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THE EFFECT OF ADMINISTRATION OF ROBUSTA COFFEE BEAN EXTRACT GEL (*Coffea robusta*) ON ALVEOLAR BONE RESORPTION IN PERIODONTITIS RAT INDUCED BY *PORPHYROMONAS GINGIVALIS*

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Abstract

Periodontitis is an inflammatory disease of the supporting tissues of the teeth caused by a specific group of microorganisms that results in progressive damage to the periodontal ligaments and alveolar bones with the formation of pockets, recessions, or both. The main etiological factor of periodontal disease is microorganisms. One of the microorganisms that can induce periodontitis is Porphyromonas gingivalis. P. gingivalis is a Gram-negative anaerobic bacteria. This bacteria in the form of a coccobacilli with a length of 0.5–2 µm. P. gingivalis can damage host cells by releasing virulence factors and extracellular proteases which will result in damage to periodontal tissue resulting in changes in innate immunity and an inflammatory response. This study uses a natural ingredient, namely robusta coffee extract gel as a therapy for tissue damage caused by the bacteria. Coffee contains many active substances such as polyphenols and alkaloids. The polyphenol contents found in coffee are, chlorogenic acid, ferulic acid, and caffeine. The content of these active ingredients has antibacterial, anti-inflammatory, and antioxidant properties that make bacteria unable to survive and suppress tissue damage, so that healing can occur faster. This study aims to analyze the effect of giving robusta coffee bean extract gel on alveolar bone resorption in male wistar rats induced by Porphyromonas gingivalis bacteria on the histological picture.

Research conducted is a laboratory experiment with a design post test only control group design which was carried out in the Biomedical Laboratory of FKG UNEJ. This study used 12 wistar mice which were divided into 3 groups, namely group I (control), group II (placebo gel), and group III (coffee gel). All groups were given a 0.05 ml injection treatment P.gingivalis with a

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concentration of 1.5x108 CFU/ml for 28 days to get a chronic periodontitis state. In group I, no further treatment was given for 14 days and decapation was carried out on the 43rd day. Group II was given a placebo gel treatment for 14 days and was decapitated on the 43rd day. Group III was given a coffee extract gel treatment for 14 days and was decapitated on the 43rd day. After being decapitated, tissue fixation with a 10% formalin solution is then carried out processing tissue with coloring hemactosilin-eosin, then observation of alveolar bone resorption using the image raster.

The data were carried out by the Shapiro-wilk normality test with normal distribution results (p>0.05), the levene homogeneity test with homogeneous results (p>0.05), and the ANOVA one-way parametric test with insignificant results (p>0.05). The results of the group given coffee extract gel produced the least bone resorption compared to the control and placebo groups. This shows the existence of anti-inflammatory, antioxidant, and antibacterial effects that cause faster tissue healing in group II The conclusion of this study is that the administration of robusta coffee extract gel is not significant (p>0.05) inhibits the resorption of alveolar bone caused by bacterial induction Porphyromonas gingivalis.

Keywords: *Robusta coffee, Porphyromonas gingivalis, Periodontitis*

INTRODUCTION

Based on data, the prevalence of periodontitis in Indonesia is 74.1%. It can be assessed that the prevalence of periodontitis in Indonesia is still fairly large and there is a need for countermeasures for periodontitis (DEPKES RI, 2018). Periodontitis is an inflammatory disease of the supporting tissues of teeth caused by a specific group of microorganisms that results in the progressive destruction of the periodontal ligaments and alveolar bones by the formation of pockets, recessions, or both (Cotti, 2010). The main etiological factor for the occurrence of periodontal disease is microorganisms. One of the microorganisms that can induce periodontitis is *Porphyromonas gingivalis* (Newman, 2019).

