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Retention and Adaptation of two 3D-Printed Denture Base resins : A Comparative In Vitro Study

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ABSTRACT

Objective: This study aims to evaluate the retention and adaptation characteristics of two 3D-printed denture base resins—Saremco Print DentureTec and Detax Freeprint Denture—fabricated using Digital Light Processing (DLP) technology. To standardize artificial saliva distribution and controlled force application, a printed key made from Detax Freeprint Model resin was introduced.

Institutional Review Board Statement: This study was conducted in accordance with the ethical standards of Hawler Medical University. Ethical approval was obtained from the Scientific Research Ethical Committee, College of Dentistry, Hawler Medical University, Kurdistan Region, Iraq (Reference Number: HMUD,2425103; Date of Approval: 14 January 2025).

Materials and methods: A total of 40 denture base samples (20 per resin type) were fabricated under standardized DLP printing parameters. Retention was assessed using a universal testing machine (UTM) to measure dislodging force in Newtons (N). Adaptation was evaluated via the silicone replica technique, with replica thickness measured using a digital micrometer. Artificial aging was simulated through thermal cycling (2500 cycles at 5°C–55°C). The printed key was utilized in retention and adaptation testing to ensure uniform conditions across trials. Statistical analyses included paired t-test.

Results: Post-aging retention force increased significantly ($p < 0.001$) across both materials. Detax Freeprint Denture initially exhibited higher retention, but after aging, its performance aligned with Saremco Print DentureTec. Adaptation remained clinically acceptable, with minor dimensional changes after thermal cycling. The printed key improved experimental accuracy by minimizing variability in saliva distribution and force application.

Conclusion: Retention improved due to polymer relaxation, while adaptation remained stable, supporting the clinical viability of 3D-printed denture bases. The printed key introduced a standardized methodology, enhancing precision and refining future research protocols.

Keywords: *3D printing, Digital Light Processing, denture retention, denture adaptation, artificial saliva, thermal aging.*

1. INTRODUCTION

The introduction of three-dimensional (3D) printing technology has significantly advanced the field of dentistry, particularly in the fabrication of denture bases. Conventional methods such as compression molding and the lost-wax technique were commonly used for denture production but were time-consuming, technique-sensitive, and often required multiple patient visits for adjustments[1] . In contrast, digital workflows utilizing computer-aided design (CAD) and computer-aided manufacturing (CAM) have streamlined the denture fabrication process, improving accuracy, customization, and clinical efficiency).[2,3]

Among various additive manufacturing (AM) technologies, Digital Light Processing (DLP) and Stereolithography (SLA) have emerged as leading techniques for producing denture bases due to their high resolution, dimensional accuracy, and excellent surface quality[3,4] . Both technologies use a layer-by-layer photopolymerization process, in which liquid resin is selectively cured by ultraviolet (UV) or visible light, allowing for the production of detailed structures with reduced material waste [5,6]).

In parallel with advances in printing technologies, the development of novel denture base materials has further improved clinical outcomes. 3D-printed denture base resins are primarily photopolymer-based, consisting of methacrylate monomers that polymerize rapidly upon light exposure. These materials offer excellent surface detail and faster production times, though concerns remain regarding their mechanical strength, dimensional stability, and residual monomer content [7,8].

The retention and adaptation of complete dentures are crucial for their clinical success, as they directly influence patient comfort, speech, and masticatory function[9].

From a clinical standpoint, two critical parameters for assessing denture performance are retention and adaptation. Retention refers to the ability of a denture to resist dislodgement during functional activities such as speaking and chewing, which in turn affects prosthetic stability and patient comfort.[10,11] Adaptation describes how closely the denture base conforms to the underlying oral tissues, particularly in the palatal and alveolar ridge areas. Improved adaptation enhances the palatal seal, promotes even load distribution, and contributes to improved retention [9,12]. Techniques such as the silicone replica method have proven effective in quantifying denture adaptation and its impact on clinical performance[2].

