pISSN, eISSN 0125-5614
M Dent J 2017; 37 (1) : 71-80

Antibacterial effect of herbal plants against three cariogenic microorganisms

Piyapanna Pumpaluk[1], Boonchoo Sritularak[2], Kittisak Likhitwitayawuid[2], Jinthana Lapirattanakul[3]

[1] *Department of Advanced General Dentistry, Mahidol University, 6 Yothi Road, Rajthawee District, Bangkok 10400, Thailand*

[2] *Department of Pharmacognosy and Pharmaceutical Botany, Faculty of Pharmaceutical Sciences, Chulalongkorn University, Bangkok 10330, Thailand*

[3] *Department of Oral Microbiology, Mahidol University, 6 Yothi Road, Rajthawee District, Bangkok 10400, Thailand*

Objective: Herbs have been recognized as therapeutic medicines that provide natural and safer remedies to dozens of common ailments for several centuries. This project evaluated the antimicrobial activity of Thai traditional herbal plants against three common oral bacteria.

Methods: Forty-three methanol herbal extracts from thirty-three plants were selected for screening test. Herbal plants which exhibited antimicrobial properties were tested further via disc diffusion and broth microdilution assays. The bioactive compound was extracted from the herb that presented the highest antimicrobial properties and its antimicrobial effect was also tested by disc diffusion.

Results: Three herbal extracts from *Dracaena loureiri* Gagnep., *Artocarpus lakoocha* Roxb. (heartwood) and *Albizia myriophylla* Benth. revealed antimicrobial properties against *Streptococcus mutans*, *Lactobacilllus casei*, and *Actinomyces viscosus* with minimum bactericidal concentration (MBC) ranging from 0.58-9.37 mg/ml. *Albizia myriophylla* Benth. presented better bactericidal effect against three strains compared to other plants. However, *A. lakoocha* Roxb. (heartwood) presented the highest inhibition zone (24 mm), which was similar to chlorhexidine (24-28 mm) and Oxyresveratrol (its pure compound) was found to have the highest effect against *S. mutans* and presented the largest inhibition zone (20 mm) at the concentration of 30 mg/ml.

Conclusion: Out of forty-three herbal extracts, only *Albizia myriophylla* Benth. and *A. lakoocha* Roxb. had superior antimicrobial properties compared to other plants. Oxyresveratrol, which was *A. lakoocha* Roxb. 's pure compound did not present better effect than crude extract.

Keywords: herbal extracts; oral microorganisms; antibacteria; *Dracaena loureiri* Gagnep.; *Artocarpus lakoocha* Roxb. (heartwood); *Albizia myriophylla* Benth.

How to cite: Pumpaluk P, Sritularak B, Likhitwitayawuid K, Lapirattanakul J. Antibacterial effect of herbal plants against three cariogenic microorganisms. M Dent J 2017; 37: 71-80.

Introduction

Epidemiological studies have shown that root caries as well as periodontitis are common in elderly people [1,2]. Gingival recession as a result of periodontal disease or mechanical injury to the periodontium could cause root surface to be exposed and undergo demineralization, which can increase the risk of root caries [3,4]. The demineralization process of cementum is easier than enamel because cementum begins to demineralize at pH 6.7, which is higher than the enamel's critical pH of 5.5. Other factors, for example, poor oral hygiene [5] and decreased salivary flow (xerostomia) [6] are also known to be associated with an increased risk for root caries.

Corresponding author: Piyapanna Pumpaluk, Department of Advanced General Dentistry, Mahidol University, 6 Yothi Road, Rajthawee District, Bangkok 10400, Thailand Tel: +66898615521 Email: piyapanna@hotmail.com
Received : 12 October 2016 Accepted : 28 December 2016

However, the most critical role in this multifactorial etiology of root caries is played by microorganisms [7,8].

Reports in the literature do not appear to show any consensus regarding specific microbial types causing root caries. Some studies [9-11] reported that higher amounts of *Streptococcus mutans*, *Lactobacillus spp.*, and *Actinomyces spp.* were found on root surfaces that had caries lesions compared to sound root surfaces. However, others studies could not specify the main bacteria of root caries [12,13].

Most elderly people who cannot manage to clean their teeth because of muscle fatigue or systemic conditions may suffer from root caries. Several preventive approaches have been suggested for patients with root caries including topical fluoride application, fluoride mouthwash or herbal mouthwash which contain antimicrobial properties.

