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Research Report

Rinsing effect of 60% bay leaf (*Syzygium polyanthum wight*) aqueous decoction on the accumulation of dental plaque during fixed orthodontic treatment

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ABSTRACT

Background: *Fixed orthodontic appliance patients have a high risk to increasing plaque accumulation in tooth surface due to the presence of fixed appliance components. Using mouthwash with antibacterial agent from herbal material can control dental plaque accumulation. Bay leaf (BL) contains active compounds such as essential oil, tannin and flavonoid that have been known as an antibacterial agent.* ***Purpose:*** *The purpose of this study was to determine the effect of rinsing with 60% of BL aqueous decoction to the accumulation of dental plaque in fixed orthodontic appliance patients.* ***Method:*** *This research was an experimental clinical research with pretest and post-test control group design conducted on 20 subjects with age ranged between 18-25 years old. All subjects were undergoing the last stage (finishing) of fixed active orthodontic treatment. The subjects were instructed to rinse with 60% of BL aqueous decoction and 0.2% chlorhexidine as a control. Wash out period that needed between rinsing with 60% of BL aqueous decoction and rinsing with 0.2% chlorhexidine was 7 days. Each mouthwash used routinely for 7 days with same duration and intensity. Plaque scoring was measured before and after each treatment using Orthodontic Plaque Index (OPI).* ***Result:*** *One-way Anova test showed that there was a significant difference in the plaque index before and after treatment between the group of rinsing with 60% of BL aqueous decoction and group of rinsing with chlorhexidine ($p<0.05$).* ***Conclusion:*** *Rinsing with 60% BL aqueous decoction can decrease the accumulation of dental plaque in fixed orthodontic appliance patients.*

Keywords: *fixed ortodontic appliance; plaque accumulation; 60% bay leaf aqueous decoction*

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INTRODUCTION

Orthodontic treatment used to be considered cosmetic, but nowadays, dentists and patients alike realize that orthodontic treatment may be a necessity. There are two kinds of orthodontic appliances; removable and fixed appliances. Fixed orthodontic appliance has more complicated design compared to removable appliance which makes cleaning procedure more difficult and increasing the risk of developing plaque retention.[1,2] Accumulation of plaque can be found on fixed orthodontic appliance such as the bracket, wire, interface between bonding material and bracket. An orthodontic bracket may create difficulties to maintain good oral hygiene, leading to plaque accumulation and increase of enamel demineralization. Wire that is used for a long time during orthodontic treatment tends to plaque accumulation which can increase the level of microorganism in oral cavity. The roughness of composite surface as bonding material for orthodontic bracket also can be a predisposition factor for the attachment and growth of intraoral microorganisms.[3,4] Plaque accumulation that is not properly cleaned during fixed orthodontic treatment may result a bad oral hygiene which leads to various oral diseases and failure of orthodontic treatment. Negligence in maintaining good oral hygiene will result in several negative effects, such as the destruction of periodontal

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tissue (gingivitis, periodontitis), caries, halitosis and affecting the length of orthodontic treatment time.[5] Around 5-10% of patients failure in fixed orthodontic treatments are caused by poor oral hygiene.[6]

One of the indicators for dental and mouth hygiene is dental plaque. Plaque control is an attempt to prevent the formation of plaque on the tooth surface. Plaque control can be performed mechanically or chemically. Mechanical plaque control includes tooth brushing and flossing, while the use of mouthwash is an example of chemical plaque control.[7] Mouthwash is a type of plaque control that is easily accessible dan practical to use. This solution is a necessity for most people because it is believed to prevent the formation of dental plaque and occurrence of gingivitis mechanically and chemically. Rinsing using mouthwash can help the solution to reach more areas of teeth and intraoral surfaces, especially the interproximal areas which are not accessible mechanically.[8] The example of mouthwash that is easily accessible in the market is chlorhexidine (CHX). CHX has been proven to decrease the accumulation of plaque due to its broad spectrum antimicrobial, bactericidal, and bacteriostatic properties to any kind of microorganisms, including bacteria, fungi, and virus.[9] CHX is still the gold standard for its antimicrobial action and high substantiveness, but side effects in long-term used such as tooth and restoration staining, soft tissue staining, increased calculus deposition, unpleasant taste, taste alteration, burning sensation, desquamation and mucosal irritation limit its continued use. CHX can also lead oral discomfort in some of patients with chemotherapy-induced mucositis, xerostomia or ulcerative oral mucosal conditions.[8,10]

