Dentistry 3000

Vol 14, No 2 (2026)
ISSN 2167-8677 (online)
DOI 10.5195/d3000/2026.1549

Effect of Modifying Dentin on the Physical Properties of Dental Ceramic

Roaa Dheyaa Mahdi, Israa Mohammed Hummudi, Ihab Nafea Yaseen
College of Health and Medical Techniques, Middle Technical University, Baghdad, Iraq

Abstract

The purpose of the study is to examine the behavior of a new additive material for dental ceramics, T-Glass. A total of 33 zirconia discs of dentin ceramic made of zirconia were placed on a 0.5 mm zirconia core that had a diameter of 12 mm and a total thickness of 1.5 mm. The dentin powder was mixed with an enamel-effect powder (T-Glass). The specimens were split into three equal groups: group A (control group) and two experimental groups prepared by adding T-Glass powder to dentin powder in ratios of 2:1 and 4:1 (groups B & C). SEM/EDX analysis assessed the microstructure and elemental composition of all groups. The translucency parameter (TP) was measured to evaluate optical performance. Group B exhibited the highest mean translucency (TP), whereas group C had the lowest. Statistically significant differences were observed between the groups ($P < 0.05$). Dental ceramic translucency was primarily controlled by the homogeneity of the glass network and microstructural organization rather than by their elemental composition alone. As a result, optimized glass modification enhanced optical performance.

Open Access

Citation: Mahdi RD et al. (2026) Effect of Modifying Dentin on the Physical Properties of Dental Ceramic. Dentistry 3000. 1:a001 doi:10.5195/d3000.2026.1549
Received: August 11, 2026
Accepted: August 21, 2026
Published: September 11, 2026

Email: ecc5002@mtu.edu.iq

Introduction

Optical performance of dental ceramics is an important factor in determining the clinical success of dental materials. Most research on dental ceramics has focused on specific materials or the effects of particular processing factors. The overall effect of compositional alterations on optical properties in ceramic systems has received insufficient attention. Thus, there is no research on the application of T-Glass as a dental additive.

Because of their aesthetic appeal, metal-free composition, and the increasing need for a beautiful, natural appearance in dental materials, the popularity of all-ceramic materials has increased [1,2].

The modern era is often referred to as the age of ceramics, owing to the increasing variety of ceramic materials available for industrial and biomedical applications. Ceramics have been used as bio-ceramics in the medical and dental professions. Over time, zirconia technology has enhanced the production of metal-free dental materials, leading to high dynamic compatibility, an aesthetically pleasing appearance of teeth, and exceptional toughness. Due to their excellent biocompatibility and satisfactory cosmetic properties, all-ceramic restorations have emerged as viable alternatives to metal restorations [3,4]. A standard biomechanical material of dental restorations is dental ceramics. Among the most popular dental materials are inlays, onlays, crowns, and overlays to repair a portion or the whole tooth [5]. The use of glass material is usually due to its transparency, strength, chemical resistance, and other desirable features [6]. The proportion and continuity of the glassy matrix, when compared, are conclusive in determining optical behavior [7]. At the incisal edge, natural enamel is high in translucency, opalescence, and fine light diffusion, which makes the anterior teeth look deep and lively. These optical features allow light to pass through and diffuse within the enamel layer, creating the soft light and incisal halo found in natural dentition. One of the materials being developed to mimic these characteristics is translucent incisal porcelain powder, also known in the prosthodontic literature as incisal powder or enamel powder. This material is used as a top coating of ceramic substructures and fired to complete the restoration. It is specially designed to recreate the translucency and adjustable light dispersion of natural enamel, thereby increasing the aesthetic result and creating a more visually compatible restoration with the adjacent teeth [8].

