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A Comparison of the Color Stability and Surface Roughness of 2 Different Laminate Porcelains in Various Solutions

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Abstract

Background: Esthetics is a primary concern in modern dentistry, and laminate veneers are commonly used for addressing discoloration and shape anomalies. Understanding the effects of various beverages on the color and surface roughness of dental ceramics is crucial for long-term clinical success.

Methods: Fifty specimens were prepared from feldspathic (VITA Cerec) and leucite-reinforced ceramic blocks (IPS Empress Esthetic CAD). After standardized polishing and glazing, the specimens were immersed in 5 solutions (coffee, tea, cola, wine, and distilled water) and stored for 3 months. Color changes (ΔE) were measured with a spectrophotometer, and surface roughness (Ra) was evaluated using a profilometer at baseline, 1 week, 1 month, and 3 months.

Results: IPS Empress Esthetic CAD specimens demonstrated greater color change than VITA specimens, with wine causing the most significant ΔE values in both groups. All color changes remained clinically acceptable ($\Delta E < 3.3$). Surface roughness increased slightly over time but did not show statistically significant differences in any group.

Conclusion: Both laminate porcelain materials demonstrated acceptable color stability and surface integrity after prolonged exposure to common beverages. Wine produced the highest color changes, while roughness changes were minimal and not significant.

Keywords: Color stability, feldspathic porcelain, laminate veneer, leucite-reinforced ceramic, surface roughness

What is already known on this topic?

- *Color stability of dental ceramics is influenced by both the material's microstructure and the type of staining agent; beverages such as red wine and coffee are among the most potent colorants due to their pigment and acid content.*
- *Feldspathic ceramics are known to have better optical properties and higher color stability than crystalline-reinforced ceramics, owing to their dense glassy matrix.*
- *Surface roughness alterations can compromise esthetics and biofilm resistance, yet short-term exposure to acidic beverages does not significantly affect the Ra values of CAD/CAM ceramics.*

INTRODUCTION

In contemporary dentistry, esthetics has become one of the foremost priorities, significantly influencing patients' treatment demands and expectations.[1] Discolorations, malformations, positional irregularities, and structural defects in the anterior teeth often lead to esthetic concerns, which can also have social and psychological impacts.[2] These demands have driven the development of minimally invasive restorative approaches that preserve as much natural tooth structure as possible while achieving high esthetic outcomes.[2] Porcelain laminate veneers are among the most widely accepted and

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What this study adds on this topic?

- *Provides a direct comparison between feldspathic (VITA CEREC) and leucite-reinforced (IPS Empress Esthetic CAD) laminate porcelains, showing that both materials maintain color stability within clinically acceptable limits (ΔE < 3.3) after prolonged exposure.*
- *Identifies red wine as the most aggressive staining solution*, *confirming beverage-specific discoloration patterns for both ceramic types under identical in vitro conditions.*
- *Demonstrates that surface roughness remains statistically unchanged over a 3-month period, suggesting glazed CAD/CAM laminate porcelains exhibit surface integrity even in acidic environments.*

reliable treatment options for addressing such issues, allowing the conservative restoration of discolored, malformed, or diastematic teeth.[3,4]

The long-term clinical success of laminate veneers depends on multiple factors, including the optical properties, color stability, surface roughness, and mechanical strength of the selected ceramic, as well as the appropriate bonding protocol.[5,6] In esthetically critical areas, maintaining long-term color harmony between the restoration and the natural dentition is essential.[2,7] Increases in surface roughness not only compromise the visual appearance but also promote plaque retention, potentially leading to secondary caries, gingival inflammation, and biofilm accumulation.[8]

Advancements in technology have facilitated the widespread clinical use of CAD/CAM systems, which allow for the production of all-ceramic restorations with high precision, improved efficiency, and predictable outcomes.[9-11] These systems utilize various esthetic and durable materials, including feldspathic ceramics, leucite-reinforced glass ceramics, lithium disilicate (LDS) ceramics, and zirconia-based ceramics.[10,12] Feldspathic ceramics are valued for their superior translucency and optical performance, while leucite-reinforced glass ceramics offer enhanced mechanical strength and improved clinical durability.[10,12,13] Both materials are widely employed in the fabrication of laminate veneers due to these favorable properties.