Nowadays, natural materials are being used and developed as more safe and cheaper alternatives with lesser side effects compared to chemical based products.[11] A type of traditional herbal plant that is commonly seen in Indonesia is bay leaf (*Syzygium polyanthum weight*). Bay leaf (BL) that is also used as cooking spice, has many pharmacological activities that are useful in the field of dentistry. The chemical properties of BL consist of tannins, flavonoid and essential oils (0.05%), including citric acid and eugenol.[12] Tannin is an active compound that has antibacterial activity. Tannin can inhibit the growth of bacteria by reacting with protein due to solidification on cell protein of bacterium (occurrence of protein denaturation). Flavonoid has biological and pharmacologic activities, including antibacterial activity.[13] Essential oil also can inhibit the growth of some bacteria. BL is very effective against several bacteria such as *Salmonella enterica* and *E. coli*.[14,15] The antibacterial activity of BL can be also due compounds non-flavonoid origin. The high contents of eugenol, methyl eugenol and fatty acid methyl esters together with other active components could contribute to its overall antibacterial activity.[16,17] This research was carried out to investigate the effect of rinsing with 60% of BL aqueous decoction to the decreasing accumulation of dental plaque in fixed orthodontic appliance patients.

MATERIALS AND METHODS

This research was a clinical experimental with pretest and post-test control group design conducted on 20 subjects with age ranged between 18-25 years old. The study was approved by The Ethics Committee of Faculty of Dentistry, Universitas Gadjah Mada with number 00789/KKEP/FKG-UGM/EC/2016. A total of 100 grams of fresh bay leaves were minced and boiled in 200 ml of boiling water until 100 ml of decoction was left. The concentration of the decoction was 100%. It was separated from the minced leaves and left to chill in room temperature (25^{O} C). The decoction was filtered afterward with a 0.45 µ pore (millipore) diameter filter. Sixty percent of BL decoction was obtained by adding 40 ml of aquades into 60 ml of 100% BL decoction.

All eligible subjects were given oral and written informations about the products and the purpose of the study and were asked to sign an informed consent prior to the studied procedures. All subjects were in the last stage (finishing) of fixed active orthodontic treatment. Exclusion criteria were considered: pregnancy, systemic disorders, patients under preventive treatment, and absence of studied evaluated teeth. Subjects were instructed to rinse their mouths with 60% BL aqueous decoction and 0.2% CHX mouth rinse as a control. The time interval between mouth rinsing with 60% BL aqueous decoction and 0.2% CHX mouth rinse was 7 days. Each mouthwash was routinely used for 7 days with the intensity of 2 times a day (after tooth brushing in the morning and at night) for 30 seconds strongly, using 10 ml of the solution in each rinsing. After a week of washout period, each group was instructed to use the opposite mouthwash for 7 days. The subjects in the study were still instructed to brushing (with *bass* technique) using pumice toothpaste for seven days of treatment. Plaque measurement was performed before and after application each mouth rinse using the Orthodontic Plaque Index (OPI) method.

The OPI developed by Declerk in 1989, is a special index for patients with fixed orthodontic appliances. OPI has a higher diagnosis performance and accuracy compared to Quigley and Hein Index, and Modified Navy Plaque Index.[18,19] In this study, we used disclosing agents that were applied on vestibular surfaces of teeth with orthodontic brackets and then the presence of dyed plaque was evaluated with the Yes-No system in 3 areas of vestibular surfaces of a tooth (Figure 1). All measurements were carried out under the same conditions and were performed by two calibrated examiners who were blinded to the applied regimen. The examiners performed their analysis with a satisfactory intraexaminer and interexaminer reliability *Kappa* index value (0.75). Each area has its own level of difficulty depending on the accessibility for cleaning (occlusal area = 1 = easily accessible; cervical area = 2 = accessible with certain difficulty; central area = 3 = poorly accessible). The values found are entered into a work table (Table 1).[20]

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Resulting index is obtained by means of the formula:[20]

$$\text{OPI \%} = \frac{\text{sum of values from dyed areas}}{\text{total number of teeth x 6}} \text{ x } 100\%$$