Vol 14, No 2 (2026) DOI 10.5195/d3000/2026.1549

Moreover, enamel effects (modifiers) play a crucial role in modifying the optical properties of the enamel layer. Within the VINTAGE ZR ceramic system, enamel-effect porcelains are categorized as translucent-effect porcelains, specifically designed to modify the optical appearance of zirconia-based restorations. These porcelains are distinguished by their translucency without opalescence, enabling precise control over color tone and light transmission in the enamel layer, especially in the incisal and superficial regions of the restoration [9]. The extent to which light can pass through a substance is known as its translucency. The property significantly increases the natural appearance and vitality of dental restorations. Therefore, to achieve perfect esthetics, not only should the color of natural teeth be replicated, but the translucency should also be recreated properly [10]. Translucency is also affected by the chemical composition, which influences the structure of the glass network. Un-optimal distribution or additional modification, on the other hand, can lead to localized heterogeneity and greater scattering [11,12].

Hussien et al., 2022 had ceramics (lithium disilicate) tested in terms of their translucency parameter (TP) regarding their thickness and processing level. The results indicated that Rosetta SM was the most translucent, followed by IPS E. max, and Upcera was the least translucent, with translucency decreasing as thickness decreased. This research has closed the knowledge gap regarding the combined effects of material type, thickness, and thermal processing on translucency. However, it did not explore how translucency relates to other optical characteristics (opalescence and color stability) [10].

Omara et al., 2024 examined the effect of simulated gastric acid on the translucency of various restorative materials. The findings indicated significant changes following the immersion, with zirconia and lithium disilicate exhibiting more stability than PEEK. The gap addressed in this study was the effect of acidic environments on the stability of translucency. But it did not consider the contribution of material thickness, nor did it examine other optical properties such as opalescence, and it was not clinically validated [13].

This research paper has filled the gap by comparing advanced ceramic materials subjected to combined aging and staining conditions. Although earlier work has examined the optical properties of various restorative materials, most studies have focused on zirconia or general material comparisons rather than in depth studies of ceramic materials alone. Moreover, little attention has been paid to intra-ceramic factors, such as compositional changes, and their relationship to translucency. The translucency and hue of materials are critical in achieving a realistic impression. They aid in reducing the similarity of natural tooth structure in restorations and impact material choices, particularly in esthetic regions. [14] This study aims to examine the behavior of a new additive material for dental ceramics and assess the effect of T-Glass powder on their optical properties.

Material and Methods

33 specimens were constructed according to DIN EN ISO 6872/2015 [15-19], with a disc shape of 12 mm in diameter and 1.5 mm in thickness, 0.5 mm zirconia thickness, and 1 mm dentin thickness from Shofu INC (Japan). The research sample was constructed in accordance with the manufacturer's recommendations.

Mold Preparation

Firstly, to make the mold, an STL model was created in SOLIDWORKS 2019 (France) with the final specimen parameters of 12 mm diameter and 1.5 mm thickness. The sculpting then took place using the live-boolean feature of Z-Brush (USA), which allows the removal of any correct form while keeping the original topology intact and without distorting the geometric measurements. The file was exported in STL format, which is highly compatible with most 3D printer models after the design process. The entire mold is 7.5 mm (1.5 mm for the specimen and 6 mm for the base). Having designed it, print it on a 3D printer (Creality K1C, China) using a soft plastic material (Reality CRTPU filament, China).

Zirconia Substructure Preparation

The digital specimens are arranged in the block, with connector locations determined. A zirconia dental ceramic block (Bloomden ST, China), 98 mm in diameter × 14 mm in height, was used to fabricate all study specimens, 12 mm in diameter and 0.5 mm in thickness. Subsequently, before beginning, milling options should be selected, including using a cylindrical ball in three milling options (3rd milling anatomical details, special machining 90° mill all facial surfaces, and special machining 90° mill painted facial surfaces).

Then, milling was performed using a 5-axis milling machine (Redon, Türkiye). After finishing the milling process, the block was removed from the milling machine, and the zirconia disc specimens were cut from the connectors using a diamond disc, grinding wheel, and diamond bur (Germany). Zirconia was then fired (sintered) in a zirconia ceramic furnace (Dentsply Sirona, Germany) at 1530°C for 11 h, following the manufacturer's recommended instructions.