To ensure standardized testing conditions, especially in in vitro environments, the application of consistent dislodging force and uniform saliva distribution is essential. In this context, a custom-printed key, designed using Detax Freeprint Model resin, was developed to control these variables during retention and adaptation evaluations.

Therefore, the objective of this study was to evaluate the retention and adaptation of two 3D-printed denture base materials—Saremco Print DentureTec and Detax Freeprint Denture—fabricated using DLP technology. A total of 40 denture base samples (20 for each material) were tested. Retention was measured using a universal testing machine (UTM), and adaptation was assessed via the silicone replica technique. To simulate intraoral aging, all specimens underwent thermal cycling (2500 cycles between 5°C and 55°C). The results from this investigation aim to contribute to evidence-based material selection and methodology in prosthodontics.

2. MATERIALS AND METHODS

The study employed a rigorous methodology to evaluate the retention and adaptation characteristics of two 3D-printed denture base materials, Saremco Print DentureTec and Detax Freeprint Denture, under simulated clinical settings.

2.1 Sample Preparation

A total of 40 denture base samples (20 per resin type) were fabricated under standardized DLP printing parameters. Retention was evaluated using a universal testing machine to measure dislodging force in Newtons[13] . Adaptation was assessed using the silicone replica technique, with replica thickness measured via a digital micrometre [9]. Artificial aging was simulated through thermal cycling (2,500 cycles at 5°C–55°C). The printed key was utilized in both retention and adaptation testing, ensuring uniform conditions across trials [14].

Methods

2.2 Fabricating a Maxillary Edentulous Model

The STL file is created from standard maxillary edentulous model then , file imported to the Aoutodesk Meshmixer V3.5.474 / USA where an overlay of soft mucosa is applied in 2mm thickness with a 0.5mm offset ,then Two STL files—"Gingiva.STL" for the mucosa and "Model.STL" for the underlying structure—were exported[15]. figure1,A,B

