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The Effect of CPP-ACP (Casein Phosphopeptide Amorphous Calcium Phosphate) on Salivary pH Changes in Children

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ABSTRACT

Background: Salivary pH plays an important role in maintaining the balance of the oral environment. An excessively acidic salivary condition may increase the risk of enamel demineralization and dental caries. Children aged 6–12 years are particularly vulnerable to oral health problems because they are in the mixed-dentition period. One potential preventive agent is casein phosphopeptide–amorphous calcium phosphate (CPP-ACP), which contains calcium and phosphate and may help maintain mineral balance and oral pH. This study aimed to determine the effect of CPP-ACP use on changes in salivary pH among children aged 6–12 years at SDN 12 Banda Aceh. Methods: This quantitative study employed a pre-experimental design using a one-group pretest–posttest design without a control group. The sample consisted of 77 children. Salivary pH was measured before and after CPP-ACP application using pH indicator paper by matching the resulting color with the standard indicator scale. Data were analyzed using the Wilcoxon signed-rank test at a significance level of $\alpha = 0.05$. Results: The mean salivary pH increased from 5.9351 to 6.8312. Before CPP-ACP application, 80.5% of respondents had acidic salivary pH, 14.3% had neutral pH, and 5.2% had alkaline pH. After application, 14.3% had acidic pH and 85.7% had neutral pH. Fifty-nine respondents experienced an increase in pH, four experienced a decrease, and 14 showed no change. The Wilcoxon signed-rank test yielded $p = 0.001$ ($p < 0.05$). Conclusion: CPP-ACP application significantly affected salivary pH and tended to increase salivary pH toward a neutral condition

INTRODUCTION

Health is a state of physical, mental, and social well-being rather than merely the absence of disease, enabling individuals to live productive lives. Efforts to maintain and improve health status should be comprehensive and include oral health. Oral health is an integral part of overall health because it plays an important role in eating, speaking, and maintaining quality of life (Maramis et al., 2023). According to the World Health Organization (Organization, 2022), approximately 60–90% of schoolchildren worldwide experience dental caries. In Indonesia, the 2018 Basic Health Research) reported a high prevalence of dental caries among school-aged children, reaching 92.6% (Kemenkes RI, 2018). Meanwhile, the 2023 Indonesian Health Survey (SKI) reported an active caries prevalence of 45.5% among elementary school-aged children in Indonesia. In Aceh Province, the prevalence of oral and dental problems was 56%, while the prevalence of active caries was 47% (Kemenkes, 2023).

Prevention of dental caries in children can be achieved through primary prevention, which involves measures taken before disease occurs. Primary preventive measures include oral health education, maintenance of oral hygiene, regular dental examinations, fluoride application, and fissure sealants. With advances in dental science, caries prevention can also involve the use of additional remineralizing agents, one of which is casein phosphopeptide–amorphous calcium phosphate (CPP-ACP), found in products such as tooth mousse (Yuniarly & Suyatmi, 2023).

CPP-ACP can increase the availability of calcium and phosphate ions in saliva, thereby helping repair early carious lesions, inhibit demineralization, and accelerate enamel remineralization (Baccolini et al., 2025). In addition, CPP-ACP may help stabilize salivary pH by supporting the buffering capacity of saliva to neutralize acids produced by cariogenic bacteria. Therefore, CPP-ACP may function not only as a remineralizing agent but also as a preventive measure to reduce the risk of dental caries in school-aged children.

Salivary acidity, expressed as pH, is an important factor in the development of dental caries (A'yun & Purnama, 2021). Normal salivary pH is generally close to neutral, at approximately 7. A decrease in

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salivary pH to ≤5.5 represents a critical condition because it may increase the risk of enamel demineralization. The growth of oral bacteria is generally optimal at a salivary pH of approximately 6.5–7.5. Conversely, at a low salivary pH of 4.5–5.5, the oral environment may favor the growth of acidogenic bacteria such as Streptococcus mutans and Lactobacillus, which are involved in the caries process (Sanusi & Purnama, 2026; Zahara et al., 2023).

