Evaluation of Colour Stability of Activa Pronto and Beautifil Flow Plus in Three Different Solutions - An In Vitro Study

Kalaivani Venkadessan[1], Leelavathi L[2*], Meignana Arumugham Indiran[3]

[1]*Post-Graduate Student, Department of Public Health Dentistry, Saveetha Dental College & Hospital, Saveetha University, SIMATS.*
Email ID: kalai11venki@gmail.com, ORCID ID: 0000-0002-8611-3203
[2]*Reader, Department of Public Health Dentistry, Saveetha Dental College & Hospital, Saveetha University, SIMATS.*
Email ID: leelavathi.sdc@saveetha.com, ORCID ID: 0000-0003-0471-9568
[3]*Professor and Head, Department of Public Health Dentistry, Saveetha Dental College & Hospital, Saveetha University, SIMATS.*
Email ID: drmei.sdc@saveetha.com, ORCID ID: 0000-0002-7519-3877
Corresponding Author: Leelavathi L

KEYWORDS
Colour Stability, Staining, Activa Pronto, Esthetics, Restoration

ABSTRACT
Objective: To assess the colour stability of two bioactive restorative materials Activa Pronto (Pulpdent, USA) and Beautifil Flow Plus (Shofu, Japan) when exposed to three commonly consumed beverages: coffee, tea, and Coca-Cola.
Materials and Methods: 80 disc-shaped specimens were prepared, 40 samples each of the material and were divided into four groups based on the staining solution, which included: distilled water (control), coffee, tea, and Coca-Cola. The specimens were placed in the respective solution for 30 days. Solutions were replaced daily to avoid contamination. Color measurements were performed before (baseline) and after 30 days using a VITA Easyshade spectrophotometer, and the colour changes (ΔE) were calculated in the CIE Lab* system.
Results: For the ΔE values, Activa Pronto showed significantly lower values than Beautifil Flow Plus in both coffee (p=0.001) and Coca-Cola (p=0.000) solutions. In the tea group, no significant difference was observed (p=0.223). Activa Pronto generally had more stable color, especially in acidic and staining solutions like coffee and Coca-Cola solutions.
Conclusion: Activa Pronto presented greater color stability than Beautifil Flow Plus; therefore, it is a more suitable material for patients who would take much notice of the aesthetic appearances of their restorations in the long term. The most stained materials by Coca-Cola and coffee meant further investigation into the long-term clinical behaviour of these materials was essential.

1. Introduction

The development of restorative materials with remarkable colour stability has become necessary due to patients' increasing interest for the aesthetic appeal of dental restorations. Modern dentistry practice has come to adopt resin-based composites because of their adaptability and cosmetic qualities. Assessing the colour stability of dental materials is essential to assuring the durability and aesthetic appeal of restorative operations (1). Maintaining the original hue and appearance of restorations is crucial since they are exposed to a variety of environmental elements, dietary impacts, and oral diseases. It is essential for dentists to comprehend the manner in which dental restorative materials behave in different conditions in order to choose materials wisely and guarantee the most effective clinical outcomes for their patients (2). Understanding the behavior of dental restorative materials in different environments is pivotal for clinicians in making informed decisions about material selection and ensuring optimal outcomes for patients. The outcomes of this in vitro study are anticipated to contribute significantly to the existing body of knowledge, guiding dental professionals toward more informed and evidence-based choices in restorative dentistry (3).

Both external and intrinsic factors can cause discolouration in composite resins. The grade of the polymer, the type and quantity of the filler, and the synergist added to the photoinitiator system all affect internally caused discolourations, which are permanent. The conversion rate and physicochemical properties of the resin, with the water sorption rate being especially significant, influence its affinity for extrinsic stains (4). The surface or subsurface of the resin restorations may become discoloured in the oral cavity due to superficial degradation or a small penetration and adsorption of staining agents at the superficial layer of the composite resins (5).