The destruction stage of periodontitis occurs due to inflammation caused by disturbances in the balance of the number of bakeries and the immune response (Kinane, 2017). Porphyromonas gingivalis secretes an endopeptidase compound in the form of gingipain that can induce macrophages and fibroblasts to produce pro-inflammatory cytokines such as interleukin (IL-8), and *tumor necrosis-factor α* (TNF-α). TNF-α can induce the expression of adhesion molecules and mediators that facilitate and strengthen the inflammatory response, the production of metalloproteinase matrix and the resorption of alveolar bone (Grenier, 2010).

Coffee (*Coffea Sp.)* is the plantation commodity that is most familiar to the community, starting from the upper to lower economic circles (Sukohar, 2011). Robusta coffee beans (*C. robusta*) have beneficial ingredients for wound healing such as chlorogenic acid and caffeine (Yuwono, 2013). The caffeine content in robusta coffee beans (*C. robusta*) is twice as much as Arabica coffee beans, and the chlorogenic acid content in robusta coffee beans (*C. robusta*) is more than in other medicinal plants (Ciptaningsih, 2012).

Robusta coffee beans (*C. robusta*) contain active compounds, namely polyphenols and alkaloids. Polyphenol compounds (chlorogenic acid) and alkaloids (caffeine) in robusta coffee beans (*C. robusta*) have effects as anti-inflammatory and antioxidant (Ciptaningsih, 2012). The anti-inflammatory properties of caffeine and chlorogenic acid can inhibit the production of a number of pro-inflammatory mediators, including TNF-α, IL-1β, IL-6 (Xu et al., 2013). From this statement, a preparation of robusta coffee extract will be made in gel form.

Gel preparations are used because they have the advantage of not needing to be repeated so that they are more efficient (Sidiqa & Herriyawan, 2017). In addition, the use in gel form will make it easier to apply the gel to the patient's periodontal pocket, reduce side effects, and increase bioavailability (Adha *et al*., 2017). Therefore, the researcher hopes that robusta coffee bean extract gel (*C. robusta*) can be used to inhibit alveolar bone resorption in periodontitis.

RESEARCH RESULTS

This study aimed to determine the effect of giving robusta coffee extract gel can inhibit alveolar bone resorption caused by the induction of *Porphyromonas gingivalis* bacteria. Alveolar bone resorption is measured by finding the *Cemento Enamel Junciton (CEJ)* point and then pulling it to the cervix until it reaches the highest point of the alveolar bone using *Image Raster Software* (Figure 4.1 and Figure 4.2).

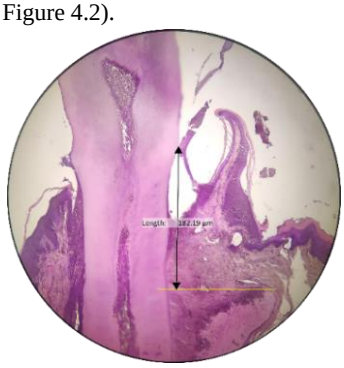
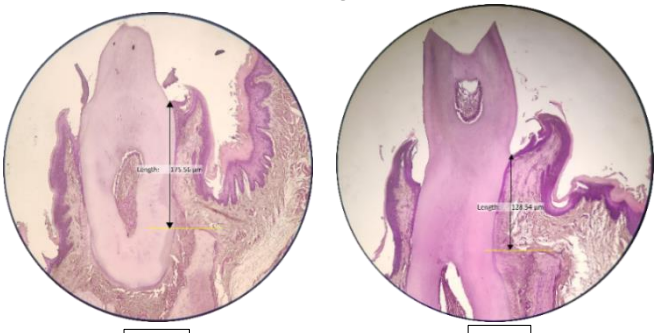


Figure 4.1 Histological description of periodontal tissue of mice in the euthanized control group at day 43. RT: bone resorption, TA: alveolar bone, GI: dental. 100x magnification