Natural products have been used as traditional medicines for thousands of years. Currently, there are several herbal extracts which have been proven to reduce the amount of oral cariogenic microorganisms such as *Streblus asper Lour* (Siamese rough bush), Oolong tea polyphenol extract, and mangosteen pericarp extract. *S. asper* (Moraceae), which has a long history as an herbal medicine was found in tropical countries such as Thailand. Various parts of this plant were used for treating different ailments such as filariasis, toothache, and leprosy. The root extract of *S. asper* has been used to relieve toothache and anti-gingivitis [14]. Moreover, its branch was used as a toothbrush for strengthening teeth and gums [14,15] until the middle of the twentieth century when the plastic brush with toothpaste become commonplace. Ethanol extracts from the sticks and leaves of *S. asper* have also been shown to inhibit the growth of *S. mutans* [16]. The minimum growth inhibitory concentration and the minimum bactericidal concentration of *S. asper* extract against 10^8 CFU/mL of *S. mutans* was shown to be 2 mg/ml [17]. In addition, Oolong tea extract also resulted in an inhibition of glucosyltransferase of *S. mutans* thereby decreasing the adherence of the growing cells of these organisms [18]. However, there are several other herbs that may have an effect in reducing the amount of cariogenic microorganisms and have not been tested or reported. In addition, there are only a few articles focusing on the effects of herbal extract against root caries microorganisms. Therefore, the aim of this study was to evaluate the antimicrobial activity of herbal crude extracts available in Thailand against *S. mutans, L. casei*, *and A. viscosus*, which are the most common bacteria related to carious tooth by disc diffusion and minimal bactericidal concentration tests.

Materials and methods

1. Crude extract preparation

Forty-three samples were prepared from thirty-three plants that were selected for initial screening (Table 1). Plant materials were dried, powdered, and then extracted with methanol to give a methanol extract. Oxyresveratrol (Figure 1) was obtained from *Artocarpus lakoocha* Roxb. (heartwood) as previously described by Sritularak et al. (1988) [19].

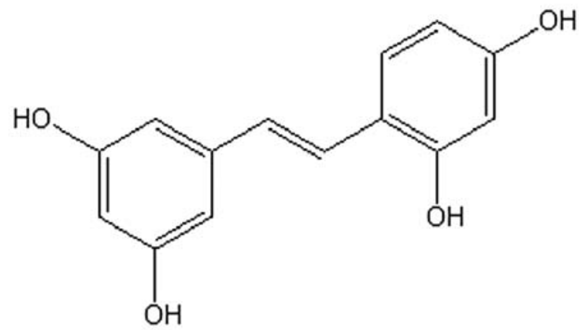

Figure 1. Chemical structure of oxyresveratrol.

Table 1. Lists of herbs and their parts used in this study.

Scientific name	Family	Part used
Abutilon indicum (L.) Sweet	Malvaceae	Leaves/ heartwood
Albizia myriophylla Benth.	Leguminosae	Stem barks
Artocarpus elasticus Reinw. ex Bl.	Moraceae	Root barks
Artocarpus gomezianus Wall. ex Tréc.	Moraceae	Leaves/ heartwood/root bark/stem barks
Artocarpus lakoocha Roxb.	Moraceae	Heartwood/root bark/stem barks
Barleria lupulina Lindl.	Acanthaceae	Leaves
Canarium subulatum Guill.	Burseraceae	Barks/ heartwood
Cajanus cajan (L) Millsp.	Leguminosae	Root barks
Cardiospermum halicacabum Linn.	Sapindaceae	Stems
Citrus aurantifolia (Christm.) Swingle.	Rutaceae	Leaves
Cochlospermum religiosum (L.) Alston	Cochlospermaceae	Seeds/fruits
Dalbergia cultrata Graham ex Benth.	Leguminasae	Stem barks
Dendrobium draconis Rchb.f.	Orchidaceae	Stems
Dendrobium capillipes Rchb.f.	Orchidaceae	Stems
Dendrobium crepidatum Lindl. & Paxton	Orchidaceae	Stems
Dendrobium lindleyi Steud.	Orchidaceae	Stems
Dendrobium secundum (Blume) Lindl.	Orchidaceae	Stems
Dendrobium thyrsiflorum Rchb.f.	Orchidaceae	Stems
Dendrobium williamsonii Day&Rchb.f.	Orchidaceae	Stems
Dracaena loureiri Gagnep.	Agavaceae	Leaves
Macaranga tanarius Muell. Arg.	Euphorbiaceae	Leaves
Millettia erythrocalyx Gagnep.	Leguminosae	Leaves/heartwood
Michelia figo (Lour.) Spreng	Magnoliaceae	Leaves
Mimusops elengi Linn.	Sapotaceae	Stem barks
Peltophorum dasyrachis (Miq.) Kurz.	Leguminosae	Barks/leaves
Piper retrofractum Vahl.	Piperaceae.	Leaves
Rhinacanthus nasutus (Linn.) Kurz.	Acanthaceae	Leaves
Schefflera leucantha R. Vig.	Araliaceae.	Leaves
*Schleichera oleosa (*Lour.) Oken	Sapindaceae	Stems
Solanum torvum Sw.	Solanaceae	Leaves
Terminalia chebula Retz.	Combretaceae	Fruits
Tinospora cordifolia Miers.	Menispermaceae	Stems
Tribulus terrestris Linn.	Zygophyllaceae	Stems