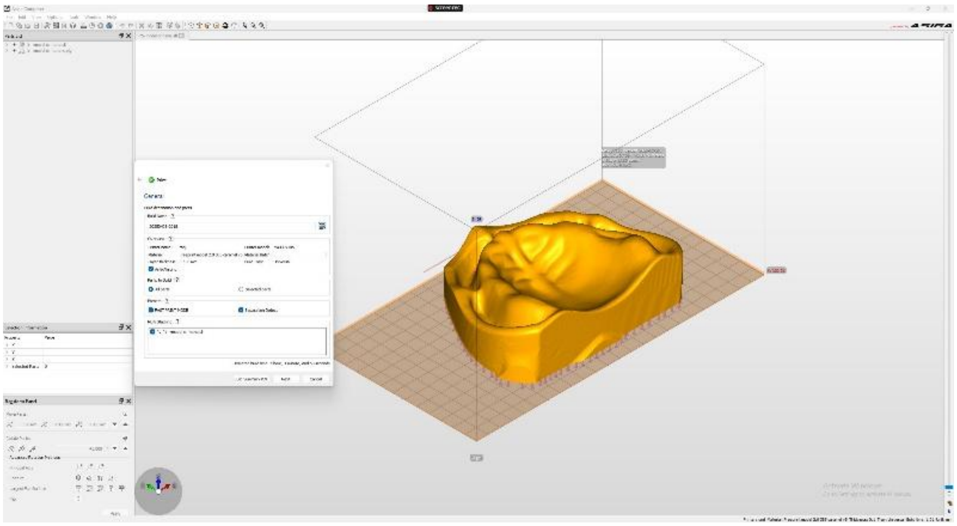


Figure 1 A. model on printing platform

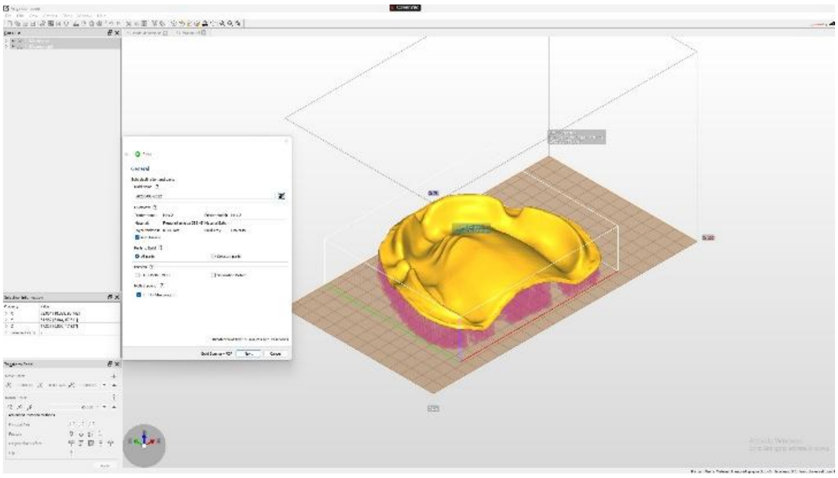
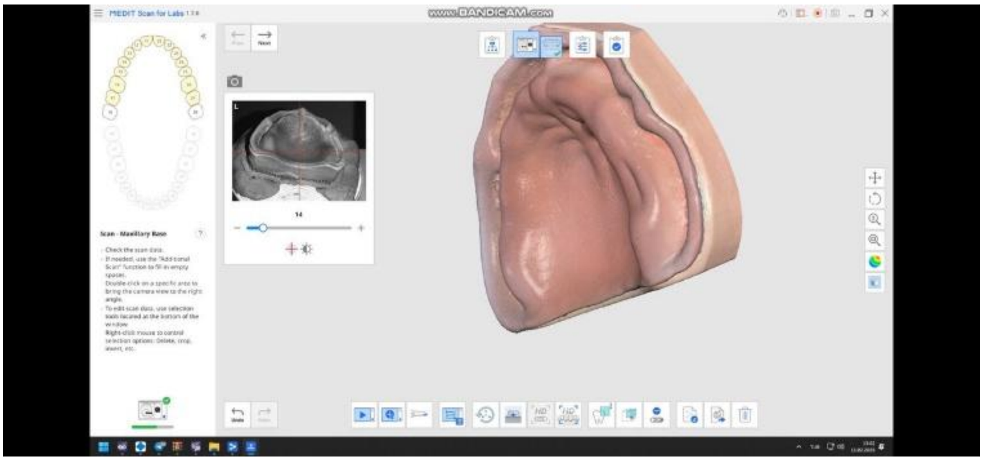


Figure 1B. Mucosa overlay soft layer on printing platform

Both components were printed using a digital light processing (DLP) printer (Asiga Max UV 385). The mucosa was fabricated from Detax Freeprint(Gingiva resin,Germany) 100 μm layer thickness) and underwent cleaning (15 minutes) and post-curing (10 minutes). The model was printed using Detax FREEPRINT MODEL resin,(Caramel 385,Germany) with the same layer thickness and post-processing steps. The mucosa and model were adhered with household glue (Elkim, Turkey)and scanned with an extraoral scanner Medit T710 for further analysis(.figure 2 explain)the Fabrication of the maxillary edentulous model, including the printed soft tissue layer, and the resulting scan.



Scan - Maxillary Base

- Check the scan data.
- If needed, use the "Additional Scan" function to fill in empty spaces.
- Double-click on a specific area to bring the camera view to the right angle.
- To edit scan data, use selection tools located at the bottom of the window.
- Right-click mouse to control selection options: Delete, crop, invert, etc.

