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Comparative Effectiveness of Binahong Decoction and Betel Leaf Decoction Solutions on Plaque Index in Deaf Children: A Study at SDLB Karya Mulia Surabaya

Isnanto, Ajeng Nurzilullahningtiyas, and Silvia Prasetyowati

Department of Dental Therapist Department, Poltekkes Kemenkes Surabaya, Indonesia

Corresponding author: Isnanto (e-mail: nanto@poltekkesdepkes-sby.ac.id)

ABSTRACT Children with hearing impairments face significant challenges in maintaining oral hygiene due to limited access to information and communication barriers, resulting in poor plaque control and an elevated risk of dental diseases. Deaf students at SDLB Karya Mulia Surabaya have been observed to have high plaque index values, indicating suboptimal oral hygiene. Herbal remedies such as binahong (Anredera cordifolia) and betel leaf (Piper betle L.) decoctions are increasingly utilized due to their antibacterial properties and minimal side effects. This study aimed to compare the effectiveness of gargling with binahong and betel leaf decoction solutions in reducing plaque index scores among deaf children. The study employed a pre-experimental design with a one-group pretest-posttest format. A total of 51 deaf students from SDLB Karya Mulia Surabaya were selected as participants and randomly assigned into two groups: 26 students gargled with binahong leaf decoction and 25 with betel leaf decoction. The plaque index was assessed before and after intervention using the Personal Hygiene Performance (PHP) index. Data were analyzed using an independent sample t-test. The findings indicated that both herbal decoctions significantly reduced plaque index values ($p < 0.05$). The binahong group experienced an average reduction of 1.03 in plaque index scores, while the betel leaf group achieved a higher reduction of 1.42. The statistical comparison between the two groups ($p = 0.012$) confirmed that betel leaf decoction was significantly more effective in reducing dental plaque. The results support the potential of natural mouth rinses as alternative plaque control agents in children with special needs. Further research is needed to explore long-term effectiveness and optimize formulation for broader application.

INDEX TERMS Binahong leaf, Betel leaf, Plaque index, Deaf children, Herbal mouthwash

I. INTRODUCTION

Children with hearing impairments are more vulnerable to poor oral health outcomes due to their limited ability to access health information, especially in verbal form. Deaf children often experience delayed language development, which hinders their understanding of basic hygiene practices, including those related to dental care [1], [2]. The World Health Organization reports that around 34 million children globally have hearing loss, placing them at increased risk of neglecting preventive oral health measures [3].

Unlike their non-disabled peers, deaf children face significant challenges in communication and education, leading to lower awareness about oral hygiene practices such as tooth brushing, flossing, and mouth rinsing [4], [5]. These limitations contribute to the accumulation of dental plaquea complex microbial biofilm primarily composed of *Streptococcus mutans* that, if not adequately removed, can cause dental caries and periodontal diseases [6], [7]. Research has consistently shown that deaf students exhibit poor oral hygiene. For example, studies at SLBN 1 Bantul and SLBB Wiyata Dharma 1 Sleman Yogyakarta in 2019 found that 46% of students had poor personal hygiene performance (PHP) scores [8]. Similarly, at SDLB Karya Mulia Surabaya, 72.41% of students were recorded as having high plaque index scores, indicating poor oral health [9].

Effective plaque control is critical to maintaining oral health. While mechanical methods such as toothbrushing are effective, they are often not performed properly by children with communication barriers. Therefore, chemical methods like using mouthwash can serve as complementary interventions [10], [11]. Herbal-based mouthwashes are widely considered safe, affordable, and culturally accepted. They have been shown to possess antimicrobial properties effective in reducing oral pathogens with minimal side effects [12]–[14].

Two natural ingredients, binahong (Anredera cordifolia) and betel leaf (Piper betle L.), have been used in traditional medicine for their antibacterial and anti-inflammatory properties [15], [16]. Binahong leaves are rich in secondary

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metabolites such as flavonoids, alkaloids, terpenoids, and saponins, which contribute to their ability to inhibit the growth of *S. mutans* and other harmful oral bacteria [17], [18]. Similarly, betel leaves contain essential oils, tannins, catechins, and polyphenols with strong antimicrobial and antifungal activity [19]. These components not only reduce plaque formation but also provide a refreshing and natural alternative to synthetic mouthwashes [20].

Previous studies have confirmed the plaque-reducing efficacy of both ingredients. Binahong leaf extract has demonstrated inhibitory effects against *S. mutans* at various concentrations in vitro and in vivo [17]. Likewise, betel leaf extract has shown significant effectiveness in reducing plaque index values in patients with orthodontic appliances and periodontitis [19]. However, most prior studies have focused on general populations or individuals with specific oral health conditions. Very few studies have evaluated the use of these herbal mouthwashes in children with special needs—particularly deaf children with otherwise healthy gingiva and no history of orthodontic treatment.