Among children aged 6–12 years, salivary conditions and pH have particular characteristics. This age range represents the mixed-dentition phase, during which primary and permanent teeth are simultaneously present in the oral cavity. Newly erupted permanent teeth have not yet reached complete mineralization and are therefore more susceptible to acidic environmental challenges (Widani et al., 2021). This condition makes children aged 6–12 years an appropriate population in which to assess the effectiveness of preventive measures aimed at maintaining salivary pH balance.

A previous study by (Pujianti, 2024) at SMPN 17 Tasikmalaya reported that CPP-ACP use significantly increased salivary pH among school students. The findings indicated that CPP-ACP was effective in improving the oral environment toward a more neutral condition, potentially reducing the risk of dental caries. According (Utami, 2021) also reported an effect of CPP-ACP administration on salivary pH.

Based on preliminary data collected by the researchers through salivary pH examinations of 10 students at SD Negeri 12 Banda Aceh, nine children had dental caries, with a mean caries index of 4.8, categorized as high. These findings indicate that oral health problems among the children remain substantial. Low salivary pH may increase enamel demineralization and consequently accelerate the development of dental caries. Therefore, this study was conducted to determine the effect of CPP-ACP use on changes in salivary pH among children aged 6–12 years at SDN 12 Banda Aceh

METHOD

This quantitative study employed a pre-experimental design using a one-group pretest–posttest design without a control group. A single group of participants received the intervention, and measurements were performed twice: before the intervention (pretest) and after the intervention (posttest). This design was selected to assess changes in salivary pH before and after CPP-ACP use in the same participants.

The study population comprised all students aged 6–12 years at SDN 12 Banda Aceh, totaling 344 children. The sample size was determined using Slovin's formula with a 10% margin of error, resulting in 77.47 and rounded to 77 respondents. Sampling was conducted using proportional random sampling based on the number of students in each class, followed by simple random sampling within each class. The sample distribution was as follows: class 1A, 7; 1B, 7; 2A, 8; 2B, 8; 3A, 7; 3B, 6; 4A, 9; 4B, 9; 5A, 5; 5B, 4; 6A, 5; and 6B, 5 respondents.

The study was conducted at SDN 12, Peuniti Village, Baiturrahman District, Banda Aceh, in May 2026. The research instruments included a diagnostic set, patient status cards, pH indicator paper, and Tooth Mousse containing CPP-ACP. Primary data consisted of salivary pH measurements obtained directly using pH indicator paper, while secondary data, including participants' names, sex, and age, were obtained from the student registration records.

The procedure began with measurement of baseline salivary pH (pretest) using pH indicator paper before the respondents brushed their teeth. The respondents were then guided in brushing their teeth. CPP-ACP-based Tooth Mousse was applied evenly to the tooth surfaces in an amount approximately the size of a pea. The respondents kept their mouths open for 3 minutes to allow the material to act, after which they were allowed to close their mouths normally and were instructed not to rinse for 10 minutes. Saliva was then collected in a collection cup, and final salivary pH (posttest) was measured. The pH was determined by matching the color change on the indicator paper with the standard color scale.

Data processing included editing, coding, data entry, and cleaning. Univariate analysis was used to describe respondent characteristics and the distribution of salivary pH before and after CPP-ACP use using frequencies, percentages, means, and standard deviations. Bivariate analysis began with a normality test. Because the data were not normally distributed, the effect of CPP-ACP use was analyzed using the Wilcoxon signed-rank test with a significance level of $\alpha = 0.05$.

RESULT

The study involved 77 students aged 6–12 years at SD Negeri 12 Banda Aceh. Data analysis included univariate analysis to describe respondent characteristics and salivary pH distributions, and bivariate analysis to assess changes in salivary pH before and after CPP-ACP use.

Table 1. Frequency Distribution of Respondents by Age and Sex among Children

No.	Child Characteristics	Frequency	Percentage
1.	Age 6–8 years 9–12 years	 43 34	 55.8 44.2
2.	Sex Male Female	 36 41	 46.8 53.2

As shown in Table 1, most respondents were aged 6–8 years (43 respondents; 55.8%), and 41 respondents (53.2%) were female.

Table 2. Distribution of Salivary pH before and after CPP-ACP Use among Children

Salivary pH Category	Before CPP-ACP Use	%	After CPP-ACP Use	%
Acidic	62	80.5	11	14.3
Neutral	11	14.3	66	85.7
Alkaline	4	5.2	0	0
Total	77	100	77	100

As shown in Table 2, before CPP-ACP use, most respondents had acidic salivary pH (62 respondents; 80.5%). After CPP-ACP use, most respondents had neutral salivary pH (66 respondents; 85.7%).