Figure 2. Scanned STL with the Extra oral Scanner

2.3 Fabricating the Printed Baseplates

Two different 3D printing resins were selected based on biocompatibility and mechanical properties, as well as availability in the dental market. These resins included Saremco Print (Denturetec Switzerland), and Detax Freeprint Denture, Germany. For each of the selected resins, twenty baseplates were printed using a DLP printer(Asiga Max UV 385 / Australia)

Ten STL baseplates were designed using 3Shape dental software(DS2022/2.12.1.0), each labelled from STL1 to STL10 by the manufacturer's commercial name. The offset was 0.05 mm to create a space for artificial saliva, with occlusal and peripheral thicknesses set at 2mm to maintain uniformity.[12,15]Each baseplate was printed at a 45-degree angle with a 100 µm layer thickness, balancing accuracy and processing time. [4,12,16]. Printing parameters remained consistent across all designs. Supports were added using Asiga Composer software, ensuring no interference with the intaglio surface. The post-processing involved ethanol cleaning (>90% for 5 minutes), drying, and UV curing (Solidilite V / Shofu / Germany) for 10 minutes. Figure 3(A,B&C) finalised denture bases fabrication, ensuring the whole designing and printing process.

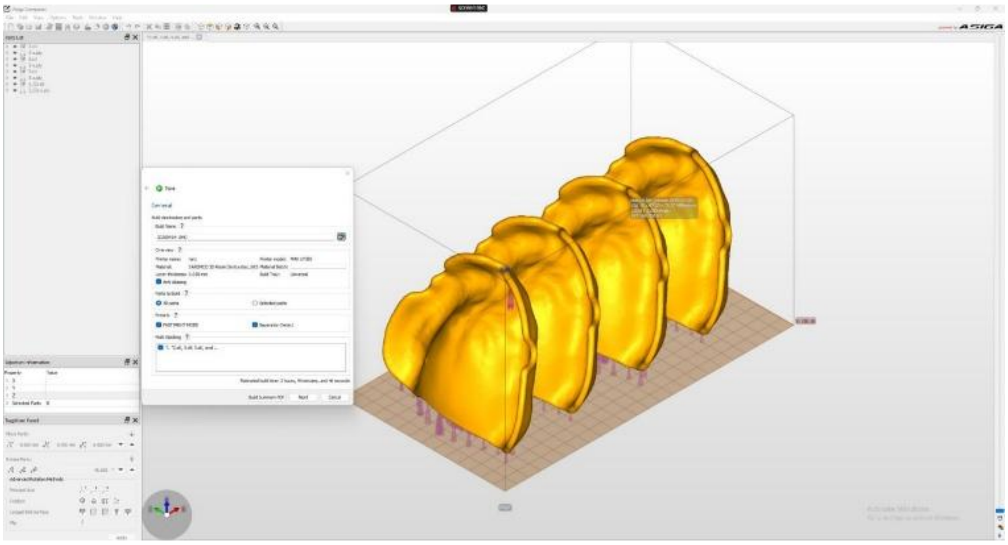


Figure 3 A. supports added on denture base before prienting

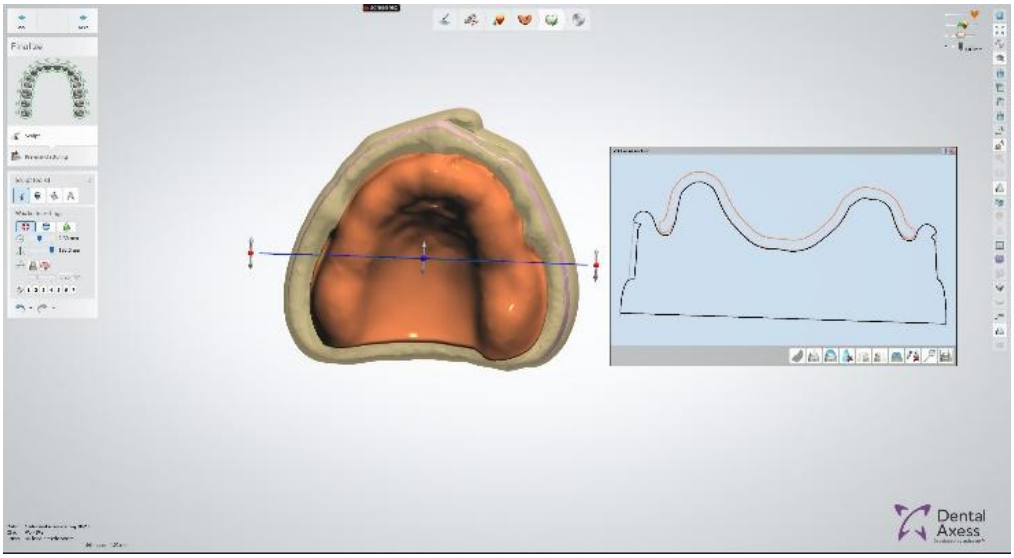


Figure 3 B. Finalise analysis pre manufacturing cross-sectional of denture base.

Figure 3C. presents a denture base on the model.

2.4 Fabricating the Printed Key

To ensure consistency and standardization during retention and adaptation tests, a printed key was duplicated with Autodesk Meshmixer V3.5.474 / USA

The same STL for the mucosa, model, and denture base depicted in(Figure 4A)was duplicated to generate a negative model of the original model, with a 0.05 mm offset from each other in order not to be retentive between the two objects, A depth was added at the midpoint to match the loop's height, ensuring a proper fit with the denture base (Figures 4 B) illustrate the intaglio surface after printing the negative model; the purpose of this key was to aid in the uniform distribution of artificial saliva across the surface. This same sample was also used to consistently separate the silicone replica layer during the adaptation test when exposed to sound. As a result, a negative model of the original structure was created.(Figure 4C) presents the final front view of both the original and negative models.

