RESEARCH PAPER

Comparative Evaluation of Salivary pH Changes Using Different Toothpastes in Visually Impaired Children: An In-Vivo Study

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ABSTRACT

Background

Children with visual impairment are susceptible to poor oral hygiene owing to physical and cognitive limitations, unhealthy dietary patterns, and diminished ability to carry out effective oral care. Although routine oral hygiene practices are known to influence salivary pH and plaque control, there is lack of sufficient evidence comparing their effects within this population.

Aim

This study seeks to evaluate and compare the impact of various toothpaste formulations on salivary pH and plaque levels in visually impaired children.

Materials and Methods

This randomized controlled clinical study comprised 66 visually impaired children, who were randomly assigned into three groups (n = 22 each): Group I – Received Chitosan toothpaste, Group II – Received Fluoridated toothpaste, and Group III – Received Non-Fluoridated toothpaste. Baseline unstimulated salivary samples were obtained from Blind Relief Institute. Salivary pH was measured using a calibrated digital pH meter, and oral hygiene status was assessed using the Silness–Loe Plaque Index. The data were analyzed statistically with the level of significance set at $p < 0.05$.

Results

The mean and standard deviation were calculated, and repeated-measures ANOVA was used to evaluate intra- and intergroup differences in salivary pH. Both the Chitosan and Fluoridated groups demonstrated a statistically significant increase in salivary pH along with reduction in plaque levels compared to the non-fluoridated group ($p < 0.001$), with no statistically significant difference between the chitosan and fluoride groups.

Conclusion

Chitosan toothpaste was found to be as effective as fluoridated toothpaste in enhancing salivary pH and reducing plaque levels. Both formulations demonstrated superior efficacy compared to non-fluoridated toothpaste.

Keywords: Chitosan toothpaste, Fluoridated toothpaste, Non-fluoridated toothpaste, Salivary pH, Plaque Index.

Source of support: Nil.

Conflict of interest: None.

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INTRODUCTION:

Oral hygiene plays a pivotal role in the prevention of dental caries and periodontal diseases, with effective plaque control and regulation of salivary pH being essential for maintaining oral homeostasis [1,2,3]. Fluoride-containing dentifrices are widely utilised due to their ability to enhance remineralization and inhibit the progression of dental caries. However, concerns regarding fluoride toxicity and dental fluorosis, particularly in children, have prompted the exploration of safer alternatives [4,5].

Visually impaired children are especially susceptible to poor oral hygiene owing to the lack of visual guidance, reliance on caregivers, and limited access to oral health education, leading to increased plaque accumulation and altered salivary pH[6,7]. Studies have demonstrated that visually impaired children exhibited quite poor oral health status compared with their sighted peers [8,9].

Chitosan, a natural biopolymer, has gained attention as a potential alternative due to its antimicrobial, bioadhesive, and remineralizing properties. It has been shown to reduce plaque formation and improve oral environment, supporting its application in dentifrice formulations [10]. Therefore, evaluating its effectiveness in comparison with conventional agents is essential for improving oral health outcomes in this population.

MATERIALS AND METHODS:

Study Design:

This study was designed as a randomized, controlled, parallel-group clinical trial conducted over a period of 15 days among visually impaired children. Participants were selected from Navajeevan Blind Relief institute, Tirupati. A total of 66 children aged 8–12 years were randomly assigned into three groups: Group I received chitosan toothpaste, Group II received fluoridated toothpaste and Group III received non-fluoridated toothpaste, with 22 participants in each group.

Ethical approval was obtained from the Institutional Ethical Committee (Approval No: CKS/IEC-PEDO/2026/37).

Inclusion criteria : The study included visually impaired children aged 8–12 years with Silness-Loe plaque index scores ranging from 1–3, who had not been under medication or remineralizing toothpastes or mouthrinses in the preceeding 2 weeks, and those whose parents/guardians provided informed consent.

Exclusion criteria : Children with xerostomia, salivary gland disorders, or systemic disorders; those undergoing orthodontic treatment; children with known allergic to toothpaste ingredients; and those with poor cooperation or inability to follow brushing instructions are excluded from the study.

