# Effect of Ethanol Extract of Artocarpus lakoocha Roxb. Leaves on the Shear Bond Strength of Metal Bracket

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**Abstract**

Fixed orthodontic treatment will lead to plaque accumulation caused by the appliance. The use of chlorhexidine mouthwash as a plaque control can affect the shear bond strength of metal bracket. Thus, natural ingredients are needed as an alternative in overcoming these side effects. The aim of the study was to determine the effect of the ethanol extract of Artocarpus lakoocha leaves on the shear bond strength of metal bracket.

This type of research is an experimental laboratory with a post-test only control group design. The samples were 25 premolars which were divided into 5 groups with different types of immersion solutions. Teeth that have been bonded with orthodontic brackets are immersed in each immersion solution for 6 hour. Shear bond strength were tested using Universal Testing Machine. Data were analyzed by one way ANOVA and posthoc LSD.

The results of the one-way ANOVA test stated that there was no significant difference in shear bond strength ($p = 0.138 > 0.05$). Statistically, the shear bond strength is not affected by the type and concentration of immersion solution. LSD test results obtained saliva with Artocarpus lakoocha 3.125% ($p = 0.03 \leq 0.05$), and Artocarpus lakoocha 3.125% with 6.25% ($p = 0.02 \leq 0.05$) had significant differences.

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## Introduction

Irregular teeth have many retention areas that cause cleaning and maintenance difficult and require orthodontic treatment. However, the existence of fixed orthodontic appliances actually add new retention areas for plaque accumulation and tooth cleaning becomes more difficult.[1–4] Plaque control is especially difficult in patients with fixed orthodontic appliances. The use of mouthwash accompanied by regular mechanical cleaning can reduce the occurrence of plaque formation on the tooth surface.[5]

Chlorhexidine (CHX) is still the most frequently prescribed mouthwash, has long been known as a chemical plaque control agent and has been proven effective in preventing dental plaque and reducing tooth decay and pathogenic microorganisms.[6-8] CHX concentration of 0.2% is considered the gold standard in reducing plaque formation and as an antibacterial compound.[9] Based on several previous studies, it was stated that CHX could be used before the bracket insertion procedure. However, the use of CHX mouthwash can affect the shear bond strength of the bracket attachment. Shear bond strength can cause the failure of fixed orthodontic treatment performed.[10,11] The minimum shear bond strength value acceptable for orthodontic clinical use is 6– 8 MPa.[12]

Bracket attachment to the tooth surface is very important for effective and efficient treatment. However, during the treatment period, the bracket may become detached from the enamel surface. Detached brackets in the patient's mouth during orthodontic treatment can cause inconvenience to both the patient and the clinician because it increases the visit time, duration of treatment and additional costs occurred.[10,13,14,15]

Several orthodontists have investigated the effect of using CHX on the shear bond strength of bracket attachments. The shear bond

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strength of the bracket attachment will not be affected if CHX is used before the bonding and etching procedure. If CHX is used on etched enamel, it can affect the shear bond strength.[13,16,17] Singh et al who compared the shear bond strength of the orthodontic bracket attachment after using herbal mouthwash (Befresh), CHX and Listerine obtained that the shear bond strength of the orthodontic bracket attachment was higher in the CHX mouthwash group.[14] Therefore, a natural ingredient is needed as an alternative to overcome the side effects of using CHX mouthwash.

Artocarpus lakoocha is one of the traditional medicinal plants found in many tropical areas. Artocarpus lakoocha is widespread in the Indian subcontinent and Southeast Asia. The main active compound components contained in Artocarpus lakoocha leaves are flavonoids.[18,19,20]

Research by Baidas et al has reported that the activity of flavonoids contained in green tea and chamomile extracts is effective in increasing the shear bond strength of orthodontic brackets.[21]

The importance of shear bond strength in supporting fixed orthodontic treatment and there has not been any research examining the ability of Artocarpus lakoocha leaves to increase the shear bond strength of orthodontic bracket, the researchers are interested in doing this research.

## Materials and methods

This research is an experimental laboratory research with a post-test only control group design. This research was conducted in three locations, namely North Sumatra ASPETRI Medicinal Plant Research and Development Laboratory, Department of Prosthodontics, Faculty of Dentistry, Universitas Sumatera Utara and IFRC Laboratory of Mechanical Engineering Masters, Universitas Sumatera Utara in January - February 2022.

The sample of this study were premolars that had been extracted and obtained from a dentist's practice in the city of Medan which met the inclusion and exclusion criteria and divided into 5 groups:

Group A: teeth that had been bonded with orthodontic brackets were immersed in artificial saliva for 6 hours

Group B: teeth that had been bonded with orthodontic brackets immersed in 0.1% chlorhexidine mouthwash for 6 hours.