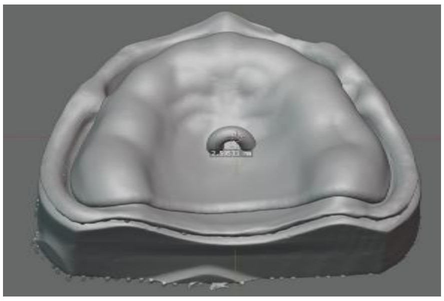


Figure 4 A .An STL of the model and denture based on Meshmixer.

Figure 4 B. printed Key intaglio surface.

Figure 4 C. printing key front view.

2.5 Artificial saliva preparation

High-viscosity methylcellulose was selected as a substitute for carboxymethylcellulose (CMC) due to its comparable rheological properties and demonstrated efficacy in mimicking the viscosity of natural saliva. Prior research has indicated that methylcellulose-based artificial saliva can achieve a viscosity profile that closely resembles that of natural human saliva, making it an effective alternative to CMC in these formulations[1,17-18]. The methodology for preparing artificial saliva involves

using a standardised laboratory protocol, modified to accommodate the solubility characteristics of high-viscosity methylcellulose. Initially, 800 mL of distilled water was heated to approximately 90–100 °C. High-viscosity methylcellulose (4000 cps; sourced from Maharashtra, India) was gradually added under continuous stirring to facilitate dispersion and prevent clumping. The solution was then allowed to cool to room temperature, during which the methylcellulose dissolved, forming a uniform, viscous gel.

After cooling, the following solid ingredients were sequentially added with manual stirring to ensure complete dissolution:

- Potassium chloride (KCl; Maharashtra, India) at a concentration of 0.12–0.20% w/v.
- Sodium chloride ($NaCl$; Maharashtra, India) at 0.12–0.20% w/v.
- Calcium chloride dihydrate ($CaCl_2 \cdot 2H_2O$; Maharashtra, India) at 0.10% w/v.
- Magnesium chloride ($MgCl_2$; Maharashtra, India) at 0.005% w/v.
- Phosphate buffer salts comprising disodium hydrogen phosphate (Na_2HPO_4) and potassium dihydrogen phosphate (KH_2PO_4) (both from Maharashtra, India) at a combined concentration of 0.03–0.20% w/v.

The mixture was transferred into a 1-litre volumetric flask. The preparation beaker was rinsed with additional distilled water, and the rinsate was added to the flask to prevent loss of material. The final volume was adjusted to exactly 1 liter with distilled water.