One of the factors contributing to patient dissatisfaction and restoration failure, suggesting replacement, has been identified as colour mismatch in direct restorations. Bioactive composites are one of the most recent

advancements in resin composite materials, and researchers and physicians are increasingly interested in them (6). This is because, in addition to their superior mechanical and physical qualities, these new composite materials have remineralising and anti-caries qualities that greatly enhance their utility. On the other hand, people's awareness and demand for aesthetics have grown. In order to forecast the long-term aesthetic outcomes of these changed restorative materials, it is imperative to examine their optical characteristics (7). The aim of this study is to investigate the effects of different common drinks consumed by patients on bioactive composites in dentistry.

2. Material and Methods

Sample Preparation

Two materials used in this study were Activa Pronto, Pulpdent, USA and Beautifil Flow Plus, Shofu, Japan (Figure 1). These materials were made into a 80 disc shaped sample (40 discs in each material) of size 10 mm in diameter and 2 mm in thickness using metal mould and were polymerized according to manufacturers' instructions (Figure 2 & 3). The light was positioned 1.5 mm away from the specimen surface, perpendicular to it. Next, to replicate clinical settings, the upper surface of every specimen was polished using fine and superfine polishing discs (8).

Figure 1: Activa Pronto and Beautifil Flow Plus composite

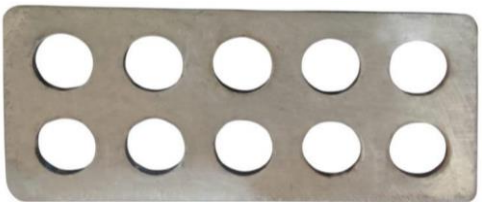

Figure 2: A metallic mould used to prepare sample discs.

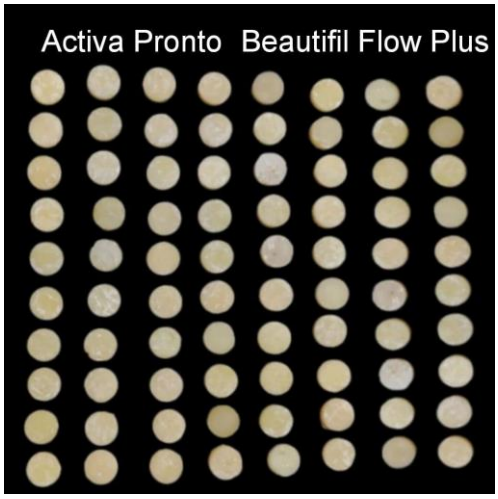

Figure 3: Sample discs made from Activa Pronto and Beautifil Flow Plus.

Ten specimens of each material were randomly assigned to four groups based on the staining solution employed in order to assess the colour change in three distinct beverages and control. Group 1: Distilled Water; Group 2: Coffee; Group 3: Tea; Group 4: Coca-Cola;

Staining Solution Preparation

The tea solution (Tata tea, Chakra Gold) was prepared by immersing two prefabricated tea bags (2 × 2 g) into 300 mL of boiling mineral water free of sugar or milk. The coffee solution (Bru) was prepared by immersing 2 g coffee in 100 mL boiling water without milk or sugar. 100ml of Coca-Cola was taken and 100 ml of distilled water was used as control. 100 mL of each solution were taken for the study (9). Composite specimens were placed into the containers with both sides being exposed to the staining solution. To prevent bacterial or yeast contamination, colourant solutions were changed daily. To keep carbonic gas from escaping and to maintain the proper degree of carbonation, the container lids were securely fastened.

Colour Assessment

Assessments were conducted at baseline and 30 days following the staining media immersion. The specimen's discolouration, or ΔE, was the difference between the starting spatial location (the initial match of L*a*b* coordinates) and the updated spatial position obtained in each measurement (10). To secure accurate results, VITA Easyshade® Advance 4.0 (a spectrophotometer) was used to record the results at each stage of the experiment (Figure 4 & 5). The Commission Internationale d'Eclairage (CIE) L*a*b* system was used to record the data, which were then utilised to calculate ΔE from the device for each time point using the equation below,

$$\Delta E = \sqrt{(L_{post} - L_{baseline})^2 + (a_{post} - a_{baseline})^2 + (b_{post} - b_{baseline})^2}.$$

Figure 4 & 5: VITA Easyshade® Advance 4.0

3. Result

In all three solutions, Colour stability of Activa Pronto is better than Beautifil Flow plus. In Coffee, Mean of Activa Pronto and Beautifil Flow plus is 4.07 and 6.84 resp., (p=0.001). In Tea, Mean of Activa Pronto and Beautifil Flow plus is 5.14 and 6.03 resp., (p=0.223). In Coca Cola, Mean of Activa Pronto and Beautifil Flow plus is 2.82 and 6.82 resp., (p=0.000). Colour Stability between the groups in Coffee and Coca-cola is statistically Significant. There was no difference noted in the control group (Table 1).