2. Microorganism preparation

Three kinds of microorganisms including *Streptococcus mutans* (MT8148), *Lactobacilllus casei* (ATCC 4646), and *Actinomyces viscosus* (ATCC 15987) were utilized as representative pathogens of caries in this study. For each strain, one colony was grown on brain heart infusion (BHI; Difco, BD, USA) agar and transferred into 5 ml BHI broth (Difco) and incubated for 16-18 hrs at 37 °C in 5% CO_2. Such bacterial culture was then used for both disc diffusion and broth microdilution assays.

3. Disc diffusion assay

Disc diffusion test was performed in order to determine the antimicrobial activity of all selected herbal extracts using standard disc diffusion method with some modifications. Briefly, bacterial suspension of each strain was adjusted equivalent to the 0.5 McFaland standard, which contained $1x10^8$ CFU (colony forming unit)/ml, then swabbed on the entire surface of a BHI plate prepared with 20 ml of BHI agar. After that, the sterile 6-mm paper disc (Whatman, Maidstone, UK) impregnated with 20 µl of each herbal extract (150 mg/ml) was placed on the surface of the agar plate. The distance between each disc was 25 mm while the distance between the discs and plate rim was 15 mm. A 20-µl aliquot of 0.2% chlorhexidine mouthwash was used as the positive control, whereas the methanol used as solvent for herbal extraction was used as negative control. The plates were incubated at 37 °C for 48 hrs, and the antimicrobial activity was measured in terms of zone of inhibition which included the diameter of the disc. Assays for each herbal extract were performed in duplicate and repeated twice. The results were then presented as the mean (mm) of all tests.

4. Broth microdilution assay

Broth dilution method in 96-well plates was used to determine minimum bactericidal concentration (MBC) of herbal extracts that showed the antimicrobial activities determined by disc diffusion assay. One hundred-µl aliquot of BHI broth was added into each well of 96-well plate, then equal volume of herbal crude extract tested (150 mg/ml) was added, and subsequently two-fold serially diluted with BHI broth. Thus, the final concentrations of herbal extracts were 75, 37.50, 18.75, 9.38, 4.69, 2.34, 1.17, 0.59, 0.29, 0.15, and 0.07 mg/ml. After the two-fold dilution of the herbal extracts, 10 µl of tested bacterial suspension containing $1x10^7$ CFUs/ml was added to each well of the two-fold diluted herbal extracts, and incubated at 37 °C for 24 hrs. After incubation, the contents of all the wells were subcultured onto BHI agar in order to determine the MBC of the herbal extracts, and MBC was defined as the lowest concentration of the extracts that showed no growth of tested bacteria on BHI agar. All herbal extracts were tested in duplicate and repeated twice. The negative and positive controls using methanol and 0.2% chlorhexidine mouthwash were also performed together with all experiments done.

Results

Antimicrobial activity of all crude extracts via the disc diffusion methods showed that only six out of the forty-three herbal extracts, which were *Dracaena loureiri* Gagnep., *Artocarpus lakoocha* Roxb. (bark and heartwood), *Albizia myriophylla* Benth., *Schefflera leucantha* R. Vig, and *Rhinacanthus nasutus* (Linn.) Kurz. presented inhibition zones for two to three kinds of cariogenic microorganisms. The diameters of these inhibition zones are shown in Table 2. Further investigation found that only three herbal extracts from *Dracaena loureiri* Gagnep., *Artocarpus lakoocha* Roxb. (heartwood), and *Albizia myriophylla* Benth. had antibacterial effect against all three kinds of tested bacteria (Table 3). A methanol extract

Table 2. Results from screening test of forty-three herbal plants by disc diffusion assay