During their clinical service, dental restorations are continuously exposed to the dynamic oral environment, including a wide range of physical and chemical challenges. Beverages such as tea, coffee, cola, and red wine are known to have significant effects on the color stability of dental materials due to their pigmentation, acidity, and surface interaction characteristics.[14,15] Color alterations can compromise the esthetic performance of restorations, particularly in the anterior region. Additionally, prolonged exposure to these solutions has the potential to increase surface roughness, which in turn may facilitate biofilm formation and reduce long-term clinical success.[8] Consequently, assessing how different ceramic materials respond to common staining agents is of critical importance for both material selection and clinical predictability.

This study aimed to evaluate the color stability and surface roughness of laminate veneers fabricated from feldspathic ceramic (VITA Cerec) and leucite-reinforced glass ceramic (IPS Empress Esthetic CAD) after immersion in commonly consumed beverages under in vitro conditions. Tea, coffee, cola, and red wine, which are known for their high staining potential, were selected to simulate clinically relevant challenges. The first null hypothesis was that immersion in these beverages would not result in a statistically significant color change (ΔE) in either ceramic material, and the second null hypothesis was that immersion would not significantly affect the surface roughness (Ra) of either material.

MATERIALS AND METHODS

This study was designed as an in vitro investigation that did not involve human participants or animal subjects. Therefore, ethical approval and informed consent were not required. Only commercially available materials were used, and no clinical or biological data were collected or analyzed. Fifty specimens were prepared, 25 from feldspathic ceramic blocks (VITA CEREC, VITA Zahnfabrik, Bad Säckingen, Germany) and 25 from leucite-reinforced ceramic blocks (IPS Empress Esthetic CAD, Ivoclar Vivadent, Schaan, Liechtenstein). Each block was sectioned under water cooling using a low-speed diamond saw (Mecatave T180, Presi, Budapest, Hungary) equipped with a diamond wafering blade (Buehler Isomet, 11-4244, Illinois, USA) at 320 rpm to produce discs approximately 0.7-0.8 mm in thickness.

All specimens were standardized in size and surface texture. Both surfaces of each specimen were sequentially polished with 400, 600, 800, and 1000-grit silicon carbide papers (Worth Sanayi Ürünleri, Istanbul, Türkiye) on a polishing machine (Minitech 233, Presi, Budapest, Hungary) under water cooling at 250 rpm for 30 seconds per grit. After polishing, each specimen was glazed according to the respective manufacturer's instructions.

Baseline color measurements were performed with a digital spectrophotometer (VITA Easyshade, VITA Zahnfabrik, Germany) under darkroom conditions against a white background. The device was calibrated before each measurement. For each surface, 3 different points were measured, and the mean of the 3 readings was recorded as the initial value. Surface roughness (Ra, μm) was assessed using a profilometer (Marsurf M 300 L, Mahr, Germany) equipped with a 5 μm diamond stylus applying 0.75 mN, scanning 350 mm at 0.5 mm/s. Three measurements were taken per surface, rotating the specimen clockwise each time, and the average value was recorded. The profilometer was calibrated before each set of measurements using the manufacturer's reference block.

Specimens were randomly distributed into 5 groups (n = 5, measured on 2 surfaces, yielding 10 measurements per group): coffee, tea, cola, red wine, and distilled water (control). Beverages were prepared as follows: coffee (Starbucks Christmas Blend, 10 g per 180 mL hot water), tea (Lipton, 1 tsp per 75 mL hot water plus an additional tsp for steeping), cola (Coca-Cola Co., Atlanta, USA) and red wine (Sava Classic, Denizli, Türkiye) were used as purchased. Beverages were allowed to cool to room temperature before immersion. Each specimen was stored in 6 mL of solution in individual sealed containers; solutions were refreshed daily.[15] Control specimens were immersed in distilled water.

Color and surface roughness measurements were repeated at 1 week, 1 month, and 3 months. After removal from the solutions, specimens were gently rinsed in 100 mL of distilled water and blotted dry before measurements. Color change (ΔE) values were calculated for each time point using the CIE L*a*b* system as $\Delta E = ((Lt-L0)^2 + (at-a0)^2 + (bt-b0)^2)^{½}$, where t represents 1 week (ΔE1), 1 month (ΔE2), and 3 months (ΔE3).

The data obtained in this study were analyzed using the SPSS 26 software package. The normality of the data was assessed using the Shapiro–Wilk test. Due to the normal distribution of the data, comparisons between groups were conducted using 1-way ANOVA and post-hoc Tukey's HSD test. A *P*-value of <.05 was considered statistically significant.

