ORIGINAL ARTICLE

The potential of rambutan honey toothpaste in reducing the dental plaque index: a Quasi Experimental study

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ABSTRACT

Introduction: The accumulation of dental plaque is a common cause of dental and oral health problems such as caries and periodontitis, therefore it is necessary to control plaque. Brushing is the most effective way to control plaque. Currently, there are various toothpastes used by the people, one of which is herbal toothpaste. One of the herbal toothpastes that has an antibacterial potential is rambutan honey toothpaste. The purpose of this study was to analyze the effectiveness of rambutan honey toothpaste in reducing the dental plaque index. **Methods**: this research was Quasi Experimental design research with a pre-test post-test control group design. The twenty samples were divided into three treatment groups, namely the group that brushed teeth with base toothpaste, rambutan honey toothpaste, and aquadest. All samples were asked to brush their teeth using base toothpaste, rambutan honey toothpaste, and aquadest twice, after using toothpaste for one day, the plaque index was measured by the Silness and Loe method. Data were analyzed using Kruskal-Wallis and post hoc Mann-Whitney tests ($p<0.05$). **Results:** There was a significant difference between the plaque index score before and after using rambutan honey toothpaste with a p-value=0.005 ($p\leq0.05$). The results also showed the effect of brushing teeth with base toothpaste, rambutan honey toothpaste, and aquadest on plaque index with a value of p=0.005 ($p\leq0.05$). The results showed that there was no significant difference in dental plaque index between base toothpaste and rambutan honey toothpaste with a p-value=0.583. **Conclusion:** Rambutan honey toothpaste has a potential in reducing the dental plaque index.

KEYWORDS
plaque index, rambutan honey, toothpaste

INTRODUCTION

In Indonesia, dental and oral health problems need serious attention from both the government and dental health workers.[1] Based on Basic Health Research (Riskesdas) data, there was an increase in the prevalence of dental and oral health problems in Indonesia within 5 years by 31.7%, with initial data in 2013 showing 25.9% of Indonesians had dental and oral health problems, then in 2018 it increased to 57.6%.[2,3] Based on this data, it can be concluded that the prevalence of Indonesians having dental and oral health problems is quite high and continues to increase.[2,3] Based on Basic Health Research (Riskesdas) data, it shows that the largest percentage of dental and oral health problems in Indonesia are caries cases, with a prevalence value of 88.8%, and the second-largest problem is periodontitis cases, with a prevalence of 74.1%.[3]

The accumulation of dental plaque is a common cause of dental and oral health problems. There are several studies that report that dental plaque is not only the main cause of caries but also a cause of periodontitis disease; therefore, it is necessary to control plaque.[4] Plaque control is essential to prevent plaque from arising. Plaque control can be done in several ways, generally mechanically and chemically.[1] Mechanical plaque control is achieved by brushing your teeth. To date, brushing has been the most effective way to carry out plaque control. The success of brushing in plaque control efforts is influenced by several factors, such as brushing techniques, brushing frequency, and toothpaste that has an effective content to reduce dental plaque.[4] Currently, there are various toothpastes used by the people, one of which is herbal toothpaste. The development of toothpaste from herbal ingredients occurred due to an increase in public interest in using natural ingredients (back to nature). Herbal toothpaste is a toothpaste that contains sodium fluoride and sodium bicarbonate and contains natural ingredients as antibacterials that are expected to suppress plaque growth and have minimal side effects on teeth.[5,6] Herbal toothpastes that have antibacterial potential, one of which is rambutan honey toothpaste.[7]

Honey has quite good anti-inflammatory, antitumor, antimutagenic, antioxidant, and antibacterial effects.[8] Factors that contribute to the antibacterial activity of honey are its high sugar content and low water content, pH and acidity level, H_2O_2 (hydrogen peroxide), methylglyoxal (MGO), and organic compounds contained in honey such as flavonoid compounds, polyphenols, and glycosides.[9] Antibacterial activity in honey can stop bacteria in the oral cavity that cause the thickening of dental plaque. Research conducted by Singhal et al.[10] in 2018 reported that rinsing the mouth with a honey solution was effective in reducing the index of dental plaque and gingiva. A previous study conducted by Alibasyah et al. in 2018 also reported the effectiveness of gargling with a 5% honey solution in reducing the plaque index.[11]