Scientific name	Part used	Inhibition zone (mm)		
		S.mutans	L.casei	A.viscosus
Abutilon indicum (L.) Sweet	Leaves/ heartwood	No inhibition zone	No inhibition zone	No inhibition zone
Albizia myriophylla Benth.	Stem barks	12-15	Zone is not clear 7-9	12-14
Artocarpus elasticus Reinw. ex Bl.	Root barks	No inhibition zone	No inhibition zone	No inhibition zone
Artocarpus gomezianus Wall. ex Tréc.	Heartwood	No inhibition zone	No inhibition zone	Zone is not clear 6.5-7.5
	Stem barks	Zone is not clear 6.5-8	No inhibition zone	7.5-9.5
	Leaves/root bark	No inhibition zone	No inhibition zone	No inhibition zone
Artocarpus lakoocha Roxb.	Heartwood/root bark/stem barks	25.5-28.5	24	30-31
Barleria lupulina Lindl.	Leaves	Zone is not clear 6.5	No inhibition zone	Zone is not clear 6.5-7
Canarium subulatum Guill.	Barks/ heartwood	No inhibition zone	No inhibition zone	Zone is not clear 6.5-7
Cajanus cajan (L) Millsp.	Root barks	No inhibition zone	No inhibition zone	Zone is not clear 6.5-7
Cardiospermum halicacabum Linn.	Stems	No inhibition zone	No inhibition zone	Zone is not clear 6.5
Citrus aurantifolia (Christm.) Swingle.	Leaves	No inhibition zone	No inhibition zone	Zone is not clear 7-8
Cochlospermum religiosum (L.) Alston	Seeds/fruits	No inhibition zone	No inhibition zone	No inhibition zone
Dalbergia cultrata Graham ex Benth.	Stem barks	No inhibition zone	No inhibition zone	No inhibition zone
Dendrobium draconis Rchb.f.	Stems	No inhibition zone	No inhibition zone	No inhibition zone
Dendrobium capillipes Rchb.f.	Stems	No inhibition zone	No inhibition zone	Zone is not clear 6.5
Dendrobium crepidatum Lindl. & Paxton	Stems	No inhibition zone	No inhibition zone	No inhibition zone
Dendrobium lindleyi Steud.	Stems	Zone is not clear 9-11	No inhibition zone	Zone is not clear 7.5
Dendrobium secundum (Blume) Lindl.	Stems	No inhibition zone	No inhibition zone	No inhibition zone
Dendrobium thyrsiflorum Rchb.f.	Stems	Zone is not clear 6.5-8	No inhibition zone	Zone is not clear 6.5-7
Dendrobium williamsonii Day&Rchb.f.	Stems	No inhibition zone	No inhibition zone	No inhibition zone
Dracaena loureiri Gagnep.	Leaves	7-8.5	Zone is not clear 8.5-12	9.5-13.5
Macaranga tanarius Muell. Arg.	Leaves	No inhibition zone	No inhibition zone	No inhibition zone
Millettia erythrocalyx Gagnep.	Leaves	No inhibition zone	No inhibition zone	No inhibition zone
	Heartwood	No inhibition zone	No inhibition zone	Zone is not clear 6.5-7
Michelia figo (Lour.) Spreng	Leaves	No inhibition zone	No inhibition zone	No inhibition zone
Mimusops elengi Linn.	Stem barks	No inhibition zone	No inhibition zone	No inhibition zone
Peltophorum dasyrachis (Miq.) Kurz.	Barks/leaves	No inhibition zone	No inhibition zone	No inhibition zone
Piper retrofractum Vahl.	Leaves	No inhibition zone	No inhibition zone	Zone is not clear 7-7.5
Rhinacanthus nasutus (Linn.) Kurz.	Leaves	Zone is not clear 8-11	No inhibition zone	7.5-11
Schefflera leucantha R. Vig.	Leaves	Zone is not clear 10-11	No inhibition zone	11-14
Schleichera oleosa (Lour.) Oken	Stems	No inhibition zone	No inhibition zone	No inhibition zone
Solanum torvum Sw.	Leaves	No inhibition zone	Zone is not clear 8-11	Clear zone 6.5, Translucent zone 6.5-7
Terminalia chebula Retz.	Fruits	No inhibition zone	No inhibition zone	No inhibition zone
Tinospora cordifolia Miers.	Stems	Zone is not clear 6.5	No inhibition zone	7-7.5
Tribulus terrestris Linn.	Stems	No inhibition zone	No inhibition zone	No inhibition zone

from the heartwood of *Artocarpus lakoocha* Roxb. had the largest inhibition zone against three strains approximately 24-25 mm (Figure 2) that is similar to the diameter of the inhibition zone of chlorhexidine, which was the positive control (24-28 mm). *Dracaena loureiri* Gagnep. and *Albizia myriophylla* Benth. exhibited inhibition zone in the range of 9-12 mm and 10-15 mm, respectively (Figure 2).

Minimal bactericidal concentration test showed that *Albizia myriophylla* Benth. revealed a similar bactericidal effect to *Artocarpus lakoocha* Roxb (heartwood) (Table 4). The minimal concentrations of these two plants affected three strains with approximately 2.34 mg/ml while *Dracaena loureiri* Gagnep. had the lowest bactericidal properties against *S. mutans* and *L. casei*. Three plants presented better bactericidal effect against *A. viscosus* compared to the other strains.