Measurement Weight/Powders Ratio

The ratios of ceramic T-Glass powder (Japan) were measured using a sensitive balance (RADWAG®, AS 220/C/1, Boland). Place the recommended amount of powder after cleaning the device, then set the zero position. First, the amount from one scoop is weighed, then the total amount for all samples is measured. Then each powder ratio was placed alone inside a container. The total ratios for Shofu Dentin powder are 2.97; 2:1 (2 Dentin powder: 1 T-Glass powder) is 1.98+0.99; and 4:1 (4 Dentin powder: 1 T-Glass powder) is 3.96+0.99.

Build-up Procedure

Bonding between the zirconia substructure and the veneering ceramic was enhanced using a wash-bake method. Shofu INC dentin powder, with or without the T-Glass modifier, was combined with the required modeling liquid to obtain a fine slurry.

Then, the mixture was poured onto the zirconia substrate as a homogeneous wash layer and fired in a VITA VACUMAT 40T furnace (Germany) according to the manufacturer’s firing parameters. Thereafter, the Shofu INC dentin powder, with or without the T-Glass modifier, was mixed with the corresponding modeling liquid at room temperature to obtain a creamy consistency.

To achieve homogeneous mixing in the experimental group, T-Glass powder was first mixed with the ceramic powder and shaken for approximately 1 minute [5]. A medical syringe (UAE) was then used to add the modeling liquid in a controlled, consistent volume, after which it was mixed manually with a plastic spatula (China) for about 3 minutes [5].

A ready-mixed mixture was poured into the mold substructure and left to settle evenly. The superfluous liquid was cleaned by tapping the mold with a stainless-steel rod to produce a light vibration, then wiping it off with absorbent tissue. The surface was set with a plastic ruler to keep all the specimens at the same level. Subsequently, using the mold, the specimens were removed, and the following furnace firing process (VITA VACUMAT 40T) was carried out according to the manufacturer's instructions.

Then, an inspection was conducted to identify any defects that might have occurred during the initial bake of the specimens, following the firing cycle and subsequent cooling. The second dentin firing was then performed as per the manufacturer's recommendation.

The specimens were then polished using a rubber polishing system (Germany) in accordance with the manufacturer's protocol, which involves using the blue disc, then the pink disc, and finally the light-gray disc, each at the corresponding rotational speed. The specimens

Vol 14, No 2 (2026) DOI 10.5195/d3000/2026.1549

were polished in a single direction at a constant speed. Lastly, the thickness of the respective specimen was measured using a digital electronic caliper (China).

Scanning Electron Microscopy/ Energy Dispersive X-Ray (SEM/EDX)
The composition and morphology of the tested materials were analyzed using SEM-EDX. One gram of each study material was used to analyze after coating with gold (Axia™ Chemi-SEM, Thermo Fisher Scientific, USA).

Translucency Test
The differences in disc color on a black-and-white background were determined by measuring each disc's translucency with a spectrophotometer. The translucency parameter (TP) was noted in the tooth's single mode, and the CIELAB color system (L, a, b) of each of the specimens was taken. Meanings were taken, and an average was calculated for each sample. The TP values were determined by the color difference observed between measurements on the black and white backgrounds of the same sample [10].
To determine the translucency parameter (TP) of the specimen, position it on a matte white background. Place the probe in the center and ensure it touches the specimen without rocking. Each specimen should be measured three times, recording values for L^*_W, a^*_W, b^*_W, C^*_W, and $h°_W$, and calculating the average of the readings. Measurements should also be taken on a matt black background to obtain L^*_B, a^*_B, b^*_B, C^*_B, and $h°_B$ [14,20].
The incident light reflects off the white background, demonstrating how the material scatters and transmits light. In contrast, a black background absorbs most of the incident light, minimizing background reflections and enhancing contrast by isolating the contributions of the specimen's transmitted or scattered light.
The translucency parameter (TP_{00}) was computed by calculating the color difference between the specimens on a black and white background, as shown in Eq. (1).

