

Research Synopsis

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Title: Impact of Sugar-Free vs. Conventional Toothpaste on Salivary Glucose and pH in Individuals with Type-2 Diabetes

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Abstract

Diabetes significantly influences oral health, primarily due to elevated salivary glucose levels that foster the growth of sugar-metabolizing bacteria. This microbial imbalance leads to acid production, inflammation, and the degradation of oral tissues, resulting in common complications such as dental caries, plaque formation, and periodontal diseases. Diabetic individuals often face additional challenges like reduced salivary flow, immune dysfunction, and impaired collagen metabolism, which collectively impair gum healing and oral hygiene.

To address these unique issues, targeted oral care solutions are essential. A specialized therapeutic toothpaste for diabetics, formulated with ingredients such as Coenzyme Q10, herbal antimicrobials (Neem, Tulsi, Turmeric), antioxidants (Grape Seed Extract), and regenerative agents (Nano-hydroxyapatite), offers a comprehensive approach. These ingredients help control microbial overgrowth, reduce inflammation, enhance tissue repair, and protect against further oral damage.

This synopsis highlights the urgent need for diabetic-specific oral care products that support both oral and systemic health by addressing the biochemical and microbial challenges inherent to diabetes. A well-formulated diabetic toothpaste can act as both a preventive and therapeutic measure, significantly improving oral health outcomes and overall quality of life in diabetic individuals.

Introduction

Diabetes Mellitus (DM), a prevalent endocrine disorder characterized by hyperglycemia, is rapidly increasing in prevalence globally and especially in India. With projections indicating that India may become the diabetes capital of the world by 2030, the burden of diabetes-related complications, including those affecting oral health, is a growing concern.

Poorly managed blood glucose levels in diabetics significantly impact oral health, leading to conditions such as periodontal disease, gingivitis, tooth loss, and salivary gland dysfunction. Elevated blood glucose translates to higher salivary glucose, creating an environment conducive

to the growth of sugar-metabolizing bacteria. These bacteria produce acids that lower oral pH, disrupt the oral microbiome, and accelerate tissue breakdown. As a result, diabetics often face increased oral infections and delayed healing.

Saliva, a key diagnostic fluid, reflects the body's metabolic and immune status. In diabetics, its altered composition further exacerbates oral complications. Given this background, everyday oral hygiene tools like toothpaste can play a vital role not only in mechanical cleaning but also in modulating salivary pH and microbial balance.

This synopsis underscores the importance of addressing the unique oral health challenges faced by diabetic individuals and highlights the need for targeted oral care solutions to help mitigate the oral-systemic effects of diabetes.

Material and method

A randomized, controlled crossover study was conducted in two phases to evaluate the relationship between diabetes and salivary glucose levels. Ethical approval was obtained from the Institutional Ethics Committee of ACPM Dental College, Dhule, and informed consent was secured from all participants.

A preliminary pilot study helped determine the appropriate sample size using standard statistical methods, resulting in a requirement of at least 20 participants per group. For the main trial, a 1:1.5 participant ratio was adopted. The diabetic group (Group A) included 30 individuals aged 38–66 years (mean age: 53), all previously diagnosed with Type 2 Diabetes Mellitus. The control group (Group B) comprised 45 non-diabetic participants aged 34–64 years (mean age: 51). Participants were selected randomly through a lottery method.

Eligibility criteria included individuals with controlled or uncontrolled Type 2 Diabetes and their first-, second-, or third-degree relatives, all of whom had at least 20 functional teeth. Participants with non-diabetic systemic illnesses or habits such as chewing tobacco or betel nut were excluded.

This study design ensured a well-matched and ethically sound participant pool, laying a strong foundation for analyzing the impact of diabetes on salivary glucose and associated oral health parameters.

Statistical analysis

The study utilized a robust statistical framework to evaluate the effectiveness of different toothpaste formulations on salivary parameters in diabetic and non-diabetic individuals. The data collected was categorical in nature, necessitating the use of both intragroup and intergroup analyses for comprehensive interpretation.

Intragroup comparisons were conducted using **paired t-tests**, which assessed changes within each group over time—comparing baseline measurements taken before brushing on Day 1 with

those recorded after four weeks of toothpaste use. This helped determine whether the interventions significantly influenced salivary glucose levels and pH within individual groups.