On Day 1, 1ml of unstimulated saliva samples were collected prior to the use of any toothpaste. Subsequently, participants brushed using their assigned toothpastein accordance with study protocol under supervision for 3min.Participants provided unstimulated saliva samples prior to their first meal of the day.These collections occurred approximately 30 minutes after toothbrushing at a consistent time each day over a 15 day period[21]. Participants were instructed to fast (avoiding all food &drink) prior to the procedure. Saliva was permitted to pool at the floor of the mouth and then expectorated into a sterile container.

Plaque scores were documented at baseline and at the end of 15 day study using Silness-Loe plaque index.

STATISTICAL ANALYSIS:

Data analysis was performed by using analyzed using repeated measures ANOVA for intragroup comparison of salivary pH and one-way ANOVA followed by Tukey post hoc test for intergroup comparison. A statistically significance was defined as p-value <0.05.

RESULTS:

- Table1 demonstrates a statistically significant increase in salivary pH was observed across all three groups from baseline to day 15 ($p < 0.001$). The most substantial improvement occurred in Group II (fluoridated toothpaste), followed by Group I (chitosan), whereas Group III (non-fluoridated toothpaste) showing minimal change. These results indicate that fluoridated toothpaste is more effective at increasing salivary pH,though the chitosan formulations also demonstrated notable efficacy compared to the non-fluoridated control.

TABLE 1: Intragroup Comparison of Salivary pH

Group	Baseline (Mean ± SE)	Day 15 (Mean ±	Mean Difference	P value

	SE)			
GroupI(Chitosan)	6.541 ± 0.033	7.636 ± 0.025	+1.095	< 0.001
Group II(Fluoridated)	6.400 ± 0.033	7.755 ± 0.025	+1.355	< 0.001
Group III (Non-fluoridated)	6.286 ± 0.033	7.127 ± 0.025	+0.841	< 0.001

According to Table 2, all groups showed significant reduction with a statistically significant variances between groups ($p < 0.05$). The Chitosan group achieved most pronounced reduction followed by the fluoridated group,while the non-fluoridated group demonstrated the least amount of clinical improvement.

TABLE 2 : Intragroup Comparison of Plaque Index

Parameter	Chitosan (Mean ± SD)	Fluoridated (Mean ± SD)	Non-Fluoridated (Mean ± SD)	p-value
Plaque Baseline	1.5955 ± 0.2380	1.7000 ± 0.2093	1.4955 ± 0.2058	0.018 *
Plaque After 15 days	0.8864 ± 0.3106	0.9500 ± 0.1406	1.1773 ± 0.1771	0.002 *

FIGURE 1 :

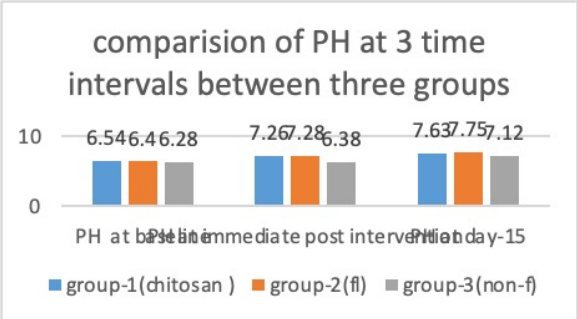
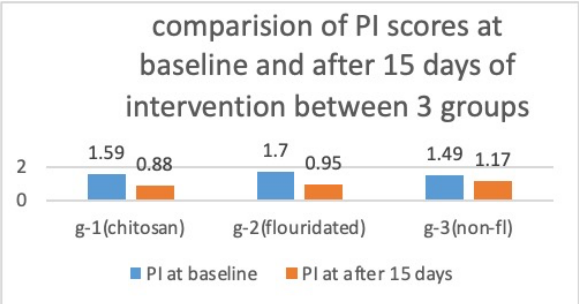


FIGURE 2 :



DISCUSSION:

Dental caries remains one of the most prevalent chronic diseases affecting children worldwide. According to the World Health Organization (WHO), approximately 60–90% of school-aged children are affected by dental caries globally [11].