The background to choosing rambutan honey is because rambutan honey is a type of honey that is produced continuously, cheap, and known to have antibacterial activity. Rambutan honey is derived from the nectar of the rambutan tree's flowers, a tropical fruit tree native to Southeast Asia. Rambutan honey is not only known for its unique and delightful taste but also for its potential health benefits. Rambutan honey is rich in various bioactive compounds, including polyphenols and flavonoids, which have been extensively studied for their antioxidant and antimicrobial properties. These properties make rambutan honey an attractive candidate for oral care products, as they can potentially inhibit the growth of bacteria responsible for dental plaque formation and help maintain a healthier oral environment.

Furthermore, the use of natural ingredients in oral care products has gained popularity due to concerns about the adverse effects of synthetic chemicals in traditional toothpaste formulations. Rambutan honey's natural composition, coupled with its potential oral health benefits, offers an intriguing avenue for exploring its use in toothpaste formulations. Based on PDKI (Intellectual Property Database) data regarding copyright and patent rights, the formulation of rambutan honey toothpaste with a concentration of 20, 40, and 60% has been registered as a patent with the number S00202103399 on behalf of Universitas Jenderal Achmad Yani. The results of preliminary research reported that rambutan honey toothpaste with a concentration of 20, 40, or 60% has antibacterial power against *Streptococcus mutans*, and rambutan honey toothpaste with a concentration of 60% has the strongest antibacterial power.[12] Another preliminary study conducted by Ramadhanty in 2021 stated that rambutan honey toothpaste with a concentration of 60% inhibits the growth of *Staphylococcus aureus* bacteria in vitro. The purpose of this study was to analyze the effectiveness of rambutan honey toothpaste in reducing the dental plaque index.

METHODS

This research was quasi-experimental with a pre-test and post-test control group design. Subject selection was carried out using the purposive sampling technique. The selected subjects had to meet the inclusion criteria and not meet the exclusion criteria. The inclusion criteria were being willing to be a research subject, having a caries-free Silness-Löe index tooth, and having received a minimum of two doses of the COVID-19 vaccine. Exclusion criteria included wearing an orthodontic device, wearing dentures, having crammed teeth, and taking antibiotics or mouthwashes during the study. This study included 20 subjects that were in various treatments, including brushing with rambutan honey toothpaste, base toothpaste, and aquadest steril.

Subjects were given a questionnaire, which was then screened offline in the Faculty of Dentistry Unjani's skill laboratory room to ensure that the research subjects met the inclusion criteria. Then the researcher provided an informed consent that had to be signed by the research subject if the subject was willing to take part in the research.

Researchers conducted a pretest plaque index examination using the Silness-Löe Index method.[13] The Silness-Löe plaque index only evaluates plaques in the cervical third without regard to plaques that extend to the middle third or incisal.[13] Plaques were visually inspected with a glass mouth and a probe or explorer without the use of a disclosing solution. Assessment of dental plaque index was carried out before and after the use of base toothpaste (BTP), rambutan honey toothpaste (RHTP), and aquadest (AQ). Subjects were recommended to brush their teeth using rambutan honey toothpaste, base toothpaste, and aquadest for one day (night and morning) with the Bass technique. A post-test plaque index examination was carried out after one day of brushing their teeth. The collected data were processed and analyzed using the SPSS program. The data were first subjected to a normality test using the Shapiro-Wilk test to find out whether they were normally distributed or not.

This study's data analysis included descriptive analysis to describe plaque index scores before and after treatment, as well as normality tests using saphiro-Wilk to determine data normality and Wilcoxon test to find out the comparison of the resamples of pre-test and post-test plaque index scores. Kruskal-Wallis test was used to determine the effect of brushing your teeth with rambutan honey toothpaste, base toothpaste, and aquadest on reducing the plaque index. Test Mann-Whitney was used to find out the average comparison of the score differences in each treatment.