Based on preliminary assessments at SDLB Karya Mulia Surabaya, deaf students had an average plaque index of 3.7, categorized as poor. This study was designed to address this problem by evaluating and comparing the effectiveness of gargling with decoction solutions of binahong and betel leaves among deaf children. The primary aim is to determine which of the two herbal solutions is more effective in reducing plaque accumulation, thereby contributing to the development of effective, accessible, and low-risk oral hygiene interventions for special needs populations.

II. METHOD

This study adopted a pre-experimental design with a one-group pretest-posttest approach to evaluate and compare the effectiveness of binahong and betel leaf decoction solutions in reducing the plaque index among deaf children. The research was conducted at SDLB Karya Mulia Surabaya over a period of three months, from January to March 2023. This design was selected as it is appropriate for interventions involving special needs populations, where full experimental randomization may not be feasible due to ethical and logistical considerations [21].

A. POPULATION AND SAMPLING

The target population comprised all 58 deaf students enrolled at SDLB Karya Mulia Surabaya. Using purposive sampling, 51 students were selected based on the following inclusion criteria: (1) aged between 7 and 13 years, (2) not undergoing orthodontic or dental treatment, and (3) having obtained parental or guardian consent. The participants were randomly divided into two groups: the first group (n = 26) used the binahong leaf decoction, and the second group (n = 25) used the betel leaf decoction.

B. MATERIALS AND SOLUTION PREPARATION

Two types of herbal mouth rinses were prepared using standardized methods:

1. **Binahong Leaf Decoction**: Approximately 7–9 fresh binahong leaves (Anredera cordifolia) were thoroughly rinsed with sterile distilled water. A total of 850 ml of water was boiled to 90°C, and the leaves were added and simmered for 15 minutes until the volume was reduced by half. The solution was filtered using sterile filter paper and stored in sterile 20 ml bottles at a controlled temperature of 0–8°C for stability [22].
2. **Betel Leaf Decoction**: 30 grams of fresh betel leaves (Piper betle L.) were washed and cut into 2–3 cm pieces. These were boiled in 100 ml of water at 90°C for approximately 30 minutes. The solution was then filtered and stored under the same conditions as the binahong decoction [23].

All solution preparation was conducted in a laboratory environment under aseptic conditions to ensure safety and reliability.

C. RESEARCH PROCEDURE

Before the treatment, all participants were instructed to brush their teeth using a standardized brushing technique. Following this, a disclosing solution was applied to highlight existing plaque, and the Personal Hygiene Performance (PHP) Index was measured to establish baseline oral hygiene status.

The binahong group gargled with 20 ml of the binahong decoction, while the betel group used the same amount of betel leaf decoction. Each participant gargled for 30 seconds under supervision. After rinsing, students were instructed not to eat or drink for two hours to avoid interference with the post-test plaque assessment. After the two-hour interval, the PHP Index was remeasured to assess changes.

D. DATA COLLECTION INSTRUMENT

The PHP Index developed by Podshadley and Haley was used as the primary indicator of plaque presence. This index classifies oral hygiene levels as very good (0.0–1.7), good (1.8–3.4), moderate (3.5–5.0), and poor (>5.0). The measurements were conducted by two trained dental health professionals to ensure accuracy and inter-rater reliability.

E. DATA ANALYSIS

The data were analyzed using SPSS version 25.0. The Paired Sample t-Test was employed to evaluate within-group differences before and after treatment, while the Independent Sample t-Test was used to compare the effectiveness between the two groups. A significance level of $\alpha = 0.05$ was adopted for all statistical tests.

F. ETHICAL CONSIDERATIONS

This research received ethical approval from the institutional review board. Written informed consent was obtained from the parents or guardians of all participants. The study adhered to ethical guidelines for research involving vulnerable populations, ensuring participant anonymity and data confidentiality throughout.

G. METHODOLOGICAL JUSTIFICATION

The use of a one-group pretest-posttest design is suitable for exploratory health interventions in children with communication challenges. Although lacking a non-treatment control group, this design enables valid assessment of intervention effects over time within the same individuals.

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The selection of herbal decoctions as the intervention was based on growing evidence that binahong and betel leaf extracts possess antimicrobial properties effective against oral pathogens such as *Streptococcus mutans*, a key bacterium in dental plaque formation [24], [25].