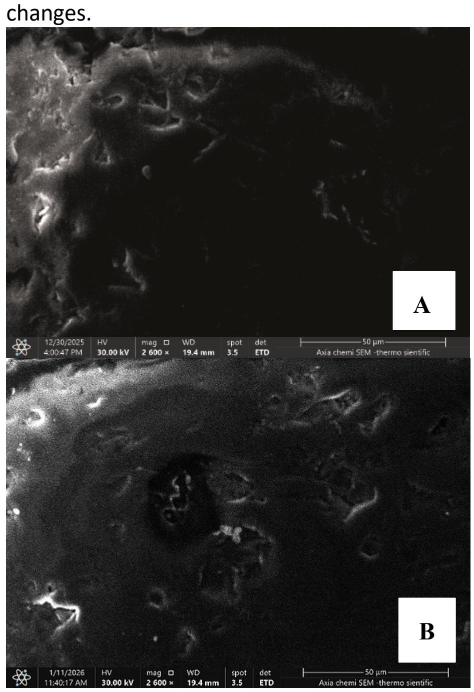
$$TP00 = \sqrt{(L * B - L * W)2 + (a * B - a * W)2 + (b * B - b * W)2} \qquad (1)$$

L^*_B, a^*_B, b^*_B = Lightness, the amount of reddish to greenish, the amount of yellowish to blueish values over a black background.
L^*_W, a^*_W, b^*_W = Lightness, the amount of reddish to greenish, the amount of yellowish to blueish values over a white background [8].

Statistical Analysis
Normality of the data was assessed using the Shapiro-Wilk test. Assuming a normal distribution, a one-way ANOVA was used to compare group means. The post-hoc analysis using the LSD was then used to compare the means of specific concentration groups pairwise.

Results

SEM/EDX
To determine the surface morphology of all the groups studied, scanning electron microscopy (SEM) was used at a magnification of 2600x, which showed distinguishable differences between the groups studied. The control group had a relatively smooth and homogeneous surface with few irregularities and no strong defects, which means that its structure is intact and homogeneous.
Contrastingly, the experimental groups that were treated with T-Glass powder showed some observable changes in the topography of their surfaces. The experimental 2:1 group exhibited slight surface changes, with slight increases in surface roughness and shallow pits and irregularities, which indicated that there was minimal contact or partial incorporation of the added particles. The more pronounced changes were observed in the experimental 4:1 group, where the surface was seen to be more heterogeneous and rougher, with more distinct depressions and irregular agglomerated structures. Figure 1 shows that T-Glass content leads to more pronounced shape changes.



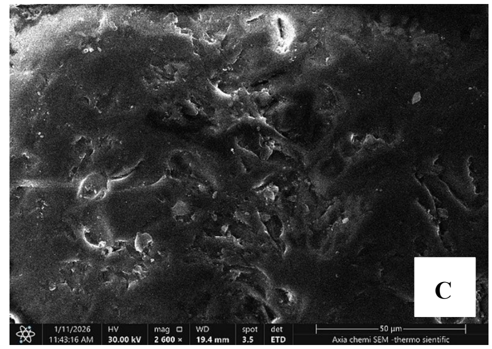


Figure 1. SEM analysis: A) Control group under 2600 x; B) Experimental group (2:1) under 2600 x; C) Experimental group (4:1) under 2600 x.

Silicon (Si), oxygen (O), carbon (C), sodium (Na), aluminum (Al), potassium (K), and calcium (Ca) were the elements found by EDX analysis in all groups. The elemental distribution was greater in the control group, and a closely comparable elemental distribution was observed in the experimental groups (2:1 and 4:1), with minimal variations in the contents of oxygen, carbon, and silicon. The groups also noted differences in the relative numbers of sodium and potassium. To ensure that all identified elements are uniformly distributed across the entire surface of the considered surfaces, elemental mapping was performed (Figure 2 and Table 1).
Translucency test
The results of the normality test indicate that the data were normally distributed, as shown in Table 2.
Table 3 presents the descriptive statistics for the translucency (TP) parameter in the control and experimental groups. The T-Glass 2:1 group (13.919 ± 0.6376) registered the highest mean TP, the control group the intermediate value (12.430 ± 0.32256), and the T-Glass 4:1 group the lowest mean TP (12.011 ± 0.6265).
The results of a one-way ANOVA indicated a statistically significant difference in translucency among the groups, indicating that the optical properties of the samples were altered by modifying dentin material.
The post-hoc analysis using the LSD test (Table 4) indicated that the TP of the T-Glass 2:1 group was significantly greater than that of the control ($p < 0.001$) and T-Glass 4:1 ($p < 0.001$) groups. However, the difference between the T-Glass 4:1 group and the control group was not statistically significant ($p = 0.098$).