A B

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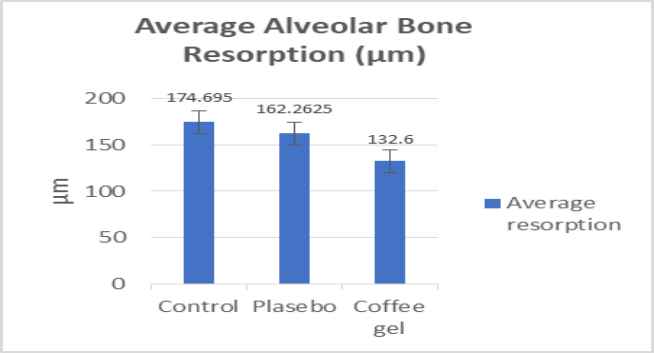
Figure 4.2 Histological description of periodontal tissue of rats in the treatment group. There was a smaller alveolar bone resorption in the robusta coffee gel treatment group (B) than in the placebo gel group (A). RT: bone resorption, TA: alveolar bone, GI: dental. 100x magnification

The results of the calculation of the average alveolar bone resorption of rats in each group are shown in table 4.1 and figure 4.3 below.

Table 4.1 Average alveolar bone resorption (µm)

Treatment Groups	Average	N	Standard Deviation
Negative Control	174.6950	4	42.93722
Placebo Treatment	162.2625	4	34.03632
Coffee Gel Treatment	132.6000	4	34.49189

Figure 4.3 Average histogram of alveolar bone resorption



Based on the results in table 4.1 and figure 4.3, it can be seen that the control group that was euthanized on day 43 had the largest average alveolar bone resorption (174.6950 µm), while the euthanized coffee gel treatment group on day 43 had the smallest average alveolar bone resorption (132.6 µm). The data analysis was continued with the Kolmogorov-Smirnov and Shapiro-Wilk Normality Tests (Table 4.2), the Levene Homogeneity Test (Table 4.3), and the ANOVA One-way Test (Table 4.4).

Table 4.2 Shapiro-Wilk Normality Test

	Treatment Groups	Shapiro-Wilk		
		Statistic	Df	Mr.
Measurement Results	Control	.961	4	.787
	Placebo Treatment	.991	4	.965
	Coffee Gel Treatment	.972	4	.851

The data obtained were tested for normality using Shapiro-wilk p>0.05 (Table 4.2). The results of the normality test showed that the data was normally distributed, then the data was tested for homogeneity using the Levene test.

Table 4.3 Levene homogeneity test

Levene Statistic	df1	df2	Mr.
.062	2	9	.940

The results of the Levene test in Table 4.3 showed that the data were homogeneously distributed (p>0.05). Next, *a one-way anova test was carried out*

Table 4.4 Anova Test

Measurement Results	Sum of Squares	df	Mean Square	F	Mr
Between Groups	3741.893	2	1870.947	1.339	.310
Within Groups	12575.300	9	1397.256		
Total	16317.193	11			

The results of the anova test showed no significant difference in table 4.4 (p>0.05) so it was not continued with the LSD test.

DISCUSSION

This study aims to determine the effect of the application of robusta coffee gel on the alveolar bones of male wistar rats induced by *Porphyromonas gingivalis*. *Porphyromonas gingivalis* bacteria is one of the main causes of periodontitis which can result in progressive damage to the periodontal ligaments and alveolar bones characterized by the formation of pockets, gingival recession, or both (Newman et al., 2019).

The results of this study showed that all treatment groups experienced periodontitis marked by tissue damage and alveolar bone resorption which was seen histologically due to *P. gingivalis bacteria*. The process of periodontitis begins when plaque bacteria (*P. gingivalis)* which have virulence factors that can diffuse into the epithelial layer of the gingiva and stimulate epithelial cells to produce mediators that can result in resorption of alveolar bone (Newman et al., 2019). *P. gingivalis* has various virulence factors, such as lipopolysaccharides (LPS), gingipain and fimbriae (Mysak et al, 2014). LPS can stimulate pro-inflammatory cytokines such as TNF-α, IL-1 α, IL-1β, IL-6 and IL-8 in monocytes that can respond to alveolar bone damage (Bostanci and Belibasakis, 2012). Gingipain can stimulate IL-6 production by epithelial cells and IL-8 production by fibroblasts, and fimbriae/pili can stimulate cytokines TNF-α, IL-1 α, IL-1β, and IL-6 by macrophages through TLR2 receptors resulting in tissue destruction and resorption of alveolar bone (Jia et al., 2019).