The result from the disc diffusion test showed that *Artocarpus lakoocha Roxb.* (heartwood) had the better antibacterial effect among the three plants. Therefore, oxyresveratrol, a major constitutent of *Artocarpus lakoocha* Roxb. (heartwood) was submitted to disc diffusion test. The results from the disc diffusion test (Table 5) showed that the concentration with the largest inhibition zone is 30 mg/ml. However, when the concentration is reduced to 3.75 mg/ml, the inhibition zone is decreased dramatically.

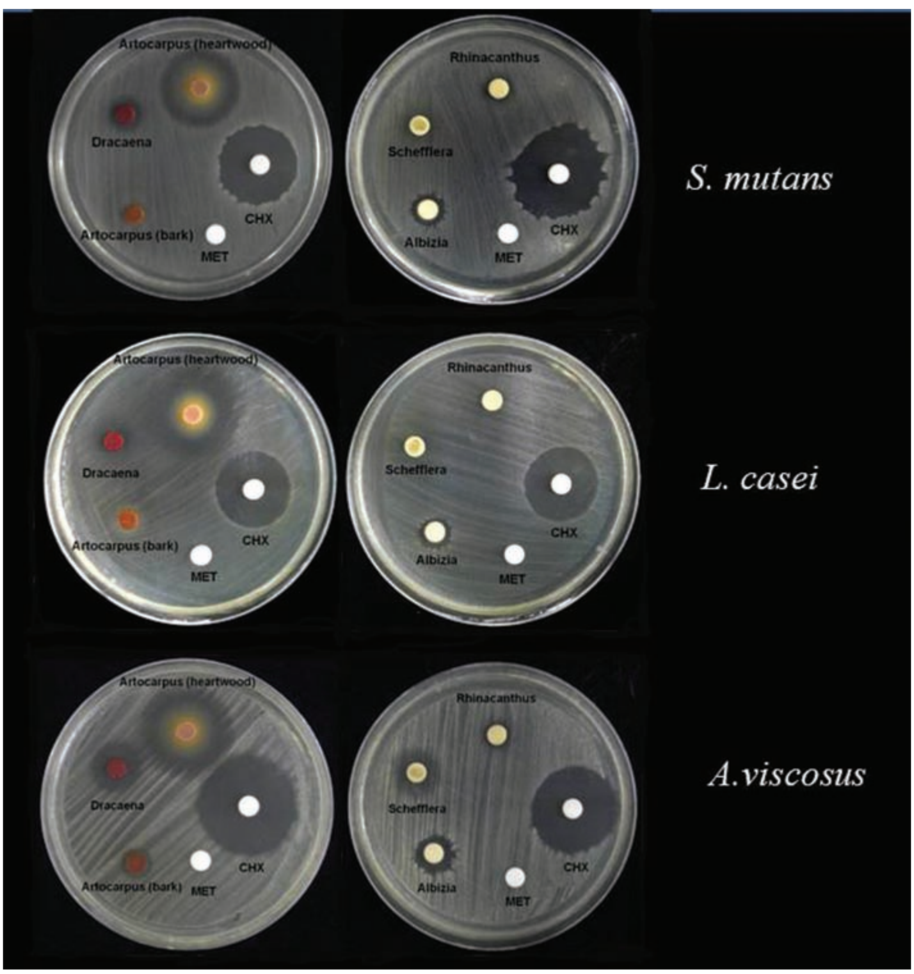

Figure 2. Inhibition zone of six herbal extracts against Streptococcus mutans, Lactobacillus casei, and Actinomyces viscocus. Positive control is chlorhexidine (CHX) and negative control is methanol (MET).

Table 3. Inhibition zone of six herbal extracts (mm±SD).

Herbs	Microorganisms (mm±SD)		
	S. mutans	*L. casei*	*A. viscosus*
Dracaena loureiri Gagnep.	10.1±0.4	10.9±1.03	14.7±0.75
Artocarpus lakoocha Roxb.(Bark)	9.1±0.49	0	9.3±0.86
Artocarpus lakoocha Roxb.(Heartwood)	24.2±0.58	24.9±1.09	25.4±2.14
Albizia myriophylla Benth.	10.4±0.78	9.8±0.75	11.9±1.04
Schefflera leucantha R. Vig.	0	0	13.6±0.45
Rhinacanthus nasutus (Linn.) Kurz.	9±0.64	0	8.1±0.51
Methanol (negative control)	0	0	0
Chlorhexidine (positive control)	29	28	29.5

Table 4. Minimal bactericidal concentration of three herbal extracts.

Herbal extracts	Microorganisms (mg/ml)		
	S. mutans	*L. casei*	*A. viscosus*
Dracaena loureiri Gagnep.	4.68	9.37	1.17
Artocarpus lakoocha Roxb.(Heartwood)	2.34	2.34	1.17
Albizia myriophylla Benth.	1.17	2.34	0.58

Table 5. Inhibition zone of oxyresveratrol isolated from *Artocarpus lakoocha* Roxb. (Heartwood).