Discussion

Elementary composition and microstructure, evaluated by EDX-SEM provided a basic framework for understanding the changes in translucency the control and T-Glass-modified ceramic groups. The amount of surface modification seems to depend on the concentration. These findings are consistent with the study of Dikicier, Korkmaz & Atay (2022) [21], who showed that the surface roughness and morphology of ceramic materials can be significantly altered through surface treatments.

Light scattering in silica-based glass ceramics is mainly found at the limits of the microstructures, crystalline inclusions, and areas of refractive index discontinuity. Materials with a more homogeneous glassy structure and less homogeneous distribution of crystalline constituents tend to exhibit better light transmission and greater translucency. Hence, the proportion and continuity of the glassy matrix, when compared to each other, are conclusive in determining optical behavior [7].

Translucency is also affected by the chemical composition, which influences the structure of the glass network. Oxides that modify the network, such as sodium oxide (Na_2O) and potassium oxide (K_2O), can weaken the Si-O-Si network to some extent by establishing non-bridging oxygen bonds. These modifiers, in the right proportions, favor a more continuous, smooth network of glass, minor refractive index differences between phases, and thus less internal light scattering, resulting in better translucency. Un-optimal distribution or additional modification, on the other hand, can lead to localized heterogeneity and greater scattering [11,12].

Our current results are consistent with those of Al-Johani et al. (2024) [7], who observed that the crystal–glass ratio and light scattering within the microstructure of dental ceramics are major factors in determining the translucency of ceramics. A higher crystal ratio led to increased light scattering and reduced light transmissivity, supporting the idea that microstructural heterogeneities play an important role in optical properties.

The control group exhibited the optical characteristics of conventional dentin ceramics, including a silica-based glassy matrix and the formation of crystalline phases, resulting in moderate translucency. The T-Glass-modified ceramics indicated that the percentage content of silica atoms does not determine the occurrence of translation, but rather the effectiveness of glass network modification and the homogeneity of the microstructure. The most translucent T-Glass formulation is 2:1, which indicates more continuous glass networks and fewer microstructural discontinuities, as shown by oxygen enrichment in EDX and balanced network-modifying oxides. The 4:1 formulation exhibited reduced translucency, attributed to ineffective glass use and compositional inhomogeneity in one region, which increased the number of light-scattering centers [7,12].

The presence of trace titanium in the 4:1 group is unlikely to directly affect translucency due to its extremely low concentration. However, it may indicate a locally heterogeneous composition, which in turn indirectly influences light dispersion. Microstructural defects are the primary cause of these minor elemental differences, rather than natural optical absorption effects [11,12].

From a clinical standpoint, the control of translucency is decisive for the esthetic outcome of ceramic restorations in the anterior region, where the restorative material must reproduce the light behaviour of natural enamel and blend with the adjacent dentition; this requirement applies equally to monolithic ceramic crowns, feldspathic ceramic restorations and porcelain veneers [22-24].

Conclusion

In the control group, moderate translucency was expected and observed, with conventional dentin ceramics having crystalline phases to enhance light scattering. The fact that T-Glass incorporation has proven to be an optimal modification strategy is crucial; the 2:1 T-Glass formulation had the highest translucency, whereas the 4:1 formulation showed low translucency.

Such findings indicate the need for a balanced modification of the glass network to achieve maximum translucency in dental ceramic restorations.

Ethical Considerations

This in vitro study used no humans or animals, so there was no need for ethical approval.

Conflict of Interest

The authors declare no conflict of interest.

Funding Statement

None.

References

1. Said AM, Abdelfattah G, Zohdy M, Salah T. The effect of speed sintering and hydrothermal aging on the biaxial flexural strength and microstructure of recent cubic zirconia material. Ain Shams Dental Journal. 2024;34(2):232-40. https://doi.org/10.21608/asdj.2024.285645.1265

2. Ahmed RK, El-Shokafy DM, Elgendy AI, Eltantawy SM. Marginal Fit of Pressed Versus Repressed Zirconia-Reinforced Lithium-Disilicate Occlusal Veneer. Ain Shams Dental Journal. 2024;35(3):115-22.