The steps for making rambutan honey toothpaste are to put rambutan honey in a sterile glass, then heat the rambutan honey in a water bath for one hour. After that, it is put in a desiccator for three hours to reduce the water content in the honey. After three hours, the standardized rambutan honey is taken to the pharmaceutical technology laboratory to be made into toothpaste as shown in figure 1.[14]

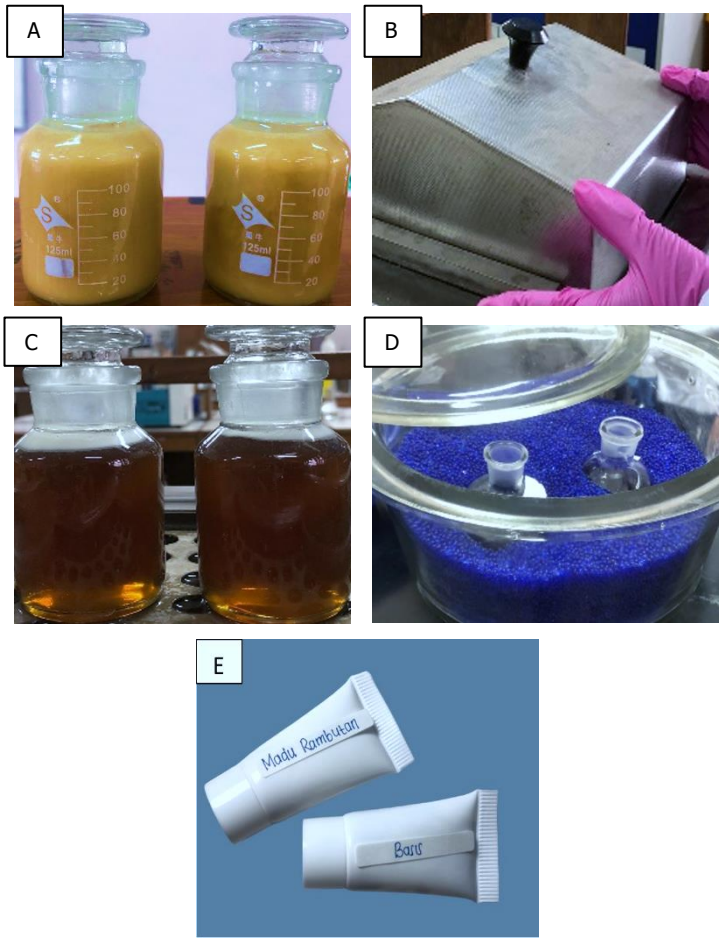


Figure 1. Steps for making rambutan honey toothpaste. A) rambutan honey in a sterile glass, B) Heat the rambutan honey in a water bath, C) and D) put rambutan honey in a desiccator for three hours, E) the standardized rambutan honey is taken to the pharmaceutical technology laboratory to be made into toothpaste

To make base toothpaste, it is carried out in a pharmaceutical technology laboratory with standard toothpaste materials such as $CaCO_3$, Na CMC, SLS, sodium benzoate, saccharin, menthol, and aquadest.

RESULTS

A description of the dental plaque index data before and after treatment, the mean value, and the standard deviation (SD) can be seen in Table 1.

Table 1. The mean value, standard deviation (SD), minimal-maximal (min-max) of the dental plaque index before and after the use of rambutan honey toothpaste, base toothpaste and aquadest

Treatment	Mean	SD	Min-Max
Rambutan honey toothpaste			
Before	0.483	0.639	0 – 2.13
After	0.139	0.172	0 – 0.67
Base toothpaste			
Before	0.462	0.642	0 – 2.79
After	0.283	0.464	0 – 1.71
Aquadest			
Before	0.160	0.234	0 – 0.83
After	0.216	0.302	0 – 1.29

Table 1 shows that the average plaque index before use of rambutan honey toothpaste (RHTP) was 0.4831 and after rambutan honey toothpaste, it was 0.1394, which can be interpreted as a decrease in plaque index of 0.344. The average plaque index before base paste (BTP) was 0.4621 and

after base paste, it was 0.2831, meaning that there was a decrease in the plaque index by 0.179, while the average plaque index before aquadest (AQ) was 0.1601 and after aquadest, it was 0.2163, meaning that there was an increase in the plaque index by 0.056.

Based on the normality test results of the significance test, the data normality test was obtained using the Shapiro-Wilk test of 0.00 for all data. The six significant values are less than the significance limit of p=0.05, so it could be concluded that the dental plaque index data before and after the use of rambutan honey toothpaste, base toothpaste, and aquadest were declared abnormally distributed. The next step was to assess the plaque index before and after treatment with Wilcoxon's nonparametric statistical test.

