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Açaí juice stains a glazed resin-modified glass-ionomer cement

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ABSTRACT

Coloured compounds (anthocyanins) in açaí can stain resin-modified glass-ionomer cement (RMGIC) due to its low staining resistance. ***Aim:*** *The aim of this study was to assess whether açaí compromises the surface colour and roughness of RMGIC in vitro.* ***Materials and Method:*** *Disc-shaped specimens (2 mm thick, 8 mm in diameter) of Vitremer™ (3M ESPE, St Paul, MN, USA) were prepared according to the manufacturer's instructions. The mixture was inserted into a silicone mould placed between two mylar strips, and light cured. Specimens were randomly divided into three groups (n=25) according to the solutions to be used for chemical degradation: artificial saliva (control), açaí sorbet and açaí juice. A spectrophotometer CM-2600d/2500d (Konica Minolta, Tokyo, Japan) was used to analyse the colour (CIELa*b* scale). Surface roughness (Ra, mm) was measured using the profilometer Surfcorder SE 1700 (Kosaka Corp, Tokyo, Japan). The specimens were subjected to three daily soaks (6 ml, 15 minutes) for 14 days at 37°C. They were washed in distilled water and placed in fresh saliva (30 minutes in the interval). After the third soak in a day, they were stored in fresh saliva overnight. Outcomes were analysed at baseline (L*, a*, b*, Ra) and after degradation (L'*, a'*, b'*, Ra').* ***Results:*** *The pH values of saliva, sorbet, and juice were 7.0, 3.8, and 4.9, respectively. ΔE* values were 6.6 for saliva, 6.9 for sorbet and 7.8 for juice. There was a significant ΔE* difference between saliva (p=0.005) and juice (p=0.002), and between juice and sorbet (p=0.019), but none between saliva and sorbet (p=0.401). There was no significant Δb* difference between the solutions. No difference between juice and sorbet was observed for Δa*, but they were significantly different from saliva (p<0.001). Brightness (L*) changed significantly. Juice showed the highest ΔE* (7.8) and ΔL* (7.7). No significant change was observed for roughness and there was no difference between the solutions for ΔRa.* ***Conclusions:*** *Açaí and saliva led to unacceptable staining, but no significant roughness changes in the resin-modified glass-ionomer cement.*

Key-words: *euterpe - glass ionomer cements - colour - in vitro techniques*

Suco de açaí provoca o manchamento do glaze do cimento de ionômero de vidro modificado por resina

RESUMO

As antocianinas presentes no açaí podem manchar o cimento de ionômero de vidro modificado por resina (CIVMR) devido a baixa resistência ao manchamento do material. ***Objetivo:*** *O objetivo desse estudo foi avaliar se o açaí compromete a cor e a rugosidade de superfície de um CIVMR in vitro.* ***Materiais e Método:*** *Amostras (2 mm de espessura, 8 mm de diâmetro) de Vitremer™ (3M ESPE, St Paul, MN, USA) foram preparadas de acordo com as instruções do fabricante. O material foi espatulado, inserido em um molde de silicone colocado entre duas tiras de poliestireno e fotopolimerizado. Após, as amostras foram randomizadas e alocadas em três grupos (n=25) de acordo com as soluções usadas para a degradação química: saliva artificial (controle) e sorbet de açaí e suco de açaí. Utilizou-se o espectrofotômetro CM-2600d/2500d (Konica Minolta, Tokyo, Japan) para a análise da cor (escala CIELa*b*) e o rugosímetro Surfcorder SE 1700 (Kosaka Corp, Tokyo, Japan) para a rugosidade de superfície (Ra, mm). As amostras foram submetidas a três imersões diárias (6 ml, 15 minutos) em cada solução por 14 dias a 37°C, tendo sido lavadas em água destilada e mantidas em saliva fresca (30 minutos) nos intervalos. Após a terceira imersão no dia, as amostras foram mantidas em saliva renovada até o dia seguinte. As variáveis foram analisadas antes (L*, a*, b*, Ra) e depois da degradação química (L'*, a'*, b'*, Ra').* ***Resultados:*** *Os valores de pH da saliva, sorbet e suco foram, respectivamente 7,0, 3,8 e 4,9. Houve diferença significante para ΔE* entre saliva (p=0.005) e suco (p=0.002) e entre suco e sorbet (p=0.019), mas não entre saliva e sorbet (p=0.401). Não foi observada diferença significante para Δb* entre as soluções. Não houve diferença significante para Δa* entre suco e sorbet, mas eles foram significativamente diferentes da saliva (p<0.001). A luminosidade (L*) mostrou alteração significante. O suco mostrou os maiores valores de ΔE* (7,8) e ΔL* (7,7)". Não houve mudança significante para a rugosidade e não foi observada diferença significante entre as soluções para ΔRa (p>0.05).* ***Conclusão:*** *O açaí e a saliva causaram manchamento inaceitável do glaze do CIVMR e insignificante alteração da rugosidade.*