The burden is notably higher among visually impaired children; Mishra et al. reported a prevalence of 71%, indicating a substantial oral health challenge within this population [12].The etiology of dental caries in visually impaired children is multifactorial. A key contributing factor is the difficulty in maintaining effective oral hygiene due to the absence of visual guidance. Additionally, increased dependence on caregivers, limited access to oral health education, and inadequate awareness further exacerbate the risk. Parental knowledge, attitudes, and practices significantly influence the oral health status of these children, underscoring the importance of caregiver involvement in preventive oral healthcare.

Saliva, a complex biological fluid, plays an essential role in maintaining oral health. It contributes to the regulation of oral pH through its buffering capacity, facilitates mechanical cleansing, and promotes enamel remineralization [13]. Among various salivary parameters, salivary pH is particularly critical in the caries process, as the balance between demineralization and remineralization is highly dependent on pH levels [14].

The present study was undertaken to improve oral hygiene among visually impaired children by modulating salivary pH using different dentifrice formulations. Toothbrushing with toothpaste represents a simple, cost-effective, and widely accepted oral hygiene practice, and is considered safe and effective even in children with visual impairment. This study evaluated the effects of chitosan, fluoridated, and non-fluoridated toothpastes on salivary pH over a 15-day period.

At baseline, no statistically significant differences were observed among the three groups ($p > 0.05$), indicating comparability. However, after 15 days, intergroup comparison revealed a highly significant increase in salivary pH in both the chitosan and fluoridated groups compared to the non-fluoridated group. Overall, both chitosan and fluoridated toothpastes demonstrated significant efficacy in elevating salivary pH.The observed increase in salivary pH, particularly in the fluoridated group, is consistent with previous studies by Featherstone and ten Cate, which highlight the role of fluoride in enhancing remineralization and inhibiting demineralization by maintaining a favorable oral

environment [4,15]. Fluoride also reduces bacterial acid production, thereby contributing to an increase in salivary pH.

The chitosan group demonstrated comparable improvements in salivary pH, in agreement with findings by Rabea et al. and Dash et al., which report its antimicrobial activity against oral pathogens [10,16]. Chitosan disrupts bacterial cell membranes and reduces the load of acidogenic microorganisms, which may account for the observed increase in salivary pH. Similar findings have been reported by Costa et al., emphasizing its role in inhibiting biofilm formation.

A reduction in plaque index was observed across all groups following 15 days of toothpaste use. Notably, the chitosan group exhibited the greatest reduction, followed by the fluoridated group, while the non-fluoridated group showed the least improvement. The differences among the groups were statistically significant, suggesting superior plaque control with chitosan-containing toothpaste. These findings support the potential role of chitosan in preventive oral health strategies.

A significant reduction in plaque index across all groups further reinforces the importance of mechanical plaque control through toothbrushing [17]. However, both chitosan and fluoridated toothpastes demonstrated significantly greater efficacy compared to the non-fluoridated formulation, consistent with studies highlighting the benefits of active therapeutic agents in dentifrices.

The greater reduction in plaque observed in the chitosan group aligns with studies by Aranaz et al., and Pasquantonio G et al.,which attribute this effect to its bioadhesive properties and its ability to inhibit bacterial adhesion and biofilm formation[18,19]. Furthermore, the absence of a statistically significant difference between the chitosan and fluoridated groups suggests comparable efficacy between the two formulations.

At baseline, the groups were comparable, supporting the validity of the study design. Following the intervention, both the chitosan and fluoridated groups demonstrated significantly lower plaque scores compared to the non-fluoridated group. These findings are particularly relevant in children with visual impairment, who are more susceptible to poor oral hygiene and dental caries due to compromised motor skills and altered salivary parameters, as highlighted by Anders and Davis.[20]

CONCLUSION:

Both chitosan and fluoridated toothpastes significantly improved salivary pH and reduced plaque levels in visually impaired children, demonstrating comparable efficacy. Chitosan showed superior plaque reduction and may serve as a potential alternative to fluoridated dentifrices, particularly in situations where fluoride use is limited or concerns regarding fluoride toxicity exist. However, as remineralization was not directly assessed in the present study and in vivo evidence regarding the remineralization potential of chitosan remains limited, further well-designed clinical studies are required to evaluate and compare its remineralization efficacy with that of fluoridated toothpastes.

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