Table 2. Differences in plaque index before and after brushing teeth with rambutan honey toothpaste, base toothpaste and aquadest

Treatment	p-value
Rambutan honey toothpaste	
Before	
After	0.005*
Base toothpaste	
Before	
After	0.059
Aquadest	
Before	
After	0.307

Description: Wilcoxon test, p≤0.05* (There was a significant difference)

The results of the data analysis in Table 2 show that there was no significant difference between the plaque index before and after brushing with base toothpaste and aquadest with a p value of more than 0.05. Then, a p value of less than 0.05 was obtained in the data before and after brushing the teeth with honey-rambutan toothpaste. This shows that there was a significant difference in the plaque index before and after using honey-rambutan toothpaste.

After obtaining the plaque index data before and after from the rambutan honey toothpaste, base toothpaste, and aquadest group, it was found that the data had a difference in the plaque index among the three groups and were not normally distributed. The next step was to test non-parametric Kruskal-Wallis statistics to determine whether there was an effect of brushing teeth with base toothpaste, rambutan honey toothpaste, and aquadest on the dental plaque index. Based on the results of the Kruskall-Wallis test, the results are in accordance with Table 3.

Tabel 3. Effect of brushing teeth with rambutan honey toothpaste, base toothpaste and aquadest on plaque index

Treatment	p-value
Rambutan honey toothpaste	
Base toothpaste	0.005*
Aquadest	

Description: Kruskall Wallis test, p≤0.05* (There was a significant difference)

Table 3 shows that based on the Kruskal-Wallis statistical test, the p value is 0.005, which means that there was an effect of brushing teeth with base toothpaste, rambutan honey toothpaste, and aquadest on the plaque index. The Mann Whitney test was used to determine the difference in plaque index between each group. Mann Whitney obtained results that are consistent with Table 4 based on test results.

Tabel 4. Differences in the difference in plaque index of rambutan honey toothpaste base toothpaste, and aquadest

Treatment	Rambutan honey toothpaste	Base toothpaste	Aquadest
Rambutan honey toothpaste			
Base toothpaste	0.583		
aquadest	0.002*	0.012*	

Description: Mann Whitney test*, p≤0.05 (There was a significant difference)

Based on Table 4, there was a significant difference in the plaque index difference between the base toothpaste and aquadest groups with a value of p = 0.012. There was a significant difference in the plaque index difference between the rambutan honey toothpaste and aquadest groups, while there was no significant difference in the plaque index between the base toothpaste group and the rambutan honey toothpaste with a p-value = 0.583.

DISCUSSION

The results of the study on 20 subjects of the Faculty of Dentistry, Universitas Jenderal Achmad Yani Class of 2021 showed that rambutan honey toothpaste had potential in reducing the dental plaque index (based on table 1 and table 2). This is shown by the results of Wilcoxon non-parametric statistical analysis on the plaque index data before and after the use of base toothpaste and aquadest which obtained no significant results with a p value> 0.05, while the plaque index data before and after the use of rambutan honey toothpaste obtained results which was significant with a p value <0.05 as shown in Table 2, this means that brushing your teeth with rambutan honey toothpaste is effective in reducing the dental plaque index.

The results of this study are supported by research conducted by Sruthi, et al. in 2021 which states that honey mouthwash can reduce the plaque index and gingivitis index.[15] A similar study was also conducted by Abid, et al. in 2022 which stated that honey mouthwash is more effective in reducing plaque compared to chlorhexidine mouthwash which is the gold standard. This decrease in plaque occurs because the antibacterial activity of honey can affect the attachment of *Streptococcus mutans* bacteria to the tooth surface which is the initial stage of dental plaque formation.[9,15] Factors that contribute to the antibacterial activity of rambutan honey are high sugar content and low water content, pH/acidity level, Methylglyoxal (MGO), organic compounds contained in honey such as flavonoids, polyphenols and glycosides, and H_2O_2 (hydrogen peroxide).[9]

The water content in honey ranges from 0.562 to 0.62, this low enough water content allows the disruption of the growth of bacteria or other microorganisms. High osmolarity because of the high concentration of sugar in honey exerts an osmotic pressure effect on the bacterial cells as a result of which water will come out of the bacteria and then the bacteria will become dehydrated and unable to survive. Honey's low acidity or pH level can contribute to its antibacterial potential. Most microorganisms grow optimally at a neutral pH, which ranges from 6.6 to 7.5 while the pH of honey is between 3.2 to 4.5, as a result the growth of bacteria is inhibited due to acidic conditions.[16]