Palavras-chave: *euterpe - cimento de ionômero de vidro - cor - técnicas in vitro.*

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INTRODUCTION

Consumption of açaí (Euterpe oleracea) is popular among Brazilian children, teenagers and adults, especially in the summer. The fruit is rich in compounds with variable colours[1] (green, red, and purple) and the pH of commercial açaí pulps is low[2]. These characteristics might be a source of potential adverse effects for aesthetic dental materials, particularly conventional glass ionomer cement[3].

The anticaries properties[4] and substantial evidence confirm the outstanding performance of resin modified glass ionomer cement (RMGI) for sealing[5] and restoring[6] primary teeth. However, some level of discolouration and increase in roughness are likely[7], even though it is more resistant to physical and mechanical changes than its conventional counterpart. The hydrophilic monomers in RMGI composition, such as HEMA (hydroxyethyl methacrylate), BIS-GMA (bisphenol A-glycidyl methacrylate), and TEGDMA (triethylene glycol dimethacrylate), may be prone to discolouration and increased roughness, shortening the material's longevity [8,9].

Although paediatric patients care about aesthetic issues, it is not reasonable for dentists to spend time polishing or even replacing restorations because of açaí-related stains (particularly in low-compliance children). Given the lack of evidence on RMGI and açaí interaction, information on it is relevant. Thus, the aim of this study was to assess the effect of açaí on the colour and surface roughness of an RMGIC in vitro. The null hypothesis tested was that açaí would not affect these variables.

MATERIAL AND METHOD

Sample Size Calculation

The sample size of 66 specimens (22 per group) was calculated in terms of the difference among the three groups (Test F; one-way ANOVA) for colour change magnitude (ΔE^*), α error level of 5%, effect size of 0.4, and β error level of 20% (software GPower 3.1.9.2, University of Düsseldorf). Given potential losses during specimen preparation, 10% (25 per group) was added.

Experimental Design

Seventy-five disc-shaped specimens (2 mm thick, 8 mm in diameter) of Vitremer, PEDO shade (3M ESPE, St Paul, MN, USA; Batch 1927700210) (Table 1)[10,11,12] were randomly distributed into three groups (n=25) corresponding to the tested solutions: artificial saliva (control), açaí sorbet and açaí juice. The chemical degradation protocol was based on Ozera et al. (2019)[13]. CIE L*a*b* and surface roughness (Ra, mm) values were analysed at baseline (L*, a*, b*, Ra) and after degradation (L'*, a'*, b'*, Ra'). The mean values of each specimen were recorded.

Material and Specimen Preparation

A trained operator hand mixed Vitremer´s powder/liquid (1:1 ratio) following the manufacturer's instructions. Silicone moulds (2 mm deep, 8 mm internal Ø) (Adsil Silicone Addition, Coltene, Vigodent, Rio de Janeiro, Brazil) were filled slowly with the material using a Centrix syringe (Dentsply Ind. E Com. Ltda., Petrópolis, RJ, Brazil). The mould was placed between two mylar strips, and the top was pressed by hand with a glass plate to make the specimens flat and smooth[14]. The glass was removed, and the mixture was light-cured with Valo (Ultradent, USA) under 1,000 mW/cm2 for 20 s, following the manufacturer's instructions. After the material had set and the strips had been removed, a thin layer of glaze (the finishing gloss included

Table 1. RMGIC composition.