Intergroup comparisons were made using **unpaired t-tests**, which evaluated differences between independent groups—diabetic vs. non-diabetic participants—allowing the researchers to measure the relative effectiveness of the toothpaste types across different populations.

All statistical analyses were performed using **SPSS software version XVI**, applying a predefined level of significance to guide the interpretation of results. This dual-layered approach enabled the identification of both internal improvements and significant differences in treatment response between groups, thereby validating the influence of diabetic status and toothpaste formulation on oral health outcomes.

Discussion

This randomized crossover study investigated the impact of sugar-free versus regular toothpaste on salivary glucose levels and salivary pH in diabetic and non-diabetic individuals. Hyperglycemia, a hallmark of diabetes mellitus (DM), leads to elevated salivary glucose, creating an altered and more acidic oral environment that increases the risk of oral health complications.

The study included two groups: 30 diabetic individuals (Group A) and 45 non-diabetic individuals (Group B). In Phase 1, Group A used sugar-free toothpaste (Vicco SF) and Group B used regular toothpaste (Colgate) for four weeks. After a washout period, the groups switched toothpaste types for another four weeks in Phase 2.

Saliva samples were collected using a standardized spitting method into containers with sodium fluoride to stabilize glucose levels. Salivary glucose was measured using the glucose oxidase-peroxidase (GOD-POD) method, and salivary pH was assessed using a digital pH meter for greater accuracy.

The results revealed that sugar-free toothpaste significantly reduced salivary glucose levels and increased salivary pH in both diabetic and non-diabetic participants. These effects were more pronounced compared to those using regular toothpaste. The lack of a significant difference between Phase 1 Group A and Phase 2 Group B supports the consistency of outcomes associated with the sugar-free formulation.

Overall, the study highlights the beneficial role of sugar-free toothpaste in improving the oral environment, particularly in individuals with diabetes.

Recommendation

The long-term evaluation of sugar-free toothpaste, especially for high-risk groups like individuals with diabetes, requires a comprehensive and multidimensional approach. Such an evaluation must consider user acceptability, clinical efficacy, potential adverse effects, and biochemical and microbial changes in the oral cavity.

User compliance is influenced by sensory attributes such as taste, texture, and foaming capacity. Regular feedback on these aspects is essential to ensure continued use and guide improvements in formulation.

Clinically, sugar-free toothpastes, which often contain non-fermentable sweeteners like xylitol or sorbitol, help reduce acid production by oral bacteria. Their efficacy should be assessed through clinical indicators like plaque index, gingival health, and prevention of enamel demineralization.

Long-term safety must also be evaluated by monitoring for adverse effects such as mucosal irritation, hypersensitivity, enamel erosion, or altered taste perception. Systematic follow-up helps establish the safety profile of the formulation.

A critical biochemical marker is the effect on salivary glucose and pH, especially in diabetics. Sugar-free toothpaste can lower salivary glucose and raise pH, creating a less acidic environment conducive to remineralization and reduced bacterial damage. Regular salivary analysis can objectively track these improvements.

Finally, microbial modulation is vital. Unlike conventional toothpastes, sugar-free formulations can suppress cariogenic bacteria like *Streptococcus mutans*. Evaluating changes in the oral microbiome before and after use provides insights into the toothpaste's impact on microbial balance, particularly in diabetic populations.

Overall, sugar-free toothpaste offers promising benefits in improving oral health and maintaining oral homeostasis, especially for diabetic individuals, but demands thorough, ongoing assessment to validate its therapeutic value.

Conclusion

This study explored the impact of sugar-free toothpaste on oral health in individuals with diabetes mellitus, focusing on salivary glucose levels, salivary pH, and overall oral condition. Diabetes often results in elevated salivary glucose, which encourages harmful bacterial growth, leading to dental caries, periodontal disease, and oral infections.

The sugar-free toothpaste used in the study, containing non-cariogenic sweeteners, demonstrated significant benefits. It notably reduced salivary glucose levels and increased salivary pH, thus creating a more alkaline oral environment that discourages the growth of acid-producing bacteria.

Participants showed improvements in plaque control, gingival health, and general oral tissue condition, with no reported adverse effects. The product was also well tolerated in terms of taste, texture, and overall user experience.

In conclusion, the findings strongly support the use of sugar-free toothpaste as an effective and safe oral hygiene measure for diabetic patients. Regular use can help regulate oral biochemical parameters, reduce the risk of dental complications, and enhance the quality of life in this high-risk population.