RESULTS

The results of the present study led to the rejection of the first null hypothesis, as IPS Empress Esthetic CAD specimens demonstrated statistically significant color changes, particularly in the red wine, coffee, and cola groups at the third-month evaluation ($P < .05$). In the VITA Cerec group, significant color differences were observed in the cola and red wine groups across all time points, in the coffee group between ΔE1 and ΔE2, and in the tea and distilled water groups between ΔE2 and ΔE3 ($P < .05$), as shown in Table 1. In contrast, the second null hypothesis was accepted, since both materials exhibited only minimal and statistically insignificant changes in surface roughness throughout the 3-month immersion period ($P > .05$), as presented in Table 2. These findings indicate that color stability is strongly influenced by the type of beverage and the ceramic composition, whereas short-term surface integrity remains largely preserved.

A total of 50 laminate porcelain specimens were evaluated for time-dependent color changes (ΔE) after immersion in different solutions. IPS Empress Esthetic CAD specimens exhibited a gradual increase in color change across all solution groups over time. In the first week measurements (ΔE1), the values ranged from 1.15 to 1.51, with the highest change observed in the distilled water and tea groups. At 1 month (ΔE2), the values increased to 1.32-1.63, and the wine group showed higher ΔE values than the other groups. However, the increase between the first week and the first month was not statistically significant ($P > .05$) (see Table 1).

By the third month (ΔE3), the IPS Empress Esthetic CAD specimens reached their highest color change values (1.37-2.31).

Table 1. Color Change (ΔE) of Porcelain Materials Over Time (Mean ± SD)

Material	Solution	ΔE1 (0-1 Week)	ΔE2 (0-1 Month)	ΔE3 (0-3 Month)	+*P*
IPS Empress Esthetic CAD	Coffee	1.15 ± 0.14^a	1.32 ± 0.25^a	1.83 ± 0.41^b	.00
	Cola	1.26 ± 0.30^a	1.32 ± 0.23^a	1.79 ± 0.24^b	.00
	Wine	1.34 ± 0.27^a	1.58 ± 0.43^a	2.31 ± 0.46^b	.00
	Tea	1.44 ± 0.40^a	1.63 ± 0.59^a	1.66 ± 0.34^a	.51
	Distilled water	1.51 ± 0.28^a	1.51 ± 0.26^a	1.37 ± 0.49^a	.61
VITA Cerec	Coffee	0.58 ± 0.18^a	1.07 ± 0.25^b	1.16 ± 0.29^b	.00
	Cola	0.57 ± 0.11^a	0.85 ± 0.21^b	1.15 ± 0.24^c	.00
	Wine	0.27 ± 0.14^a	0.50 ± 0.17^b	1.34 ± 0.17^c	.00
	Tea	0.54 ± 0.16^a	0.64 ± 0.20^a	1.18 ± 0.16^b	.00
	Distilled water	0.54 ± 0.19^a	0.61 ± 0.10^a	0.89 ± 0.28^b	.00

The different lowercase letters on the same row indicate stage groups with significant differences ($P < .05$).
ΔE: color change

Table 2. Surface Roughness (μm) of Porcelain Materials Over Time (Mean ± SD)

Material	Solution	First Day	1 Week	1 Month	3 Month	+*P*
IPS Empress Esthetic CAD	Coffee	0.84 ± 0.41[a]	0.95 ± 0.37[a]	0.98 ± 0.27[a]	1.04 ± 0.38[a]	.66
	Cola	1.06 ± 0.28[a]	0.91 ± 0.22[a]	1.11 ± 0.32[a]	1.11 ± 0.35[a]	.40
	Wine	0.95 ± 0.28[a]	0.96 ± 0.28[a]	0.97 ± 0.20[a]	0.97 ± 0.17[a]	.99
	Tea	0.86 ± 0.26[a]	0.92 ± 0.28[a]	0.91 ± 0.34[a]	0.92 ± 0.23[a]	.95
	Distilled water	0.80 ± 0.34[a]	0.80 ± 0.33[a]	0.71 ± 0.33[a]	0.71 ± 0.25[a]	.86
VITA Cerec	Coffee	0.58 ± 0.14[a]	0.58 ± 0.08[a]	0.57 ± 0.09[a]	0.59 ± 0.08[a]	.10
	Cola	0.61 ± 0.07[a]	0.58 ± 0.07[a]	0.55 ± 0.03[a]	0.62 ± 0.07[a]	.22
	Wine	0.66 ± 0.12[a]	0.65 ± 0.11[a]	0.66 ± 0.11[a]	0.68 ± 0.12[a]	.26
	Tea	0.60 ± 0.07[a]	0.60 ± 0.06[a]	0.60 ± 0.08[a]	0.62 ± 0.10[a]	.20
	Distilled water	0.58 ± 0.11[a]	0.56 ± 0.04[a]	0.54 ± 0.14[a]	0.59 ± 0.08[a]	.64

The different lowercase letters on the same row indicate stage groups with significant differences ($P < .05$).