MGO which is an antibacterial component that can affect the DNA. In gram-positive bacteria such as *Streptococcus mutans*, MGO will affect bacterial cell division due to downregulation of the autolysin enzyme, whereas in gram-negative bacteria MGO affects the stability of the bacterial cell wall.[17] Hydrogen peroxide which is an enzymatic product in honey has bactericidal activity because it can cause oxidative damage to membranes, proteins, enzymes, and DNA in bacterial cells.[10] Honey contains polyphenols which are able to inhibit the attachment of *Streptococcus mutans* to the tooth surface either by interacting with bacterial cell membrane proteins or by inhibiting the formation of the enzyme glucosyl transferase (GTF).[16] Research conducted by Putri et al.[18] in 2020 reported that gargling with green tea solution and honey solution was effective in reducing the plaque index even though the polyphenol content of green tea was higher than honey, this happened because the polyphenol content in honey was not the main factor for antibacterial activity but worked together with other factors such as high sugar content, low water content, pH/acidity level, MGO, and H_2O_2 (hydrogen peroxide), whereas in green tea the content of polyphenols (catechins) was the main factor for antibacterial activity.[18]

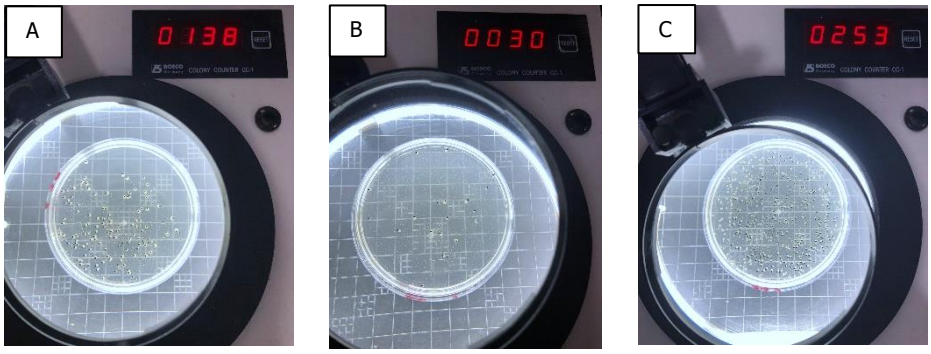
Table 4 shows there was no significant difference in the plaque index difference between the base toothpaste and rambutan honey toothpaste groups with a p value =0.583. The results of this study are supported by research conducted by Suresh et al.[19] which stated that brushing teeth with herbal and conventional toothpaste gave the same results in reducing the plaque index because mechanical cleaning factors played a greater role in reducing the plaque index. Research conducted by Wulandari et al. in 2020 showed different results where herbal toothpaste was more effective in reducing the dental plaque index than non-herbal toothpaste. The difference in the results of this study with the research conducted by Wulandari et al. influenced by the time of plaque index measurement, method of plaque index measurement, and the content of herbal toothpaste.[20] This is because base toothpaste and rambutan honey toothpaste both contain abrasives, namely calcium carbonate ($CaCO_3$), which helps clean debris, plaque, and extrinsic stains on enamel.

The timing of plaque index measurements in the Wulandari study was carried out on the eighth day after treatment, while in this study the plaque index measurements were carried out one day after treatment. Additionally, findings from Suresh et al.[16] in 2021 comparing the effectiveness of herbal and conventional dentifrices in reducing dental plaque and gingivitis have shown promising results. The review highlighted that herbal toothpaste, often containing natural components with antibacterial properties, exhibit comparable efficacy to conventional dentifrices in reducing both dental plaque and gingivitis. These findings support the potential effectiveness of herbal components, such as rambutan honey, in mitigating dental plaque, aligning with the outcomes observed in our study. Plaque index measurement one day after treatment showed accurate results because on the first day the study subjects were still able to absorb the instructions given by the researchers well, whereas on the following day the subjects tended to return to their initial habits. In addition, the way to measure the plaque index in Wulandari's study used the O'Leary Index method which involved examining all teeth and assisted by applying a disclosing agent to the entire tooth surface.[16,19,20] The final factor that distinguishes this study from the research conducted by Wulandari is the content in herbal toothpaste. In Wulandari's study, the herbal toothpaste contained *phellodendron amurense* bark extract, *Camellia*

sinensis extract, and piper betel leaf as antibacterial while in this study the herbal toothpaste contained rambutan honey which has antibacterial properties.[19,20]