Table 3. Results of the Normality Test for Salivary pH before and after CPP-ACP Use

Variable	Kolmogorov–Smirnov Statistic	df	Sig.
Salivary pH before CPP-ACP use	0.233	77	<0.001
Salivary pH after CPP-ACP use	0.956	77	<0.001

The Kolmogorov–Smirnov normality test showed significance values of <0.001 for salivary pH before and after CPP-ACP use. Both values were below 0.05, indicating that the data were not normally distributed. Therefore, the bivariate analysis was performed using the Wilcoxon signed-rank test.

Table 4. Wilcoxon Test Results for Changes in Salivary pH before and after CPP-ACP Use

Salivary pH Change	N	Mean Rank	Sum of Ranks
Negative ranks (posttest < pretest)	4	26.00	104.00
Positive ranks (posttest > pretest)	59	32.41	1,912.00
Ties (posttest = pretest)	14	–	–
Total	77	–	–

As shown in Table 4, 59 respondents experienced an increase in salivary pH after CPP-ACP use, four experienced a decrease, and 14 showed no change.

Table 5. Statistical Results of the Wilcoxon Signed-Rank Test

Variable	Z	Sig. (2-tailed)	Interpretation
Posttest – Pretest	−6.637	0.001	Significant

The Wilcoxon signed-rank test yielded a Z value of −6.637 and a significance value of 0.001 ($p < 0.05$). Thus, there was a statistically significant change in salivary pH between the pretest and posttest measurements among children aged 6–12 years at SDN 12 Banda Aceh

DISCUSSION

The results showed that CPP-ACP use affected changes in salivary pH among children aged 6–12 years at SDN 12 Banda Aceh. The Wilcoxon signed-rank test yielded a significance value of 0.001 ($p < 0.05$),

indicating a statistically significant difference between salivary pH values before and after CPP-ACP use. The mean salivary pH increased from 5.9351 to 6.8312. Before CPP-ACP use, most respondents were in the acidic category, whereas after CPP-ACP use, most were in the neutral category.

The increase in salivary pH after CPP-ACP use may be attributed to the ability of the compound to provide and maintain calcium and phosphate ions in the oral cavity. The availability of these ions supports the salivary buffering system in neutralizing acidic conditions and maintaining the balance between enamel demineralization and remineralization. CPP-ACP can also bind to dental plaque biofilm, oral soft tissues, and tooth surfaces, thereby facilitating the availability of calcium and phosphate ions within the oral environment (Lesmana et al., 2022).

Saliva is an important factor in maintaining oral health because it contributes to natural cleansing, microbial balance, and maintenance of pH. When salivary pH decreases and remains acidic for prolonged periods, enamel demineralization may occur more readily, increasing the risk of dental caries. Conversely, a salivary pH close to neutral supports remineralization and helps maintain the structural integrity of enamel (Sutanti et al., 2021; Zahara et al., 2023).

Fifty-nine respondents experienced an increase in pH, four experienced a decrease, and 14 showed no change. These differences in response may be influenced by individual factors, such as salivary flow rate, salivary buffering capacity, consumption patterns of acidic or cariogenic foods and beverages, oral hygiene, and individual biological characteristics. These factors may affect the ability of saliva to maintain pH stability, resulting in different responses to CPP-ACP use.

The findings of this study are consistent with those of (Utami, 2021), who reported an effect of CPP-ACP administration on salivary pH. (Pujianti, 2024) also reported that CPP-ACP application could increase salivary pH among school students. The consistency of these findings supports the potential of CPP-ACP to positively influence salivary conditions through increased availability of calcium and phosphate ions in the oral cavity.

Based on the findings, underlying theory, and supporting previous studies, CPP-ACP use significantly affected changes in salivary pH among children aged 6–12 years at SDN 12 Banda Aceh. These findings suggest that CPP-ACP may be considered as one preventive measure to help maintain salivary pH balance among school-aged children

CONCLUSION

Based on the research results, it can be concluded that CPP-ACP application significantly affected salivary pH and tended to increase salivary pH toward a neutral condition.

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