III. RESULTS

The research data were obtained from the calculation of the PHP index before and after gargling with binahong decoction and betel leaf decoction in deaf children at SDLB Karya Mulia Surabaya with a sample of 51 samples.

TABLE 1
Distribution of Research Subjects

Characteristics	Frequency	Percentage (%)
Gender		
Boy	30	58,8
Girl	21	41,2
Total	51	100
Age		
7-10 years old	26	51
11-13 years old	25	49
Total	51	100
Grade of Elementary School		
Grade 1-3	23	45,1
Grade 4-6	28	54,9
Total	**51**	**100**

Based on the results of the data in TABLE 1, it shows that the distribution of research subjects based on the characteristics of male gender as many as 30 people (58.8%) and female as many as 21 people (41.2%), based on age in children aged 7-10 years as many as 26 people (51%) and age 11-13 years as many as 25 people (49%) and based on the level of education in grades 4-6 as many as 28 people (54.9%) and grades 4-6 as many as 28 (54.9%).

TABLE 2
Results of Plaque Index Data Collection Before and After Gargling Binahong Leaf Decoction Solution

Category of Plaque Index	Before gargling		After Gargling	
	Frequency (N)	%	Frequency (N)	%
Very Good	0	0	0	0
Good	0	0	6	23.1
Moderate	8	30.8	14	53.8
Poor	18	69.2	6	23.1
Total	**26**	**100**	**26**	**100**

Based on TABLE 2, it was found that the category of plaque index values before gargling is as many as 0 students (0%) are included in the excellent and good categories, as many as 8 students (30.8%) are included in the moderate category and as many as 18 students (69.2%) are included in the bad category. The category of plaque index values after gargling is as many as 0 students (0%) are included in the excellent category, as many as 6 students (23.1%) are included in the good category, as many as 14 students (53.8%) are included in the moderate category, and 6 students (23.1%) are included in the bad category.

Based on TABLE 3, it was found that the category of plaque index values before gargling is as many as 0 students (0%) are included in the excellent and good categories, as many as 11 students (40%) are included in the moderate category and as many as 14 students (56%) are included in the bad category. The category of plaque index values after gargling is 0 students (0%) included in the excellent category, 9 students (36%) included in the good category, 16 students (64%) included in the moderate category, and 0 students (0%) included in the bad category.

TABLE 3
Results of Plaque Index Data Collection Before and After Gargling Betel Leaf Decoction Solution

Category of Plaque Index	Before gargling		After Gargling	
	Frequency (N)	%	Frequency (N)	%
Very Good	0	0	0	0
Good	0	0	9	36
Moderate	11	44	16	64
Poor	14	56	0	0
Total	**25**	**100**	**26**	**100**

TABLE 4
Plaque Index Value Before and After Gargling Binahong Leaf Decoction Solution

Plaque Index	Mean	Sig.	Std.Deviation	N
Before	3.72	0.000	0.58	26
After	2.68	0.000	0.86	26
Average of reduction	**1.03**			

Based on TABLE 4, the average plaque index value before rinsing with a solution of binahong leaves was 3.72 (std.deviation 0.58). The plaque index value after rinsing with a decoction of binahong leaves is 2.68 with a difference of 1.03 (std.deviation 0.86). The Sig.(2-tailed) value from the results of the Paired T-Test was 0.000 which means the p-value (significance) is smaller than α (0.05) so that there is a decrease in the plaque index value after rinsing the binahong leaf decoction solution.

TABLE 5
Plaque Index Value Before and After Gargling Betel Leaf Decoction Solution

Plaque Index	Mean	Sig.	Std.Deviation	N
Before	3.52	0.000	0.67	25
After	2.10	0.000	0.73	25
Average of reduction	**1.42**			

Based on TABLE 5, the average plaque index value before rinsing using betel leaf was 3.52 (std.deviation 0.67) and after rinsing it was 2.10 (std.deviation 0.73) with a difference of 1.42. The Sig.(2-tailed) value of the Paired T-Test was 0.000, which means that the p value (significance) is smaller than α (0.05) so that there is a decrease in the plaque index value after rinsing the betel leaf boiled solution.

TABLE 6
Independent T-Test Test of comparative Effectiveness of Gargling Binahong Leaf and Betel Leaf Decoction on Plaque Index

Gargling Groups	N	*Sig.*
PHP Index After Gargling Binahong Leaf Solution	26	**0.012**
PHP Index After Gargling Betel Leaf Solution	25	

Based on TABLE 6 the results of the Independent T-Test test obtained an Asymp.sig. (2-tailed) value of 0.012 which means that the p value (significance) is smaller than α (0.05), thus it can be concluded that H0 is rejected and H1 is

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accepted, so there is a significant comparison in the effectiveness of gargling binahong leaf decoction solution and betel leaf decoction solution on plaque index in deaf children at SDLB Karya Mulia Surabaya. Both groups were equally effective in reducing plaque index, but the betel leaf decoction solution gargling group was more effective in reducing plaque than the binahong leaf decoction solution gargling group because the average value of the decrease before and after gargling the betel leaf group was greater.