Although rambutan honey toothpaste and base toothpaste were able to reduce the dental plaque index, rambutan honey toothpaste in this study showed better results in reducing the dental plaque index where the average decrease in the plaque index of rambutan honey toothpaste was 0.344. Meanwhile the average decrease in base toothpaste was 0.187. Suresh et al.[16] offers a comprehensive comparison between herbal and conventional dentifrices in reducing dental plaque and gingivitis, providing valuable insights into the efficacy of herbal formulations. Saliasi et al.[5] findings on Carica papaya leaf extract may indirectly support our study's conclusion regarding herbal components' potential in oral care. Although the primary outcome measured in the two studies differs (gingival bleeding vs. dental plaque index reduction), both highlight the potential benefits of herbal extracts in oral health maintenance. Therefore, while not directly comparable due to the difference in the measured outcomes, the study by Saliasi et al.[5] contributes to the broader understanding of the potential effects of herbal extracts in oral care, supporting the premise that certain herbal components, such as Carica papaya leaf extract and rambutan honey, may have beneficial impacts on oral health parameters. The findings from Suresh et al.[16] and Saliasi[5] support our study's conclusions regarding the potential effectiveness of herbal dentifrices, especially those containing natural antibacterial agents, in reducing dental plaque. Their review suggests that herbal toothpaste formulations, often incorporating natural components with antibacterial properties, exhibit comparable efficacy to conventional dentifrices in reducing both dental plaque and gingivitis. Comparatively, our study specifically highlights the efficacy of rambutan honey toothpaste in reducing the dental plaque index, attributing this effectiveness to the inherent antibacterial properties of rambutan honey. While our study focuses on a specific herbal ingredient, the broader systematic review by Suresh et al.[16] reinforces the overall efficacy of herbal dentifrices, indicating the potential benefits of herbal components in oral care products including those with antibacterial properties like rambutan honey, having the potential to be effective in reducing dental plaque, contributing positively to oral health maintenance.[5,16] This is presumably because rambutan honey toothpaste has antibacterial activity from rambutan honey which is not found in base toothpaste.

Different results were shown in research conducted on *Streptococcus mutans* bacteria. From the results of colony condominiums using the Total Plate Count method, the results showed a significant decrease in the number of *S. mutans* colonies on plates that had been treated with base toothpaste (number of colonies=30) compared to the decrease in the number of *S. mutans* colonies that had been treated with rambutan honey toothpaste (number of colonies=138), and aquadest (number of colonies=253) as shown in Figure 2.



A. Number of colonies: 138
Rambutan honey toothpaste
Dilution 10^{-3}

B. Number of colonies: 30
Base toothpaste
Dilution 10^{-3}

C. Number of colonies: 253
Aquadest
Dilution 10^{-3}

Figure 2. The number of *S.mutans* bacterial colonies was counted using a colony counter

The difference in reducing the number of *S. mutans* colonies of base toothpaste and rambutan honey toothpaste is influenced by the sugar content in rambutan honey toothpaste, which is not present in base toothpaste. The sugar content in rambutan honey toothpaste can provide nutrients for *S. mutans* bacteria to survive and reproduce. Bacteria will convert sugar into energy for metabolic activities and cell development. Therefore, the more sugar contained in the medium, the more colonies will be formed.[19,20]

Rambutan honey toothpaste has good prospects in the field of dentistry. Apart from its effectiveness in lowering the index of dental plaque, this toothpaste is based on rambutan honey, so side effects are minimal. Another advantage of rambutan honey can be seen from study of Yuslianti, which reports that giving rambutan honey can heal wounds in the human oral cavity due to its content of antioxidants.

CONCLUSION

Rambutan honey toothpaste is effective in reducing the dental plaque index and there is no difference in effectiveness in reducing dental plaque index between the usage of rambutan honey toothpaste and base toothpaste.

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Conflicts of Interest: The authors declare no conflict of interest.

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