The condition of oral hygiene then evaluated according to the following scheme: 0-30%= excellent hygiene; 30-50%= average hygiene; over 50% = insufficient hygiene.[20]

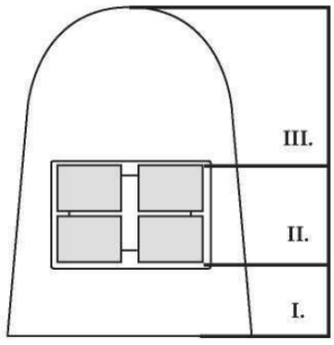

Figure 1. Scheme distribution of vestibular surface for evaluation of OPI: I = occlusal area=easily accessible; cervical area = 2 = accessible with certain difficulty; central area = 3 = poorly accessible[21]

RESULTS

The result showed decreasing of plaque index before and after rinsing with 60% BL aqueous decoction as well as rinsing with CHX. Decreasing of plaque index on group using 60% BL aqueous decoction 60% amounts 43.1% ± 4.02%, while other group rinsing with CHX was 42.1% ± 4.3%. Figure 2 shows the coloured dental plaque after application of disclosing agent solution in patients rising with 60% of BL aqueous decoction and rinsing with 0.2% CHX.

Normality test result by Shapiro-Wilk showed normal distribution of data ($p>0.05$), while homogeneity test by Levene's Test showed all the data have a homogeneous variance ($p>0.05$). The result of normality test and homogeneity test showed analysis could be done by parametric test using One-way Anova. Table 2 showed the result of One-way Anova analysis obtained p-value $p<0.05$. The result showed that there were significant differences in plaque indexes before and after rinsing between treatment groups. Differences between treatment groups could be determined by post-hoc test using Least Significant Difference (LSD). The results of LSD test in Table 2 showed that there were significant differences in group before and after rinsing with BL, group after rinsing with BL and before rinsing with CHX, group before and

Table 1. Orthodontic Plaque Index: recorded dental plaque in individual areas multiplied by the relevant factor of cleaning difficulty[20]

Cervical	2×											Total
Central	3×											Total
Occlusal	1×											Total
Teeth		5	4	3	2	1	1	2	3	4	5	
Occlusal	1×											Total
Central	2×											Total
Cervical	3×											Total

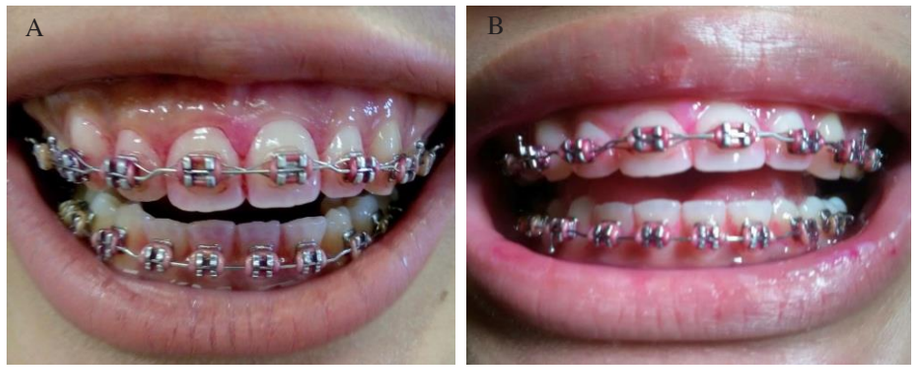

Figure 2. Coloured dental plaque after application of disclosing agent solution in patients rinsing with 60% of bay leaf aqueous decoction (A) and rinsing with 0.2% CHX (B).

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after group rinsing with CHX ($p<0.05$). Whereas in the group before rinsing with BL and before rinsing with CHX, group after rinsing with BL and after rinsing with CHX had no significant difference ($p>0.05$).