Material	Vitremer
Manufacturer	3M ESPE (St Paul, MN, USA)
Batch #	1927700210
Powder content	Fluoroaluminosilicate glass; redox system. Mean Filler Size 3.0 µm.
Liquid content	Copolymer of Acrylic and Itaconic Acids, water, HEMA, Ethyl Acetate, Diphenyliodonium Hexafluorophosphate.
Glaze content	Triethylene Glycol Dimethacrylate (TEGDMA), Bisphenol A Diglycidyl Ether Dimethacrylate (BISGMA), Triphenylantimony, 4-(Dimethylamino)-Benzeneethanol, Hydroquinone.

Content information obtained from manufacturer information[10,11,12] in the Vitremer kit) was applied to protect the specimens, followed by light curing, as described above[15]. A radiometer (Hilux Dental Curing Light Meter, Benlioglu Dental Inc., Demetron, Ankara, Turkey) was used to monitor the irradiance before and after three measurements. The specimens were not subjected to finishing and polishing procedures. Finally, all 75 specimens were placed in deionized water at 37°C for 24 h to set (manufacturer's recommendation)[14].

Colour and roughness assessments

A CM-2600d/2500d spectrophotometer (Konica Minolta, Tokyo, Japan) was used to record the mean values of each colour coordinate (measured in triplicate). The ΔE* calculation followed the formula $\Delta E^* = [\Delta L^{*2} + \Delta a^{*2} + \Delta b^{*2}]^{1/2}$[13]. Placing the specimens on a white background prevented potential absorption effects. Surface roughness was measured with a Surfcorder SE 1700 instrument (Kosaka Corp, Tokyo, Japan) to record the mean values (Ra, mm) from three successive measurements at the centre of each specimen in different directions, covering 1.25 mm with a cut-off length of 0.25 mm at a tracing speed of 0.1 mm/s[15].

Solutions and Chemical Degradation Protocol

Table 2 provides the composition, manufacturer, batch number and pH of the solutions (artificial saliva, sorbet, and juice). The decrease in the pH of açaí observed after 7 days in the pilot study required the use of fresh solutions. The specimens were subjected to three daily soaks (6 ml, 15 minutes) for 14 days at 37°C. After these soaks and a wash with distilled water, the specimens were placed in fresh saliva for 30 minutes. After the third soak, the specimens were placed in fresh saliva, where they remained until the next day[13]. A SC06 electrode (Sensoglass, SensopH Ind. E Comércio de Sensores, São Paulo) coupled to an ion 450 M analyser (Analyser Analytical Instrumentation, São Paulo, Brazil) was used to check the pH before beginning the test.

Statistical analysis

Statistical analysis was performed with Jamovi 1.2. software (5% significance). The Shapiro–Wilk and Levene tests were used to assess data normality and homogeneity. The variables L*, a*, b*, b'*, ΔL*, and ΔE* were subjected to ANOVA followed by Tukey's test. The other variables (Ra, Ra', ΔRa, L'*, a'*, Δa* and Δb*) were subjected to the Kruskal–Wallis test followed by the Dwass-Steel-Critchlow-Fligner test (Table 3).

RESULTS

Saliva, sorbet, and juice pH values were 7.0, 3.8 and 4.9, respectively. Table 3 shows the roughness and colour ordinates baseline and final values. ΔE* values were 6.6 for saliva, 6.9 for sorbet, and 7.8 for juice. All specimens showed clinically significant pigmentation ($\Delta E > 3.3$) regardless of the solution. There was a significant ΔE* difference between saliva ($p=0.005$) and juice ($p=0.002$), and between juice and sorbet ($p=0.019$), but none between saliva and sorbet ($p=0.401$). No difference between juice and sorbet was observed for Δa*, but they differed significantly from saliva ($p<0.001$). Brightness (L*) changed significantly. Juice had the highest ΔE* (7.8) and ΔL* (7.7).

DISCUSSION

This study shows that açaí might discolour RMGIC, although there is no change in roughness. Specimen standardization was used to manage bias. For instance, saliva/açaí was removed from the freezer/

Table 2. Tested solutions.

