.078%	0.156%	(7)
	Flower buds	Ethanol extraction	<12.5 mg/ml	50 mg/ml	(15)
	Flower buds	Ethanol extraction	1.56 mg/ml	>12.5 mg/ml	(16)
Terminalia bellirica	Fruit	Ethanol extraction	<12.5 mg/ml	25 mg/ml	(15)
Zanthoxylum limonella	Fruit	Hydrodistillation	0.156%	0.156%	(7)

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