3. Fouad RI, Al Jorani LEA, Al-Azzawi AKJK. Evaluation of the Effect of Different Glazing Brands on Surface Roughness of Monolithic Zirconia. Journal of Techniques. 2023;5(2):155-62. https://doi.org/10.51173/jt.v5i2.940

4. Turki SA, Abdulsattar MH, Alwahab ZN. Effect of Different Polishing Systems on Surface Roughness of IPS Empress Ceramic Materials. Journal of Techniques. 2023;5(3):234-9. https://doi.org/10.51173/jt.v5i3.1074

5. Fawzy ZD, Muhsin SA, Abood TH. In Vitro Evaluation of Ceramic-Amber Hardness Supported Zirconia. Iranian Journal of Materials Science and Engineering. 2025;22(2):58-65. https://doi:10.22068/ijmse.3836

6. Chutithanapanon N, Jaiboon O, Laopaiboon R, Laopaiboon J, Bootjomchai C. Influence of Cu2O doping and gamma irradiation on the structural and elastic properties of soda-lime glass. Radiation Physics and Chemistry. 2025; 226:112244. https://doi.org/10.1016/j.radphyschem.2024.112244

7. Al-Johani H, Haider J, Satterthwaite J, Borba M, Silikas N. A Comprehensive Review of the Multifaceted Characterisation Approaches of Dental Ceramics. Prosthesis. 2024;6(5):1055-90. https://doi.org/10.3390/prosthesis6050077

8. Emmons JD. Method and compositions for producing life-like dental porcelain restorations and dental porcelain restorations so produced. Google Patents; 1994. Patent No. US5308243A

9. Shofu Inc. (n.d.). VINTAGE ZR enamel effect Set: Technical product description. Kyoto, Japan: Shofu Dental. https://www.shofu.de/downloads/Produkte/S0051-VINTAGE-ZR/VINTAGE-ZR-SBS-EN-2013-01-633

10. Hussien SHE, Morsi TS, Zohdy MM. Translucency & flexural strength of three lithium disilicate ceramic materials for CAD/CAM restorations (In Vitro Study). IOSR J Dent Med Sci (IOSR-JDMS). 2022;21 (6): 041-62. https://doi.org/10.9790/0853-2106074162

11. Anusavice KJ, Shen C, Rawls HR. Phillips' science of dental materials 12th ed. St. Louis: Elsevier Health Sciences; 2013, pp. 418–473.

12. Kelly JR, Benetti P. Ceramic materials in dentistry: historical evolution and current practice. Australian dental journal. 2011; 56:84-96. https://doi.org/10.1111/j.1834-7819.2010.01299.x

13. Omara AA, Othman HI, Aldamaty MF, Metwally MF. Effect of acidic environment on color and translucency of different indirect restorative materials. BMC Oral Health. 2024;24(1):472.

14. Yang F, Zhang L, Yang M, Chen J, Xing W. The effect of deviations in sintering temperature on the translucency and color of multi-layered zirconia. BMC Oral Health. 2024;24(1):471. https://doi.org/10.1186/s12903-024-04243-4