DISCUSSION

Based on the study there were decreasing of plaque indexes in groups rinsing with 60% BL aqueous decoction as well as groups rinsing with CHX in fixed orthodontic appliance patients. Percentage of plaque index reduction in groups gargling by 60% BL aqueous decoction was 43.1% ± 4.02%, while other group rinsing with CHX was 42.1% ± 4,3%. Both of groups belongs to average hygiene category (31-50%).[20] The study used pumice as a toothpaste thus anti-bacterial agent only came from mouthwash (BL and CHX) so reduction of plaque index was not optimal and only achieved moderate level. The used of pumice toothpaste without detergent and abrasive materials aimed to minimalize a bias observation. Results of the study in each group showed rinsing with 60% BL aqueous decoction as well as rinsing with 0.2% CHX could decrease accumulation of dental plaque in fixed orthodontic appliance patients ($p<0.05$). Another study showed that chlorhexidine was a gold standard of mouthwash and proven to be broad-spectrum of anti-bacterial agent and also having bactericidal and bacteriostatic towards all of the type microbes, fungi and virus.[22]

In this study, BL potentially proved on reduction plaque index in fixed orthodontic appliance patients. It is supported by a previous study conducted by Sumono and Wulan[12] that rinsing with BL aqueous decoction could decrease the colony number of *Streptococcus sp*. BL are rich in essential oils, flavonoids and tannins which have been known as antibacterial agent.[23] The activity of essential oils can affect both the external envelope of the cell and the cytoplasm of bacteria. The specific mechanisms action of essential oils in decreasing bacterial accumulation is via hydrophobicity. The typical of essential oils allows them to partition in the lipids of the bacterial cell membrane and mitochondria and leading to leakage of its cell contents and responsible for the disruption of bacterial structures.[24,25] Tannin also has antibacterial activity and it is related to the ability to inactivated adhesin bacterial cell, enzyme and interfered protein transport on cell layer so that bacterial metabolism becomes impaired.[26] Tannin have the ability to reduce the attachment of bacteria by binding to proline-rich protein of the salivary pellicle or to the cell-surface lipoteichoic acid.[27] Tannin can also inhibit growth and kill bacteria by reacting with the cell membrane, resulting in leakage of essential metabolites that inactivate the bacterial enzyme system.[28]

BL also contained flavonoid besides essential oil and tannin. Flavonoids are well-known plant compounds that have antibacterial property.[29] Action mechanism of flavonoid as an antibacterial is to interfere motility of bacteria, synthesis of nucleic acid, damage fluidity of membrane therefore membrane fluidity of outer and inner layer will decrease and interfere energy metabolism of bacteria.[30,31] Moreover, their mode of antimicrobial action may be related to their ability to inactivated microbial adhesion, enzymes and cell envelope transport proteins.[32] The antibacterial activity of BL can be also due to compounds non-flavonoid origin. The high contents of eugenol, methyl eugenol and fatty acid methyl esters together with other active components could contribute to its overall antibacterial activity.[16,17]

Plaque index score in group before rinsing using BL with group before rinsing with CHX showed no significant differences ($p>0.05$), while plaque index score in group after rinsing using BL and group before rinsing with CHX showed significant differences ($p<0.05$). The result showed washout process period in this study was successful. Washout period aimed to ensure the effect of prior exposure of first mouthwash had been stopped before the second mouthwash applied.[33] Plaque index score in group after rinsing with BL and after rinsing with CHX showed no significant difference ($p>0.05$), the means rinsing used 60% BL aqueous decoction have the same effect with chlorhexidine as gold standard mouthwash to decrease the accumulation of dental plaque. One of excellences rinsing with BL was no alteration in taste sensation, while rinsing with CHX raised bitter tastes, caused change of temporary sensation and burning sensation and also long-term use of CHX can be associated with local side effects such as impaired sense of taste, tooth staining and occasional irritation and desquamation of mucous membranes.[8,10,34,35]

Table 2. Descriptive statistics and results of the Anova and LSD tests comparing the plaque index in the 4 groups tested

Group	n	Plaque index (%)	Significance*	p-value		
				After BL	Before CHX	After CHX
Before BL	10	56.4±3.05	p=0.001	0.001*	0.621	0.001*
After BL	10	43.1±4.02			0.,001*	0.741
Before CHX	10	57.0±3.78				0.001*
After CHX	10	42.7±4.30				

Values are presented as mean ± standard deviation or p-value only. *by ANOVA, *Significant differences between groups ($p < 0.05$).

ANOVA: Analysis of variance; BL: 60% Bay leaf aqueous decoction, CHX: 0.2% Chlorhexidine

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Finally, it can be concluded that rinsing with 60% bay leaf (*Syzygium polyanthum wight*) aqueous decoction can reduce the accumulation of dental plaque in fixed orthodontic appliance patients.

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