Table 1: Comparison of colour stability between two materials at various time points in different solutions. (Independent sample t test)

S.No	Material	Solution (Mean SD)	P value
Coffee			
1	Activa Pronto	4.070±1.3	0.001
2	Beautifil Flow Plus	6.844±1.83	
Tea			
3	Activa Pronto	5.141±1.45	0.223
4	Beautifil Flow Plus	6.037±1.71	
Coca-Cola			

5	Activa Pronto	2.951±1.07	0.000
6	Beautifil Flow Plus	6.820±1.46	

4. Discussion

Results from the study show significant elements of color stability between two popular restorative dental materials, Activa Pronto and Beautifil Flow Plus, against common beverages like coffee, tea, and Coca-Cola, all well known to extrinsic staining. This could become an everyday difficulty in sustaining the aesthetic quality of composite restorations.

In terms of performance, Activa Pronto demonstrated superior color stability than Beautifil Flow Plus regardless of which solution was used. Indeed, the most pronounced staining was noted in Beautifil Flow Plus, mainly with the Coca-Cola and coffee-based solutions. The ΔE value of Beautifil Flow Plus demonstrated highest value with Coca-Cola, indicating this material to be more sensitive to acidic beverage staining. This may mean that this Coca-Cola, due to its low pH and deep colour, can be regarded as a contributor to a higher staining potential due to its erosive tendency on the composite surface, which enables staining agents to penetrate (11). In the case of coffee, it resulted in the discoloration of both materials to be considerable, although in the case of Activa Pronto, its ΔE value was much lower when compared to Beautifil Flow Plus. The fact is in conformity with other studies that report coffee as one of the most potent chromogens for staining as well (12) (13) (14) (15) . Presumably, the lower discoloration of Activa Pronto may be associated with greater resistance to the uptake of chromogen absorption that may be due to the bioactive resin matrix and filler composition of the material.

In contrast, tea did not prove as potent a stainer of both materials. No statistically significant difference was shown between the two groups. The reason for this could have been the type of tea used or the fact that the stain potential of the tea solution was not strong enough compared to the coffee and Coca-Cola used in this study. Study done by Tian et al (14) revealed coca cola had the least staining capacity compared to Coffee and Tea. Earlier similar research drew a similar conclusion that it depends strongly on the type of restorative material used, and therefore resin-based materials resulted in better colour stability as compared to GIC-based materials in accordance with filler particles and composition (16) (17).

Practitioners should consider the clinical implications of these findings when choosing materials for patients who often drink staining beverages. Patients who are worried about the restorations' long-term colour stability might consider Activa Pronto. Its bioactive qualities and improved stain resistance make it a good option for attaining long-term functional and aesthetic appeal (18) (19) (20) (21). Results of this study would be useful information for dental practitioners in guiding the material selection for patients who are concerned with aesthetic outcomes in the long term. Activa Pronto's higher color stability makes it a better choice where beverages that stain are consumed frequently. More long-term clinical testing is warranted to confirm these findings and assess the further performance of the material in more stress-bearing oral environments.

5. Conclusion

The in vitro study showed that when exposed to staining beverages like coffee, tea, or Coca-Cola, Activa Pronto demonstrated higher color stability compared with Beautifil Flow Plus. Among the liquid solutions tested, it was found that both Coca-Cola and coffee presented itself to be the worst perpetrator of this discoloration and that Beautifil Flow Plus was more prone to staining than Activa Pronto. The results of this study would appear to make Activa Pronto better suited for the restorations in beverage consumers prone to staining.

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