15. Hamed JG, Bakry SI, Hussein SA, Al Abbassy FH. Evaluation of biaxial flexural strength and

Vol 14, No 2 (2026) DOI 10.5195/d3000/2026.1549

translucency of multichromatic translucent zirconia and lithium disilicate ceramics. Alexandria Dental Journal. 2018;43(2):86-93. https://doi.org/10.21608/adjalexu.2018.57637
16. Mohammed NA, Yasse IN. Evaluation the Effect of Different Thicknesses Core on the Micro-Hardness of Zirconia Ceramic Material. Al-Nisour Journal for Medical Sciences. 2019;1(2):223-31. https://doi.org/10.70492/2664-0554.1031
17. Vallerini BdF, Silva LD, de OC Villas-Bôas M, Peitl O, Zanotto ED, Pinelli LA. Microstructure and mechanical properties of an experimental lithium disilicate dental glass-ceramic. Ceramics International. 2024;50(1):188-96. https://doi.org/10.1016/j.ceramint.2023.10.093
18. Silmeoglu Yagli O, Talay Cevlik E, Kurklu Arpacay D. The impact of aging and thickness on flexural strength of various zirconia ceramics. BMC Oral Health. 2024;24(1):967. https://doi.org/10.1186/s12903-024-04745-1
19. Souza LFB, Teixeira KF, Cadore-Rodrigues AC, de Souza Pires T, Valandro LF, Moraes RR, et al. Evaluating mechanical and surface properties of zirconia-containing composites: 3D printing, subtractive, and layering techniques. journal of the mechanical behavior of biomedical materials. 2024; 157:106608. https://doi.org/10.1016/j.jmbbm.2024.106608
20. Arslan E, Degˇ irmenci K. Translucency and Color Difference of Monolithic Zirconia Restorations: The Effect of Surface Finishing on Background Color. Journal of Advanced Oral Research. 2024;15(1):91-9. https://doi.org/10.1177/23202068241238822
21. Dikicier S, Korkmaz C, Atay A. Surface roughness and characteristics of CAD/CAM zirconia and glass ceramics after combined treatment procedures. BMC Oral Health. 2022;22(1):524. https://doi.org/10.1186/s12903-022-02389-7
22. Usubova NR. Strength of monolithic ceramic crowns supported by incisors. Endodontics Today. 2022;20(1):36–41. https://doi.org/10.36377/1683-2981-2022-20-1-36-41
23. Mordanov OS, Matveev AI. Anterior teeth restoration after endodontic treatment and vital teeth with porcelain veneers and eLab Prime system. Endodontics Today. 2023;21(1):36–41. https://doi.org/10.36377/1683-2981-2023-21-1-36-41
24. Naidyonova OA. Use of feldspathic ceramics in a digital protocol: A clinical case. Endodontics Today. 2024;22(3):254–258. https://doi.org/10.36377/ET-0031

Table 1. Element composition of the study before and after modification.

Element	Atomic% Control	Weight% Control	Atomic% (2:1)	Weight% (2:1)	Atomic% (4:1)	Weight% (4:1)
C	14.5	9.1	11.2	7.1	21	0.9
O	56	47.1	59.8	50.4	51.8	1.4
Na	4.3	5.2	5.3	6.4	4.2	0.2
Al	5.7	8	5.5	7.8	5	0.2
Si	16.5	24.3	15.8	23.4	15.1	0.2
K	2	4.2	1.7	3.4	1.9	0.1
Ca	1	2.2	0.7	1.5	0.7	0.1
Ti					0.2	0.1