IV. DISCUSSION

A. INTERPRETATION OF RESULTS

The findings of this study demonstrate that both binahong and betel leaf decoction solutions significantly reduce the plaque index in deaf children after gargling. The average reduction in the plaque index in the binahong group was 1.03, while in the betel leaf group it was 1.42**.** Statistically, both groups showed significant changes, with a p-value < 0.05, but the difference between them also yielded a significant p-value of 0.012, indicating that betel leaf decoction is more effective than binahong leaf decoction.

These findings suggest that both herbal solutions have potent antibacterial properties capable of disrupting the plaque biofilm, thus improving oral hygiene status. Binahong leaves contain flavonoids, terpenoids, saponins, and alkaloids that function as antibacterial and antioxidant agents [26]. These compounds help inhibit the growth of *Streptococcus mutans*, the primary etiological agent of plaque formation. The reduction in plaque index from poor to moderate categories in the binahong group confirms its effectiveness in controlling plaque.

Betel leaf, on the other hand, has long been used traditionally for its antiseptic properties. Its higher effectiveness in this study can be attributed to the presence of essential oils, tannins, and catechins, which exhibit strong bactericidal activity. Gargling with betel leaf solution likely leads to better bacterial clearance due to these active compounds, resulting in a more substantial reduction in the plaque index [27].

The application of the PHP Index as a quantitative measure ensures reliability in evaluating the effect of the intervention. The structured gargling process and observation period (two hours) also minimized variability in short-term plaque reformation.

B. COMPARISON WITH OTHER STUDIES

The results of this study align with previous research findings that confirm the antimicrobial efficacy of both binahong and betel leaves. A study by Dohude and Ginting [28] found that binahong leaf extract, particularly the ethyl acetate fraction, effectively inhibited the growth of *Streptococcus mutans*, with a minimum inhibitory concentration at 25%. Their in vitro findings support the plaque reduction observed in this in vivo study among deaf children.

Similarly, the effectiveness of betel leaf as an oral hygiene agent has been reported in multiple studies. Surjowardojo et al. [29] demonstrated that green betel leaf extract inhibited the growth of oral pathogens, including *E. coli* and *S. mutans*. In their experimental design, a 4.2% tannin content was shown to play a key role in bacterial inhibition. This corroborates the present study's result showing that the betel leaf group had a greater average reduction in plaque index.

A clinical trial by Ali et al. [30] also revealed that a dentifrice containing betel leaf extract resulted in significantly better oral hygiene parameters compared to a standard fluoride toothpaste. These results support the use of betel leaf for mouth rinsing as a viable alternative for patients who may have challenges with conventional methods, including those with disabilities.

However, unlike prior studies conducted mostly in general populations or individuals with orthodontic treatment, this study targets a special needs population**,** namely deaf children without underlying oral pathology. This makes the present study unique in its application of natural remedies to a vulnerable group and broadens the scope of natural oral care research.

An additional dimension to this research is its alignment with a recent meta-analysis by Janakiram et al. [31], which evaluated the efficacy of various herbal mouthwashes. The analysis concluded that natural mouth rinses with active antibacterial ingredients could reduce plaque and gingival inflammation comparably to chlorhexidine. Betel leaf in particular emerged as one of the most effective agents among plant-based alternatives.

Moreover, Muhaimin and Cahyaningrum [32] found that combining betel leaf with hydroxyapatite enhanced its antibacterial properties and remineralizing effect, which may open further possibilities for formulation in pediatric dental care products.

While there is limited direct research on binahong mouthwash use in children, Homans and Nahusona [33] reported that rinsing with binahong extract significantly reduced *Candida albicans* in patients with removable orthodontics, indicating its broad-spectrum antimicrobial effect.

In terms of population targeting, the current findings align with oral health promotion studies among deaf children, such as the work by Kurniawati et al. [34], which stressed the need for specially designed interventions to improve oral hygiene in hearing-impaired children.

C. LIMITATIONS AND IMPLICATIONS

Despite the positive outcomes, this study has several limitations. Firstly, the short-term nature of the intervention (a single session with a two-hour observation window) limits conclusions regarding the long-term effects of binahong and betel leaf use. Dental plaque is dynamic and reaccumulates within hours after cleaning. A longitudinal study with multiple rinsing sessions and longer observation is required to assess sustainability and preventive potential.