Group C: teeth that have been bonded with orthodontic brackets immersed in ethanol extract of Artocarpus lakoocha leaves with a concentration of 3.125% for 6 hours.

Group D: teeth that have been bonded with orthodontic brackets immersed in ethanol extract of Artocarpus lakoocha leaves with a concentration of 6.25% for 6 hours.

Group E: teeth that have been bonded with orthodontic brackets immersed in ethanol extract of Artocarpus lakoocha leaves with a concentration of 12.5% for 6 hours.

The research procedure consisted of several stages, namely sample preparation, preparation of ethanol extract of Artocarpus lakoocha leaves, dilution of the extract, sample immersion, and shear bond strength test of bracket attachment. Data were analyzed using one way ANOVA test and post hoc LSD.

## Results

The results of this study report on the shear bond strength of the metal bracket which is affected by the ethanol extract of Artocarpus lakoocha leaves as a natural compound compared to CHX and saliva.

| Group | Mean | |
|---|---|---|
| | Shear bond strength (MPa) | Standard deviation |
| A | 16,29 | 6,68 |
| B | 14,78 | 3,19 |
| C | 10,27 | 0,74 |
| D | 16,70 | 3,68 |
| E | 13,20 | 4,26 |

**Table 1.** Average Value of Shear Bond Strength in the Research Group.

Table 1 shows the various shear strength of each group. The best shear bond strength was found in the ethanol extract of Artocarpus lakoocha leaves with concentration of 6.25%, namely 16.70 MPa, followed by the saliva group. Although the salivary group has similarities with the Artocarpus lakoocha 6.25% group, the salivary group has a high standard deviation value, meaning that this group has a high error value which can allow its adhesive properties to be disrupted with a short duration of time. Based on the description analysis, the ethanol extract of Artocarpus lakoocha leaves with concentration of 6.25% had better performance compared to

the CHX group and the saliva group.

The data is said to be normally distributed and homogeneous if the test results show p > 0.05. So, it has requirements to be analyzed with One Way ANOVA.

| Group | p *value* |
|---|---|
| A | |
| B | |
| C | 0,138 |
| D | |
| E | |

Description: p>0.05 = there is no significant difference

**Table 2.** One Way ANOVA Test of Shear Bond Strength in the Research Group.

One Way Anova analysis in Table 2 can be stated that there is no significant difference in shear bond strength between the treatment groups with p = 0.138> 0.05. The results show that statistically the shear bond strength is not affected by the type and concentration of immersion solution.

Table 3 reports the results of the follow-up test from One Way ANOVA, namely the LSD test. The LSD test was carried out to see if there were significant differences between the groups tested. From the test results it was found that the shear bond strength showed that the group that had a significant difference was the salivary group with 3.125% Artocarpus lakoocha Leaves (p = 0.03 ≤ 0.05), between 3.125% Artocarpus lakoocha Leaves and 6.25% Artocarpus lakoocha Leaves groups (p = 0.02 ≤ 0.05). In addition, there is no significant difference between them (p>0.05).

| Group | A | B | C | D | E |
|---|---|---|---|---|---|
| A | | 0,58 | 0,03 | 0,88 | 0,25 |
| B | 0,58 | | 0,10 | 0,48 | 0,55 |
| C | 0,03 | 0,10 | | 0,02 | 0,28 |
| D | 0,88 | 0,48 | 0,02 | | 0,20 |
| E | 0,25 | 0,55 | 0,28 | 0,20 | |

**Table 3.** LSD Further Test of Shear Bond Strength Values in the Study Group.

## Discussion

Fixed orthodontic appliances have a complicated shape, so that this can facilitate the formation of plaque accumulation on the surface of the teeth and around the brackets as well.[22] Poor oral hygiene of fixed orthodontic users can result in plaque build-up and an increase in the number of cariogenic bacteria, including Streptococcus mutans.[16] A study conducted by Ananda et al reported that Streptococcus mutans bacteria would be significantly reduced after using CHX.[23]

CHX is an antibacterial or antiseptic agent that is well known and widely used in dentistry. CHX is very effective as a plaque control agent and treats gingivitis. CHX is much more effective in preventing plaque accumulation than reducing existing plaque deposits.[16] CHX was chosen as a positive control in this study because the compound has significant antibacterial ability against gram-positive cariogenic bacteria.[24] Research conducted by Cury et al reported that its application as prophylactic agents prior to bracket placement procedures can prevent accumulation of plaque and debris that damage teeth.[25]

Fluoride is one of the prophylactic materials that can affect the strength of bracket attachment, so it is not recommended. Instead, Chlorhexidine has been proven and effective as an antibacterial agent.[16] The mechanism of action of CHX interferes with the process of cell membrane transport and bacterial metabolism, so that the cell wall becomes lysis.[26] Application of CHX on the enamel surface is a prevention on the tooth surface around the bracket against cariogenic bacteria.[27] A study conducted by Frey et al stated that the concentration of CHX had no effect on the shear bond strength on the enamel surface. The use of CHX as a prophylactic agent on teeth before etching is recommended as part of the orthodontic bracket bonding procedure.[25] In this study, researchers used CHX at a concentration of 0.1%.