Solution	Composition	Manufacturer/Batch No.
Artificial saliva	Calcium (0.1169 g of calcium hydroxide/L of deionized water); 0.9 mM of phosphorus and potassium (0.1225 g potassium phosphate monobasic/L of deionized water); 20 mM TRIS buffer (2.4280 g TRIS buffer/L of deionized water)	Pharmaderm, Cascavel-PR, Brazil.
Sorbet	Açai pulp, water, sugar, guar gum, carboxymethyl cellulose, tara gum, natural guarana extract, citric acid acidulant, natural guarana aroma identical, glucose, artificial dye amaranth and brilliant blue FCF, xanthan gum.	Polpa Norte, Japurá-PR, Brazil; 0136(TB)
Juice	Medium açai pulp (100 g) blended with water (100 ml)	Polpa Norte, Japurá-PR, Brazil; 0430

Table 3. Colour parameters and roughness of RMGIC at baseline and after chemical degradation with the three solutions.

	Treatment			
	Saliva	Sorbet	Juice	p values
Ra	0.15 (0.10) A	0.18 (0.10) A	0.19 (0.10) A	0.159^{KW}
Ra'	0.15 (0.15) A	0.15 (0.10) A	0.20 (0.18) A	0.241^{KW}
ΔRa	-0.0008 (0.13) A	- 0.03 (0.12) A	0.00 (0.18) A	0.660^{KW}
L	69.1 (2.1) A	68.5 (2.3) A	69.2 (1.7) A	0.502^{OwA}
L'	62.5 (1.6) A	61.7 (1.7) A	61.4 (1.7) A	0.073^{KW}
ΔL	-6.5 (1.3) A	-6.8 (1.7) AB	-7.7 (1.1) B	0.003^{OwA}
a*	- 1.7 (0.4) A	- 1.6 (0.3) A	- 1.5 (0.4) A	0.367^{OwA}
a'*	- 1,9 (0.2) A	- 1.1 (0.8) B	- 1.0 (0.7) B	<.001^{KW}
Δa*	-0.3 (0.2) A	0.5 (0.5) B	0.5 (0.5) B	<.001^{KW}
b*	11.7 (1.2) A	10.9 (1.1) A	11.2 (1.0) A	0.087^{OwA}
b'*	11.9 (1.1) A	11.4 (0.8) A	11.5 (1.1) A	0.316^{OwA}
Δb*	0.2 (0.8) A	0.5 (0.7) A	0.2 (0.9) A	0.229^{KW}
ΔE*	6.6 (1.2) A	6.9 (1.6) A	7.8 (1.1) B	0.002^{OwA}

Mean (standard deviation), n= 25. The symbol (') means after chemical degradation. Different letters indicate significant differences by row. One-way ANOVA (OwA)/ Tukey's test. Kruskal–Wallis (KW)/Dwass-Steel-Critchlow-Fligner´s test (p<0.05).

refrigerator immediately before checking pH and the beginning of the protocol.

The three solution ΔE* values (>3.3) supported rejection of the null hypothesis. Açaí juice made the specimens darker with lower lightness coordinates (ΔL)[7], and the positive Δa* indicates a shift towards red. These results suggests that the coloured compounds in the fruit and the liquid have stronger staining potential than those in the sorbet. Moreover, staining could be critical for other fruit colours. We speculate that staining was limited to the glaze applied to prevent surface irregularities[15]. The BIS-GMA (glaze) and HEMA (matrix and liquid content)[16] may have increased pigment transportation during the test. Glaze removal by brushing machine and a long-term protocol would show the possibility of body discolouration. The colour results for the saliva group might have been related to carboxymethyl-cellulose (a thickening agent), which can cause discolouration. Even composite resins showed noteworthy ΔE* values (7.8 to 10.6) when immersed in artificial CMC-based saliva[17]. The negative Δa* and ΔL values indicate a shift towards green colour and darker specimens, respectively.

A polyester strip provided a smooth surface[14], which is why the samples were not polished[15]. The surface roughness variation (ΔR<0.00) was not significant (null hypothesis accepted). Despite the conflicting reports, experimental dissimilarities may explain disagreements[18]. The longer the time in coloured acid solution, the more colour would change. Scanning electron microscopy could provide information about the specimen surfaces. Inter-RMGIC comparison is still under investigation. The authors conclude that açaí and saliva led to unacceptable RMGIC staining, but no significant change in its roughness.

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CONFLICT OF INTEREST

The authors declare no conflicts of interest concerning the publication of this article.

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