The results showed that the administration of robusta coffee bean extract gel (*C. robusta*) could inhibit alveolar bone resorption in periodontitis-induced wistar rats. This is because the active content of the gel compound content of robusta coffee bean extract is in the form of chlorogenic acid and caffeine. Chlorogenic acid and caffeine have anti-inflammatory effects because they act as adenosine A1 receptor antagonists that transduce danger signals into cells and can elicit inflammatory responses (Muqaku, 2016). In the study of Hall et al. (2015), it was explained that caffeine also has anti-inflammatory properties that can inhibit the production of TNF-α stimulated by LPS, so that it can suppress inflammation. Chlorogenic acid also has anti-inflammatory properties that can inhibit the production of a number of pro-inflammatory mediators, including TNF-α, IL-1β, IL-6 and interferon-γ (IFN-γ) in macrophage cells which can result in suppression of osteoclast activity (Xu et al., 2013; Hienz et al., 2014).

The control group that was euthanized at day 43 (Figure 4.1) had the largest average alveolar bone resorption compared to the other

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groups. This is caused by the induction of *Porphyromonas gingivalis* bacteria for 28 days and then not treated for 14 days, so there is a possibility of an increase in bacteria that play an indirect role in producing more inflammatory mediators, inflammatory mediators can stimulate the production of enzymes that will damage gingival tissue and cause fibroblast death which is useful for repairing damaged tissue and will increase the production of osteoclasts which can resorcise bone and suppress the production of osteoblasts that can repair bone (Ulipe, 2011).

The treatment group of euthanized robusta coffee bean gel on day 43 (Figure 4.2 preparation B) had the lowest average resorption. This is due to the anti-inflammatory effect of chlorogenic acid which inhibits the production of a number of pro-inflammatory mediators, including TNF-α, IL-1β, IL-6, IL-8 and interferon-γ (IFN-γ) in macrophage cells which can suppress osteoclast activity (Xu et al., 2012). Decreased production of IL-1β and TNF-α can improve osteoblast activity and can help restore resorption alveolar bone (Shen et al., 2012).

The method used by the researcher is the induction of *P. gingivalis* bacteria and then the administration of robusta coffee gel sequentially, intended as a simulation of alveolar bone that has been chronically absorbed due to periodontitis and provides treatment as therapy. The results showed that there was a decrease in the average resorption of the control group with the treated group. Robusta coffee gel can inhibit resorption but is not significant. This can happen because the content of caffeine anti-inflammatory compounds from each type of coffee varies (Dewi, *et al.* 2018), or the concentration of robusta coffee extract gel (Andalausia, *et al.* 2018). Andalausia et al. (2018) also stated that the larger the dose given, the more caffeine in robusta coffee is given and the greater the effect caused.

CONCLUSION

Gelling robusta coffee extract could inhibit alveolar bone resorption caused by the induction of *Porphyromonas gingivalis* bacteria in wistar rats, but the results of the gel treatment did not provide statistically significant results.

SUGGESTION

Suggestions that can be conveyed from this study are:

1. Further research is needed on the method of administering robusta coffee extract gel after bacterial induction treatment *P.gingivalis* for 28 days but using larger doses to prove this method could be effective in inhibiting alveolar bone resorption and could be used as a basis for further research;
2. Further research is needed on the effectiveness of robusta coffee extract gel against other tissue damage due to periodontitis to find out how effective robusta coffee extract gel is in repairing tissue damage.

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