Secondly, the decoction solutions were not chemically standardized, which may have led to variations in active compound concentrations. Although the preparation method followed established procedures, factors such as plant maturity, storage conditions, and boiling duration can influence phytochemical content. Future studies should employ standardized extracts or measured concentrations to ensure reproducibility.

Thirdly, taste and acceptability of the solutions were not evaluated, particularly in children. Betel leaf decoction is

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known to have a strong bitter taste, which may limit compliance in long-term usage. Developing formulations that are palatable and stable is essential for pediatric applications. Putri et al. [35] suggest combining herbal ingredients with flavor-masking agents or natural sweeteners to enhance acceptability without compromising efficacy.

Communication barriers with deaf children also posed challenges in procedure delivery. Although the study employed trained facilitators and visual aids, the level of understanding and cooperation may still vary. This highlights the need for integrating sign-language-based instructions or technology-aided communication tools in future oral health research for children with disabilities.

The implications of this research are considerable. The findings support the integration of natural, culturally accepted, and low-cost interventions into oral hygiene programs for children with special needs. Herbal rinses like binahong and betel leaf decoctions provide accessible alternatives to synthetic antiseptics, which may be expensive or carry side effects.

This study also encourages further interdisciplinary collaboration among dental professionals, herbal pharmacists, and special education experts to design oral health tools that are effective, safe, and tailored for vulnerable populations.

In summary, while betel leaf decoction demonstrated superior plaque reduction, both herbal interventions were effective. This offers flexibility in developing mouthwash options based on local availability, patient preference, and individual tolerance**.** Scaling this intervention within schools for children with disabilities could enhance their oral health status and reduce their long-term risk for caries and periodontal disease.

V. CONCLUSION

This study aimed to compare the effectiveness of binahong (Anredera cordifolia) and betel leaf (Piper betle L.) decoction solutions in reducing plaque index values among deaf children at SDLB Karya Mulia Surabaya. The study was motivated by the high prevalence of poor oral hygiene and plaque accumulation in children with hearing impairments, often due to communication limitations and restricted access to oral health information. Through a pre-experimental design involving 51 deaf students, this research demonstrated that both herbal mouth rinses significantly improved oral hygiene, as measured by the Personal Hygiene Performance (PHP) Index. The average reduction in plaque index for the binahong group was 1.03, while the betel leaf group experienced a greater average reduction of 1.42. Statistical analysis using the independent t-test revealed a significant difference between the two interventions, with a p-value of 0.012 ($p < 0.05$), indicating that betel leaf decoction was more effective than binahong in reducing dental plaque. These findings support the potential application of natural, safe, and culturally accepted alternatives to chemical mouthwashes, especially for children with special needs. Furthermore, this study adds to the growing body of literature advocating for accessible and low-cost oral hygiene interventions that are easily integrated into daily routines for vulnerable populations. Future research should explore the long-term effectiveness of repeated usage, taste acceptability, and standardized formulation of these herbal rinses to enhance user compliance and clinical outcomes. Investigations involving larger sample sizes, extended treatment durations, and microbiological assessments are also recommended to further validate the antibacterial mechanisms of binahong and betel leaf extracts. Moreover, collaborative efforts between dental professionals, educators, and herbal pharmacologists are essential to develop effective communication strategies and tailored interventions for special needs populations. In conclusion, betel leaf decoction has demonstrated greater efficacy in plaque reduction compared to binahong, making it a promising herbal agent for oral hygiene maintenance in deaf children and potentially in broader pediatric populations.

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DATA AVAILABILITY

No datasets were generated or analyzed during the current study.

AUTHOR CONTRIBUTION

Isnanto conceptualized the study, supervised the intervention, and led the data interpretation and manuscript preparation. Ajeng Nurzilullahningtiyas was responsible for conducting fieldwork, data collection, and participant coordination. Silvia Prasetyowati contributed to the literature review, prepared the herbal decoctions, and assisted in data analysis. All authors reviewed the final manuscript, approved its content, and agreed to be accountable for all aspects of the work.

DECLARATIONS

ETHICAL APPROVAL

The authors declare that there is no conflict of interest regarding the publication of this paper. All procedures involving human participants were conducted in accordance with ethical standards and approved by the institutional review board. Informed consent was obtained from all guardians prior to participation. This research was conducted independently and received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

CONSENT FOR PUBLICATION PARTICIPANTS.

Consent for publication was given by all participants

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COMPETING INTERESTS

The authors declare no competing interests.

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