Vol 14, No 2 (2026) DOI 10.5195/d3000/2026.1549

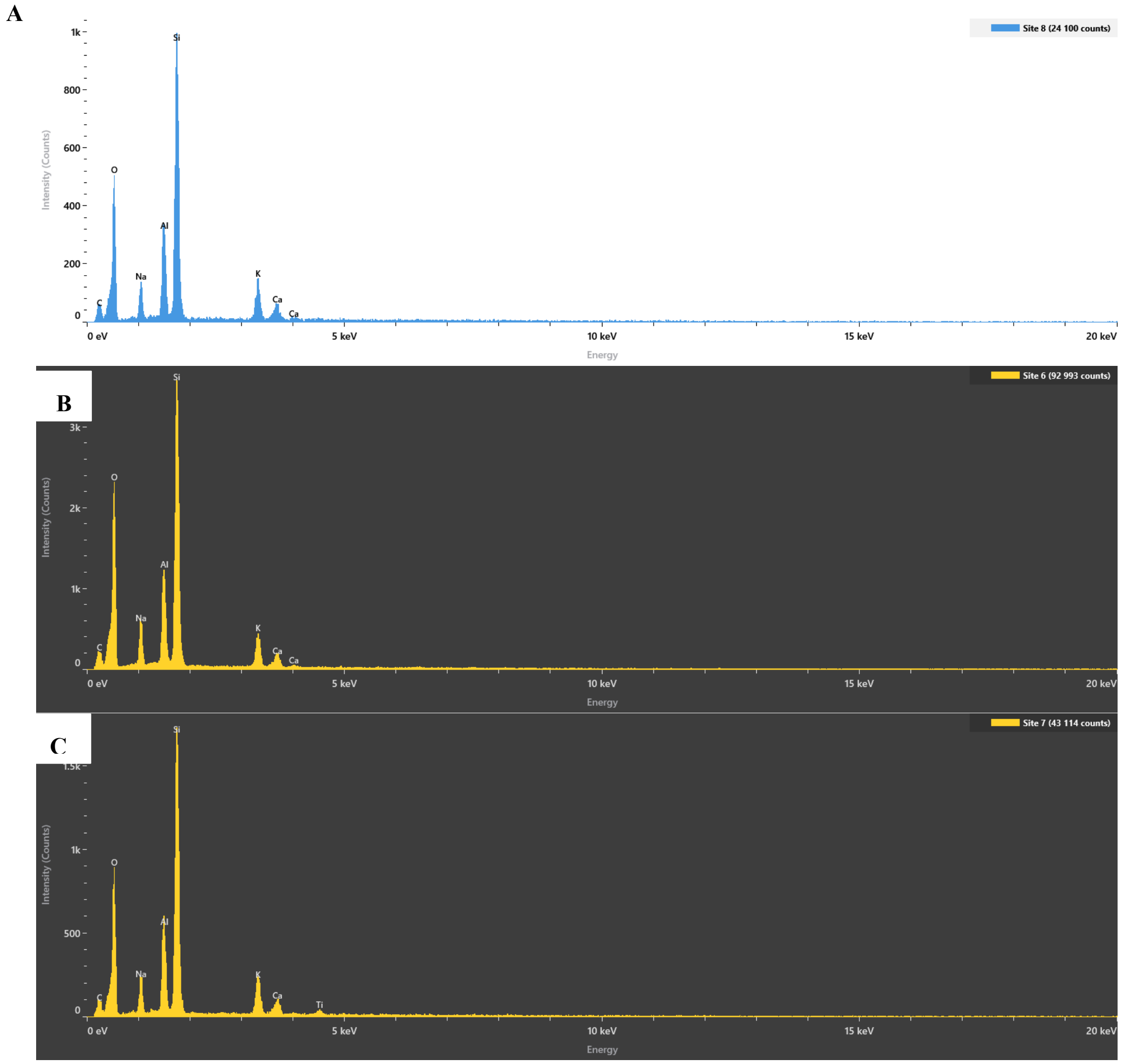


Figure 2. EDX analysis: A) Control group; B) Experimental group (2:1); C) Experimental group (4:1).

Table 2. Tests of normality.

Biaxial flexural strength		Shapiro-Wilk	
		Statistic	p-value
	Control	0.946	0.619
Groups	T-Glass 2:1	0.98	0.965
	T-Glass 4:1	0.893	0.184

Vol 14, No 2 (2026) DOI 10.5195/d3000/2026.1549

Table 3. Descriptive statistics and One–way ANOVA test of the translucency test (TP) at different modifications of the T-Glass powder.

Translucency test Mean ± Std.	Control	T-Glass 2:1	T-Glass 4:1		
	12.43±.32256	13.919±.6376	12.011±.6265		
Repeated Measures ANOVA	Sum of Squares	df	Mean Square	F	p-value
Between Groups	20.108	2	10.054	33.398	0.000
Within Groups	8.128	27	0.301		
Total	28.235	29			

(I) Groups	(J) Groups	Mean Difference (I-J)	P-Value	95% Confidence Interval	
				Lower Bound	Upper Bound
Control	T-Glass 2:1	-1.48822-*	0.000	-1.9917-	-0.9848
	T-Glass 4:1	.41996	0.098	-0.0835-	0.9234
T-Glass 2:1	T-Glass 4:1	1.90818*	0.000	1.4047	2.4116

*The mean difference is significant at the 0.05 level.