The red wine group demonstrated a statistically significant and markedly higher color change ($P < .05$). The increases in ΔE3 values were also statistically significant for the coffee and cola groups, whereas the changes in the tea and distilled water groups were not statistically significant.

VITA CEREC specimens exhibited overall lower color changes compared with IPS Empress Esthetic CAD. In the first week (ΔE1), the values ranged from 0.27 to 0.58, with the lowest change recorded in the red wine group. At 1 month (ΔE2), the values increased to 0.50-1.07, with the highest change observed in the coffee group. During this period, the increases in the coffee and cola groups were statistically significant ($P < .05$). By the third month (ΔE3), the values reached 0.89-1.34, with the red wine group showing the highest ΔE value ($P < .05$). When ΔE2 and ΔE3 were compared, all groups except coffee exhibited statistically significant increases over time (see Table 1).

When evaluated comparatively, IPS Empress Esthetic CAD specimens demonstrated significantly higher ΔE values than VITA CEREC specimens at all time points ($P < .05$). Both materials followed a similar pattern of color change: wine > coffee ≈ cola > tea > distilled water. All ΔE values remained below the clinically acceptable threshold of 3.3 (30) (see Table 1).

There was no significant difference in baseline surface roughness values between the feldspathic and leucite-reinforced ceramic groups ($P > .05$). At the first week, first month, and third month measurements, all groups exhibited slight increases in Ra values; however, these changes were not statistically significant ($P > .05$). The increase in surface roughness was more pronounced in the red wine and coffee groups, whereas the changes in the tea and cola groups were more limited. The distilled water group showed almost no change in surface roughness throughout the study period (see Table 2).

DISCUSSION

The findings led to the rejection of the first null hypothesis, as IPS Empress Esthetic CAD specimens exhibited statistically significant color changes, particularly in the red wine, coffee, and cola groups at the third month measurements ($P < .05$). VITA Cerec specimens showed significant color differences in the cola and red wine groups across all time points, in the coffee group between ΔE1 and ΔE2, and in the tea and distilled water groups between ΔE2 and ΔE3 ($P < .05$). In contrast, the second null hypothesis was accepted, as the surface roughness of both materials demonstrated only minimal and not statistically significant changes throughout the 3-month immersion period ($P > .05$). These findings indicate that color stability is influenced by both beverage type and ceramic composition, whereas short-term surface integrity remains largely preserved.

O'Brien[16] classified ΔE values as follows: ΔE=0 indicates clinically perfect color match; 0.5-1 represents an excellent and almost imperceptible match; 1-2 indicates a good but partially acceptable match; 2-3.5 is considered clinically acceptable; and values greater than 3.5 represent clinically unacceptable color perception. According to various studies, the threshold for visually perceptible color differences has been considered to be 3.3.[17,18] To evaluate the color changes on the ceramic surfaces as accurately and comprehensively as possible, the CIE Lab color system was used in this study, and the clinical acceptability threshold for ΔE was set at 3.3. The results revealed that IPS Empress Esthetic CAD specimens exhibited higher ΔE values at all time points compared with VITA Cerec. However, all ΔE values remained below 3.3, indicating that the color changes did not exceed the clinically acceptable threshold.

The higher ΔE values observed in IPS Empress Esthetic CAD can be explained by the microstructural characteristics of the material. Leucite-reinforced ceramics have a higher crystalline content compared with feldspathic ceramics. This crystalline phase can increase light scattering and facilitate the adsorption of pigments onto the surface.[19] In contrast, feldspathic ceramics contain a higher proportion of glassy matrix, which provides a more homogeneous and dense surface structure, resulting in more limited pigment penetration.[20] The findings of the present study are consistent with the literature reporting that feldspathic ceramics exhibit higher color stability. Souleiman et al[20] conducted a 2-year in vivo study comparing feldspathic and LDS laminates and found that feldspathic groups were more stable, whereas crystalline-reinforced groups were more prone to color change.

