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ORIGINAL ARTICLE

Effect of tropical fruit juices on dentine permeability and erosive ability in removing the smear layer: An *in vitro* study

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Abstract *Background/purpose:* Acidic diet is one major cause of dentine hypersensitivity. The objective of this study was to determine the effects of different tropical fruit juices on dentine permeability and their erosive ability to remove the smear layer in extracted human teeth.

Materials and methods: Thirty-six noncarious human premolars were used, and the dentine was exposed at the tip of the buccal cusp by cutting a cavity (diameter 3 mm, depth 3 mm). Permeability of the dentine was tested under different conditions: with a smear layer and 5 minutes after the application of freshly squeezed green mango, lime, tamarind, and star-fruit juices. The smear layer was created before each treatment by gently cutting the dentine with a diamond bur. In the final treatment, the dentine was etched with 37% phosphoric acid for 30 seconds. The erosive ability of these fruit juices to remove the smear layer was also examined using a scanning electron microscope.

Results: Results revealed that application of green mango, tamarind, lime, and starfruit juices for 5 minutes significantly increased dentine permeability by 128.2%, 73.4%, 80.6%, and 70.4%, respectively ($P < 0.05$, Friedman repeated measures analysis of variance on ranks). The corresponding value of 37% phosphoric acid was 125.1%. Scanning electron microscopy data showed that green mango and lime juices had very strong erosive ability to remove the smear layer, similar to 37% phosphoric acid.

Conclusion: We conclude that tropical fruit juices, especially green mango and lime, increase dentine permeability and have a strong erosive ability to remove the smear layer, which causes dentine hypersensitivity.

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Introduction

Dentine hypersensitivity is a common oral health condition in the adult population,[1] with a prevalence ranging between 4% and 57% in general population.[2,3] In patients with dentine hypersensitivity, the dentine is exposed due to either loss of enamel or gingival recession.[4]

The transduction mechanism of pain in dentine is different from that in other organs of the body because there are no nerve terminals on the exposed dentine surface. The intradental nerves that are responsible for pain in teeth are mostly located in the pulp.[5] At present, most evidence supports the so-called hydrodynamic theory explaining the mechanism of dentine sensitivity.[6–8] This mechanism involves a rapid movement of fluid in the dentinal tubules produced by pain-producing stimuli, which is strong enough to excite the nerve terminals in the underlying pulp.[6–8]

However, patients who have their cervical dentine exposed either due to a loss of enamel or due to gingival recession may not develop dentine hypersensitivity, because the dentine is covered by a smear layer that occludes the exposed dentinal tubules.[9] These patients feel no pain or only mild pain when their teeth are exposed to stimuli such as cold water or air blasts. The term "dentine sensitivity" was used to represent these cases. The term "dentine hypersensitivity" was used when these patients described a significant increase in their dentine sensitivity.[9] One mechanism that could develop dentine hypersensitivity is exposure of patients' dentine to acidic diets.[10–12] Absi et al[10] demonstrated that hypersensitive dentine had more open dentinal tubules per unit area and a larger diameter of the dentinal tubules. Many natural fruit juices are acidic, which could remove the protective smear layer and increase dentine permeability.[13–15]

Ajcharanukul et al[16] developed a fluid filtration technique to compare the permeability of dentine; they applied different treatments on the same dentine of the crown in extracted teeth. On the basis of their study, we evaluated the effect of different treatments on the same exposed dentine.

This study aimed to determine the effects of different tropical fruit juices, including green mango, lime, tamarind, and starfruit juices, on dentine permeability using this method. The morphology of the exposed dentine after treatment with these juices was also investigated to evaluate their erosive ability to remove the smear layer.

Materials and methods

The experiments were carried out on 36 extracted premolars. All teeth were free of caries and extracted for orthodontic purposes. After extraction, the teeth were stored in 0.9% normal saline solution with amoxycillin (500 mg/L) at 4°C and used within 2 weeks. The experimental protocol was approved by the Institutional Review Board, Faculty of Dentistry/Faculty of Pharmacy, Mahidol University, Bangkok, Thailand (COE. No. MU-DT/PY-IRB 2012/017.2908).

Tooth preparation

All teeth were sectioned 1–2 mm below the cementoenamel junction using a diamond disc. The coronal pulp was removed, and a cavity (3 mm in width and 3 mm in depth) was prepared on the buccal cusp using a diamond bur in a high-speed handpiece under water spray.

Preparation of freshly squeezed tropical fruit juices

Tropical fruits, including green mango (*Manaifera indica* Linn), lime (*Citrus aurantifolia*), tamarind (*Tamaridus indica* Linn), and starfruit (*Averrhoa carambola* Linn), were purchased from a local market. The juices were freshly squeezed just before application.

Measurement of pH

The initial pH of each freshly squeezed acidic fruit was determined using an Orion 2 star benchtop pH meter (Thermo Fisher Scientific Inc., Beverly, MA, USA) at room temperature. Each fruit was tested using four different samples.

The total acidity of each freshly squeezed acidic fruit was determined by placing 20 mL of each fruit juice in a glass beaker and titrating with 0.1M sodium hydroxide solution until the pH reached 7.0. Each solution was stirred continuously as the sodium hydroxide was added. The volume of sodium hydroxide required to increase the pH of the sample to neutrality was noted, and this was repeated four times for each fruit.

Dentine permeability measurement

Permeability of dentine was determined by measuring its hydraulic conductance using the fluid filtration method.[16] In brief, after tooth preparation, the cut dentine surface of the crown was glued with cyanoacrylate adhesive (Alteco Inc., Osaka, Japan) to a plastic block, which had been sealed to a stainless-steel tube (G18). The tube was connected to a glass capillary with an internal diameter of 300 μm (DADE, Miami, FL, USA) and to a mercury manometer via the polyethylene tube. The pulp chamber, tube, and capillary were filled with normal saline solution. Fluid flow through dentine was detected by observing the movement of a small air bubble introduced into the capillary (Figure 1).

Fluid flow through dentine was recorded before and after juice treatment with a positive pressure of 100 mmHg. Hydraulic conductance values of dentine were calculated.

Application of freshly squeezed tropical fruit juices and experimental design

Four fruit juices were applied to each crown (green mango, lime, tamarind, and starfruit) and lastly crowns were treated with 37% phosphoric acid. The order in which the