Microoganisms	30mg/ml	15 mg/ml	7.5mg/ml	3.75 mg/ml
SM	20.17 (1.03)	16.25 (0.76)	12.17 (0.68)	7.17 (0.26)
LC	11.25 (0.5)	8 (0)	7 (0)	0
AV	18.67 (1.51)	13 (0.71)	8.58 (0.49)	7.17 (0.26)

Discussion

Medicinal plants have been used as therapeutic agents for several centuries and they are widely recognized as alternative medicines for curing varying ailments. Additionally, there has been an increased attention on the effect of herbal plants against oral microorganisms. Therefore, this study investigated the antibacterial effect of various Thai traditional herbal plants that have been used for curing diseases and reducing inflammation to test against three major cariogenic microorganisms, which were *S. mutans*, *L. casei and A. viscosus*. The results from this study showed that six herbal extracts had antimicrobial effect against *S. mutans*, *L. casei and A. viscosus*. However, further investigation revealed that only *Artocarpus lakoocha* Roxb. (heartwood) and *Albizia myriophylla* Benth. had the dramatic effect to these three strains. *Artocarpus lakoocha* Roxb. (heartwood) provided the largest inhibition zone that was slightly the same as chlorhexidine's, which was approximately 24 mm, whereas *Albizia myriophylla* Benth. had inhibition zone approximately 10 mm. In contrast, the result from the MBC test presented that *Albizia myriophylla* Benth. had slightly better antimicrobial effect to the three tested bacteria compared to *Artocarpus* *lakoocha* Roxb (heartwood). This result may be attributed to the problem of solubility of *Albizia myriophylla* Benth. in methanol; therefore, the result from the disc diffusion test was slightly different compared with the result from the MBC test.

Artocarpus lakoocha Roxb., which is called monkey jack or Ma-Had, can be found widely in the regions of South and SouthEast Asia such as in India and Thailand. It is used as Thai traditional medicine for anti-inflammatory therapies as well as an anti-skin aging agent [20]. Its heartwood contains artocarpin, norartocarpin, norcycloartocarpin, cycloartocarpin, resorcinol, oxyresveratrol, and β-sitosterol [21]. Oxyresveratrol is a major component of the heartwood of *Artocarpus lakoocha* Roxb. Previous pharmacological studies of oxyresveratrol have shown that oxyresveratrol possesses various activities including potent inhibitory activity against tyrosinase [22], anti-inflammatory activity, antioxidant activity [23], and antiviral activity [24]. However, the results from this project showed that the antibacterial effect of 30 mg/ml oxyresveratrol isolated from *Artocarpus lakoocha* Roxb. (heartwood) was not better than the crude extract 150 mg/ml. It had higher effect on *S. mutans* and *A. viscosus*. compared to *L. casei.* This may be due to the presence of additional compositions in crude extract enhancing the antibacterial effects. Moreover, the concentration of oxyresveratrol may need to be increased in order to have the same effect as the crude extract.

Another effective anticariogenic herbal plant is *Albizia myriophylla* Benth., which is a small tree belonging to the Leguminosae family. This plant is found widely distributed in tropical and subtropical regions such as in India, Thailand, Malaysia, and Vietnam. Previous reports stated that the medical effects of *Albizia* ingredients came from triterpene saponins, spermine alkaloids, and flavonoids [25,26]. The medicinal effect of this plants that have been reported were cytotoxicity against human cancer cell lines [27,28], and antioxidant activity [29,30], anti-inflammatory effect [31], and antimicrobial activity [32,33]. One study proposed that lupinopholin from the flavonoid group was the most potential agent against the *S. mutans* [26]. The antibacterial properties of *Albizia myriophylla* Benth. extract against *S. mutans* have been reported with minimum inhibitory concentration (MIC) that ranged from 3.9 to 500 μg/ml depending on the growing location [34]. The difference in important ingredients in the same plant is influenced by environment such as temperature, water, soil ingredients, and genetic, which could have led to the different results of antibacterial activity. The MBC value of crude extract from *Albizia myriophylla* Benth. in this study were 1.17, 2.34 and 0.58 mg/ml against *S. mutans*, *L. casei and A. viscosus*, respectively. Therefore, the results of the herbal plant tests from this study provided promising results which may be used to develop potential natural products in the future.