Aneja et al[21] compared the color stability of LDS, zirconia-reinforced lithium silicate, and feldspathic porcelain, reporting that LDS exhibited the lowest color change (ΔE=2.1 ± 0.5), whereas feldspathic porcelain showed the highest (ΔE=4.5 ± 0.8). Furthermore, red wine was identified as the most potent staining agent for all materials. These findings indicate that ceramics with a dense glassy phase and low porosity are more resistant to pigment penetration, whereas crystal-reinforced ceramics with relatively porous structures are more susceptible to discoloration. In the present study, feldspathic ceramic (VITA CEREC) demonstrated significantly lower ΔE values compared to the leucite-reinforced IPS Empress Esthetic CAD. The ranking of color change was red wine > coffee ≈ cola > tea > distilled water, confirming the decisive influence of pigment concentration and acidic pH on ceramic surfaces.

A recent study by Patil et al[22] compared the color stability and surface roughness of LDS, zirconia, and feldspathic porcelain. The findings revealed that zirconia exhibited the lowest color change (ΔE=2.8-4.1), feldspathic porcelain the highest (ΔE=5.3-7.5), and LDS demonstrated intermediate values (ΔE=3.6-5.2). The recorded sequence of color change was red wine > coffee > cola > distilled water, with red wine identified as the most aggressive staining agent due to its high tannin and polyphenol content combined with an acidic pH, which facilitates pigment penetration. The study also reported that the increase in surface roughness was particularly pronounced in feldspathic porcelain (ΔRa=+0.05 μm), while zirconia showed minimal changes. These findings support the notion that dense ceramics with low porosity are more resistant to pigment infiltration, whereas more porous, crystal-reinforced materials are more prone to discoloration. Consistent with these observations, in the present study, feldspathic ceramic (VITA CEREC) exhibited better color stability compared to the leucite-reinforced IPS Empress Esthetic CAD, with the highest color change observed in red wine.

Elter et al[23] evaluated the color stability of different laminate veneer materials following coffee immersion and thermal aging. In their study, IPS e.max CAD, Lava Ultimate, CEREC Blocs, and IPS InLine were luted with either light-cured or dual-cured resin cements. The findings demonstrated that all materials exhibited significant color changes after coffee immersion. Clinically perceptible thresholds (ΔE > 3.3) were particularly observed in Lava Ultimate (resin nanoceramic) and in certain IPS e.max and CEREC combinations. Only the IPS InLine+Variolink Veneer group maintained a ΔE < 3.3, remaining within clinically acceptable limits. Furthermore, observer assessments indicated that Lava Ultimate exhibited the highest marginal discoloration, whereas IPS InLine showed no discoloration. These results suggest that coffee exposure can induce visually detectable color changes in laminate porcelains and hybrid ceramics, potentially compromising long-term esthetic outcomes. In this study, however, feldspathic and leucite-reinforced laminate porcelains in the coffee group demonstrated only moderate ΔE values, all of which remained within clinically acceptable thresholds.

The color change observed in the cola group was found to be comparable to that of coffee but higher than that of tea. This outcome is attributed to the low pigment content of cola; however, the presence of citric acid lowers the pH, causing slight dissolution of the glaze layer.[15,24] The literature also reports that, although cola alone does not induce strong discoloration due to its low pigment content, its acidic nature sensitizes the surface and facilitates staining.[25] Güler et al[26] further explained that the greater staining effect of coffee and tea compared with cola primarily results from the presence of yellow chromogenic compounds in these beverages. The higher discoloration potential of coffee compared with tea is attributed to the lower polarity of its pigment particles, which allows for stronger adsorption and absorption on the material surface.[15] Similarly, Bagheri et al[27] reported that dental materials exhibit greater staining when exposed to coffee, tea, and red wine than to soy sauce or cola.

In the study by Başak et al[28] investigating the color stability of CAD/CAM provisional materials, the observed color changes were reported to be associated with the pigment concentration and pH of the solutions. However, while Başak et al. recorded the highest ΔE values in the coffee group, the study demonstrated that red wine induced more pronounced color changes. This discrepancy may be attributed to the higher susceptibility of polymer-based provisional materials to pigment adsorption due to their water absorption and organic matrix structure, whereas feldspathic and leucite-reinforced ceramics exhibit more superficial and limited pigment penetration.

In the tea groups, color changes were lower compared with the other beverage groups. Although tea has a high polyphenol content, its near-neutral pH does not cause dissolution of the glaze layer. Furthermore, the polar nature of tea pigments does not facilitate adsorption onto ceramic surfaces as readily as coffee pigments do.[15] Consequently, only limited ΔE changes were observed in the tea groups in the study. Nonetheless, in the VITA CEREC specimens, tea (ΔE=1.18) and coffee (ΔE=1.16) produced the highest color changes after red wine, followed by cola (ΔE=1.15), while the lowest color change was recorded in distilled water (ΔE=0.89). The minimal differences in ΔE values among these 3 beverages suggest that they exert a similar level of effect on the material.