The success of a fixed orthodontic treatment depends on the attachment between the brackets to the tooth enamel so that it does not fall off during treatment.[10,13] Ideally, orthodontic brackets should provide good bond strength, support masticatory loads, and be easily removed without causing injury to the tooth surface.[28]

Based on the results of the study, in general the ethanol extract of Artocarpus lakoocha leaves has an effect on the shear bond strength of metal bracket. From the results of this study it can be seen that the best shear bond strength was in the ethanol extract group of Artocarpus lakoocha leaves with a concentration of 6.25% with an average shear bond strength of 16.70 MPa. The ethanol extract of Artocarpus lakoocha leaves with a concentration of 6.25%

had better performance compared to the control group, namely CHX and saliva. However, in some literature, there are no clear guidelines regarding shear bond strength limits, but in fact a good biomaterial should allow for minimal shear bond strength to be generated so that the teeth are not damaged when the bracket is removed.[29,30]

The results of the Oneway Anova test can be stated that there is no significant difference in shear bond strength between the treatment groups ($p>0.05$). The results show that statistically the shear bond strength is not affected by the type and concentration of immersion solution. Biologically, the penetration of plant active ingredients into metals and bonding materials prevents an increase in porosity and increases material elongation, so that the material mixed with plant active compounds can work together to reduce the size of the porosity, thus strengthening the bond between the bracket and the tooth surface, increasing the concentration of Artocarpus lakoocha leaves extracts can indirectly increase the surface hydrophobicity of the bonding area, so that the shear bond strength increases when pressure is applied.[31] Martalia et al reported that brackets' bonding can at least withstand a pressure force of 6–8 MPa, chemical bonding mechanisms are known to be able to hold surfaces together after orthodontic treatment is complete.[32]

Artocarpus lakoocha belongs to the Moraceae family, this plant is known as Monkey Jack in English and Ayurvedic is known as Lakuch, Kshudra Panas, Granthiphala and Pitanaasha.[33] Artocarpus lakoocha plants contain flavonoids, tannins, saponins and glycosides. The main components of Artocarpus lakoocha leaves are found in flavonoids such as artonin a, artonin b, and artocarpin which can inhibit chemical mediators.[34]

Pharmacodynamically, flavonoids and other compounds present in Artocarpus lakoocha leaves have antioxidant properties. Mechanically these flavonoid compounds increase tension when tension occurs and decrease stress when adapting to environmental changes. Flavonoid compounds are polyphenolic compounds that have 15 carbon atoms arranged in a C6-C3-C6 configuration, meaning that their carbon skeleton consists of two C6 groups (substituted benzene rings) connected by a three-carbon aliphatic chain.[35,36]

The results of this study are in line with Berger et al that the content of flavonoids in green tea extract can increase the shear bond strength of orthodontic brackets.[37] The results of this study were also supported by Baidas et al that chamomile extract can increase the shear bond strength of orthodontic brackets due to the content of flavonoids, apigenin and quercetin.[21] A study by Alhasyimi et al stated that the application of mangosteen peel extract as an antioxidant due to the content of flavonoids as antioxidants can reverse the reduced shear bond strength in orthodontic brackets.[38]

In this study it was seen that the shear bond strength test did not show a significant difference. This means that the treatment group, namely the ethanol extract of Artocarpus lakoocha leaves as well as the salivary and CHX control groups, did not have a significant effect on changes in shear bond strength and maximum load, although the description indicated that there were differences in shear strength values between each of these groups. Researchers assumed that the solution used for the bracket immersion had different quality and quantity in response to an increase in adhesive bonding. This difference tends to be influenced by the constituent elements of the compounds contained therein, in this case the flavonoids which are contained in many plants.

## Conclusions

•The ethanol extract of Artocarpus lakoocha leaves did not significantly affect the shear bond strength of metal bracket.

•Differences in the concentration of the ethanol extract of Artocarpus lakoocha leaves did not have a significant effect on the shear bond strength of metal bracket.

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## Declaration of Interest

The authors declare no conflict of interest, financial or otherwise.

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