Several products are used as mouthwashes have been launched to the market such as chlorhexidine gluconate and sanguinarine containing mouthwashes. Chlorhexidine is the commonly used mouthwash and has the broadspectrum antimicrobial effect against gram-positive and gram-negative bacteria as well as fungi. Its action disrupts the microbial cell walls [35]. However, because of the side effect of chlorhexidine such as staining and taste reduction of the taste bud, it could not be used in long-term. Therefore, herbal mouthwashes have been introduced in the market for using as a substitute chemical mounthwash such as green tea containing monthwash. Previous studies have reported that catechins in green tea had the ability to inhibit enzyme activity produced from *S. mutans* [36]. Mouthwash was usually suggested for patients who have high caries risk or elderly people who do not have the ability to clean their teeth properly. Therefore, herbal mouthwash should be developed to improve their potential and ability to prevent oral microbial activity.

In conclusions, *Dracaena loureiri* Gagnep., *Artocarpus lakoocha* Roxb. (heartwood) and *Albizia myriophylla* Benth. had antimicrobial effects against *S. mutans, L. casei, A. viscosus.* In addition, only *Albizia myriophylla* Benth. and *A. lakoocha* Roxb. had superior antimicrobial properties compared to *Dracaena loureiri* Gagnep. Oxyresveratrol, which was *A. lakoocha* Roxb. 's pure compound at concentration of 30 mg/ml has bactericidal effect to *S. mutans* similar to crude extract while presented lower effect to other strains compared to crude extracts.

Acknowledgement: None
Conflict of interest: declare no conflicts of interest
Funding: none
Ethical approval: none

References

1. Hellyer PH, Beighton D, Heath MR, Lynch EJ. Root caries in older people attending a general dental practice in East Sussex. *Br. Dent J* 1990; 169: 201-206.
2. Papapanou PN. Periodontal diseases: epidemiology. *Annals of Periodontology* 1996; 1: 1-36.
3. Lawrence HP, Hunt RJ, Beck JD. Three-year root caries incidence and risk modeling in older adults in North Carolina. *Journal Public Health Dentistry* 1995; 55: 69-78.
4. Ravald Nand Hamp SE. Prediction of root surface caries in patients treated for advanced periodontal disease. *J Clin Periodontol* 1981; 8: 400-414.
5. Kitamura M, Kiyak HA, Mulligan K. Predictors of root caries in the elderly. *Community Dentistry and Oral Epidemiology* 1986; 14: 34-38.
6. Gupta BK, Marya C, Juneja V, Dahiya V. Root Caries: An Aging Problem. *The Internet Journal of Dental Science* 2007; 5.
7. Shen S, Samaranayake LP, Yip HK, Dyson JE. Bacterial and yeast flora of root surface caries in elderly, ethnic Chinese. *Oral Disease* 2002; 8: 207-217.
8. Spratt DA, Pratten J. Biofilms and the Oral Cavity. *Reviews in Environmental Science and Biotechnology* 2003; 2: 109-120.
9. Fure S, Romaniec M, Emilson CG, Krasse B. Proportions of *Streptococcus mutans*, lactobacilli and *Actinomyces spp* in root surface plaque. *Scandinavian Journal of Dental Research* 1987; 95: 119-123.
10. Bowden GH. Microbiology of root surface caries in humans. *Journal of Dental Research* 1990; 69: 1205-1210.
11. Sumney DL, Jordan HV. Characterization of bacteria isolated from human root surface carious lesion. *Journal of Dental Research* 1974; 53: 343-351.
12. Schupbach P, Osterwalder V, Guggenheim B. Human root caries: Microbiota of a limited number of root caries lesions. *Caries Research* 1996; 30: 52-64.
13. Sansone C, Van Houte J, Joshipura K, Kent R, Margolis HC. The association of mutans streptococci and non-mutans streptococci capable of acidigenesis at a low pH with dental caries on enamel and root surfaces. *Journal of Dental Research* 1993; 72: 508-516.
14. Gaitonde BB, Vaz AX, Patel JR. Chemical and pharmacological study of root bark of *Streblus asper Linn*. *Indian Journal of Medical Research* 1964; 8: 191–199.
15. Lewis WH. Plants used as chewing sticks. *The Journal of Preventive Dentistry* 1980; 6: 71–73.
16. Triratana T, Thaweboon B. The testing of crude extracts of *Streblus asper* (Koi) against *Streptococcus mutans* and *Streptococcus salivarius*. *J Dent Assoc Thai* 1987; 37: 19–25.
17. Wongkham S, Laupattarakasaem P, Pienthaweechai K, Areejitranusorn P, Wongkham C, Techanitiswad T. Antimicrobial activity of *Streblus asper* leaf extract. *Phytotherapy Research* 2001; 15: 119–121.
18. Nakahara K, Kawabata S, Ono H, Ogura K, Tanaka T, Ooshima T, Hamada S. Inhibitory effect of oolong tea polyphenols on glycosyltransferases of mutans streptococci. *Applied and Environmental Microbiology* 1993; 59: 968–973.
19. Sritularak B, De-Eknamkul W, Likhitwitayawuid K. Tyrosinase inhibitors from *Artocarpus lakoocha*. *Thai Journal of Pharmaceutical Sciences* 1998; 22: 149-155.
20. Suwannalert P, Povichit N, Puchadapirom P Junking M. Anti-Aging Activity and Non-Toxic Dose of Phytooxyresveratrol from *Artocarpus lakoocha Roxb*. *Tropical Journal of Pharmaceutical Research* 2012; 11: 69-74.