The minimal ΔE changes observed in the distilled water group can be explained by the phenomenon of water absorption reported in the literature. Notably, in IPS Empress Esthetic CAD specimens, a slight decrease in ΔE values was recorded by the end of the third month. This may be associated with the material reaching saturation with water or the partial dissolution of pigments accumulated on the surface. Seghi et al[29] reported that water absorption in specimens stored in distilled water can lead to small but measurable color changes. Similarly, Aysan et al[30] also observed ΔE variations attributable to water absorption in samples immersed in distilled water. In this study, the higher susceptibility of IPS Empress Esthetic CAD specimens to water absorption supports these findings.

From a clinical perspective, both feldspathic and leucite-reinforced laminate porcelains demonstrated esthetic safety against commonly consumed beverages over the 3-month period. Although IPS Empress Esthetic CAD specimens were more prone to color changes due to their structural characteristics, all ΔE values remained below the clinically acceptable threshold. Nevertheless, the regular consumption of pigment-rich beverages such as red wine and coffee may increase the risk of long-term esthetic alterations.[20] Therefore, in laminate veneer restorations, patients should be informed about the potential impact of their dietary habits, and regular oral hygiene should be encouraged. Consistent tooth brushing, preference for low-pigment beverages, and maintenance of the glaze layer are key clinical strategies to support the long-term color stability of laminate porcelains.

Tad et al[31] investigated the changes in surface roughness of various CAD/CAM ceramics following exposure to acidic solutions. Lithium disilicate, resin nanohybrid ceramic, resin nanoceramic (RNC-L), and polymer-infiltrated ceramic specimens were immersed in citric acid, Coca-Cola, and artificial saliva for 168 hours, and their surface roughness was evaluated. The findings revealed that acidic beverages significantly increased the surface roughness of hybrid ceramics with higher polymer content, whereas LDS, with its high glass phase and low porosity, remained more stable. In this study, although no distinction was made between glazed and polished surfaces, the limited increase in Ra observed in laminate porcelains exposed to acidic beverages is consistent with the findings of Tad et al.[31]

A recent systematic review and meta-analysis by Silva et al[32] comprehensively evaluated the effects of gastric acid exposure on the surface, optical, and mechanical properties of CAD/CAM ceramics. The findings indicated that feldspathic and leucite ceramics exhibited significant increases in surface roughness under acidic conditions, whereas zirconia and LDS remained more stable due to their high glass content and low porosity. Although the meta-analysis did not reveal a statistically significant difference in roughness among ceramic types, feldspathic and leucite ceramics were found to be more clinically susceptible to surface alterations. This phenomenon can be explained by the dissolution of ions within the glass matrix in acidic environments, which facilitates the formation of microporosities. The limited Ra increase observed in the present study aligns with this literature and further underscores the critical role of material selection and acid exposure in the long-term esthetic success of laminate veneer restorations.

The study has several limitations. First, no thermal cycling or mechanical loading was performed; therefore, the results may not fully reflect clinical conditions. In addition, only a single glazing and surface finishing protocol was evaluated. Future studies incorporating various surface finishing methods, combined thermomechanical loading, and long-term aging tests would provide a more comprehensive understanding of the surface roughness behavior of laminate porcelains.

CONCLUSION

In conclusion, three-month evaluation of CAD/CAM laminate porcelains revealed the following:

- Both feldspathic and leucite-reinforced laminate porcelains maintained clinically acceptable color stability and surface integrity after 3 months of immersion in commonly consumed beverages.
- Red wine induced the greatest color change, whereas surface roughness alterations were minimal and not statistically significant.
- IPS Empress Esthetic CAD exhibited slightly higher color change than VITA CEREC, yet all values remained below the clinical threshold (ΔE < 3.3).
- CAD/CAM laminate porcelains can be considered esthetically reliable in the short term; however, clinicians should be mindful of potential discoloration in patients with frequent consumption of pigment-rich beverages.

Data Availability Statement: The data that support the findings of this study are available on request from the corresponding author.

Ethics Committee Approval: Ethics committee approval was not required as this study was conducted exclusively on in-vitro material and did not involve human participants, human data/tissues or animal experiments.

Informed Consent: Informed consent was not required as this study did not involve human participants or identifiable human data/samples.

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