21. Khare CP. ***Indian herbal remidies: rational western therapy ayurvedic and other traditional usage botany***. Springer-Verlag Berlin Heidelberg 2004.
22. Kim M, Park J, Song K, Kim HG, Koh JS, Boo YC. Screening of plant extracts for human tyrosinase inhibiting effects. ***International Journal of Cosmetic Science*** 2012; 34: 202-208.
23. Singhatong, S., Leelarungrayub, D., & Chaiyasut, C., (2010). Antioxidant and toxicity activities of *Artocarpus lakoocha Roxb*. heartwood extract. ***Journal of Medicinal Plants Research*** 2010; 4: 947-953.
24. Likhitwitayawuid K, Supudompol B, Sritularak B, Lipipun V, Rapp K, Schinazi RF. Phenolics with anti-HSV and anti-HIV activities from *Artocarpus gomezianus*, *Mallotus pallidus*, and *Triphasia trifolia*. ***Pharmaceutical Biology*** 2005; 43: 651-657.
25. Yoshikawa M, Morikawa T, Nakano K, Pongpiriyadacha Y, Murakami T, Matsuda H. Characterization of new sweet triterpene saponins from *Albizia myriophylla*. ***Journal of Natural Product*** 2002; 65: 1638–1642.
26. Joycharat N, Thammavong S, Limsuwan S, Homlaead S, Voravuthikunchai SP, Yingyongnarongkul BE, Dej-Adisai S, Subhadhirasakul S. Antibacterial substances from *Albizia myriophylla* wood against cariogenic *Streptococcus mutans*. ***Archives of Pharmacal Research*** 2013; 36: 723-730.
27. Haddad M, Laurens V, Lacaille-Dubois MA (2004). Induction of apoptosis in a leukemia cell line by triterpene saponins from *Albizia adianthifolia*. ***Bioorganic & Medicinal Chemistry*** 2004; 12: 4725-4734.
28. Liu R, Ma S, Yu S, Pei Y, Zhang S, Chen X, Zhang J. Cytotoxic oleanane triterpene saponins from *Albizia chinensis*. ***Journal of Natural Product*** 2009; 72: 632-639.
29. Jung MJ, Chung HY, Kang SS, Choi JH, Bae KS, Choi JS. Antioxidant activity from the stem bark of *Albizzia julibrissin*. ***Archive of Pharmacal Research*** 2003; 26: 458-462.
30. Vaughn K, McClain C, Carrier DJ, Wallace S, King J, Nagarajan S, Clausen E. Effect of *Albizia julibrissin* water extracts on low density lipoprotein oxidization. ***Journal of Agricultural and Food Chemistry*** 2007; 55: 4704-4709.
31. Nagaraja Perumal G, Bhavani Shankar R, Malini S, Soumya V, Janardhanan S, Palanivel V, Senthil Kumar KL. Antiinflammatory and ulcer prtotective activities of chloroform extract of *Albizzia chinensis* bark and its phytochemical studies. ***Der Pharmacia Sinica*** 2010; 1: 95-103.
32. Amornchat C, Kraivaphan P, Dhanabhumi C, Tandhachoon K, Trirattana T, Choonhareongdej S. Effect of Chaem Thai mouthwash on salivary levels of mutans streptococci and total IgA. ***The Southeast Asian Journal of Tropical Medicine and Public Health*** 2006; 37: 528-531.
33. Rukayadi Y, Shim JS, Hwang JK. Screening of Thai medicinal plants for anticandidal activity. ***Mycoses*** 2008; 51: 308-312.
34. Joycharat N, Boonma C, Muangnua S, Poorisakpaisal P, Suwannawong C, Limsuwan S. Anti-*Streptococcus mutans* activity of lupinifolin from ethanol extract of *Albizia myriophylla* Benth. ***Khon Kaen University Science Journal*** 2014; 42: 806-819.
35. McDonnell G, Russell AD. Antiseptics and Disinfectants: Activity, Action and Resistance. ***Clinical Microbiology Reviews*** 1999; 12: 147-179.
36. Hamilton-Miller JM. Anti-cariogenic properties of tea (*Camellia sinensis*). ***Journal of Medical Microbiology*** 2001; 50: 299-302.