The resulting artificial saliva was stored in a sterile, airtight container at 4–8 °C to maintain chemical stability and prevent microbial growth. Before each use, the container was gently shaken to ensure uniform distribution of its components. Since the artificial saliva doesn't contain preservation material, the composition was prepared twice before and after ageing for retention test evaluation, in order not to lose its properties.(Figure 5)shows the final prepared artificial saliva.

Figure 5 . Artificial saliva on the beaker

2.6 Retention Evaluation

Retention is a critical factor for the success of complete dentures.[15]. The physical factors that influence denture retention include adhesion, cohesion, surface tension, salivary film thickness, and atmospheric pressure [19]. retention for denture base is defined as the resistance of a denture to movement away from the tissues in the direction opposite to insertion. Retention was assessed using a Universal Testing Machine. [19,20]

Each baseplate was prepared for testing on a Universal Testing Machine, with a loop attached near the center[21]. Key anatomical landmarks (labial frenum and pterygomaxillary fissures) were used to locate Point D, which was further connected to Point A to mark the baseplate's center. A loop (3.5mm high, 9.3mm wide) was digitally designed and placed precisely for retention measurement.

This comprehensive methodology ensures accurate denture model fabrication and consistent evaluation of retention properties.[22]

The retention test evaluation was conducted using a Universal Testing Machine (GT-AI-3000/Gotech, China) to measure the denture base's ability to resist displacement forces[23]. First, all denture base samples were conditioned in distilled water for 48 hours to ensure polymer hydration stability. [15,19].Then, 5 mL of used methylcellulose-based artificial saliva, which improved wettability and interfacial adhesion applied using.A digitally fabricated printed key, where 98 Newtons (N) of force was applied for 20 seconds to achieve uniform distribution of saliva across the maxillary model and denture base[14,18,21].(Figure6A)which is shows the denture base in adaptation by using priented key .

Each denture base was securely attached to a central loop, which was connected to the universal testing machine clamp. A tensile force was applied at a speed of 25 mm/min, gradually increasing until the denture base detached from the model.[15,21,24]. The peak retention force in Newtons (N) was recorded, and each sample underwent three consecutive trials,[13,19]. with mean values calculated for final retention assessment. This method ensured precision, consistency, and elimination of operator-dependent variability, optimizing comparative analysis between different 3D-printed denture base resins. The utilization of a printed key for saliva distribution and controlled force application represents a significant advancement, providing a standardized and accurate approach to evaluating denture base retention[9,19]. Figure

Figure 6A. Denture base adaptation for artificial saliva distribution

Figure 6B. Retention test evaluation

2.7 Adaptation Evaluation

The adaptation of 3D-printed denture bases has been examined through various methodologies in several studies. A prevalent approach involves measuring the gap or discrepancy between the intaglio surface of the 3D-printed denture base and the master model or cast that represents the patient's edentulous arch [2] To evaluate adaptation, researchers have utilized techniques such as the silicone replica technique, which employs a silicone-based impression material to create a replica of the gap between the denture base and the master model. The thickness of the silicone replica can then be measured to quantify the extent of the discrepancy ([3,25]. This silicone replica technique is widely adopted in dental prosthetics to assess the adaptation of denture bases.

The adaptation of denture bases is crucial for ensuring patient comfort and preventing excessive pressure on the underlying mucosa[9,12].The silicone replica technique, as enhanced with a printed key, was employed to quantitatively assess denture base adaptation by measuring the thickness of the silicone layer between the denture base and the maxillary edentulous model.[3]

This technique involves several steps. First, a light-body silicone impression material, (Ventura Impress 2.0, Spain), was injected between the intaglio surface of the denture base and the edentulous cast within a controlled environment. Then, a digitally printed key was used, after placing the key to apply a uniform load, the 50 N (5 kilogram) force was measured on the scale and applied for 3 minutes to simulate occlusal forces and ensure consistent seating of the denture base[3,12,26]. (Figure 6A&B) illustrates the mechanical force application and the prientied key

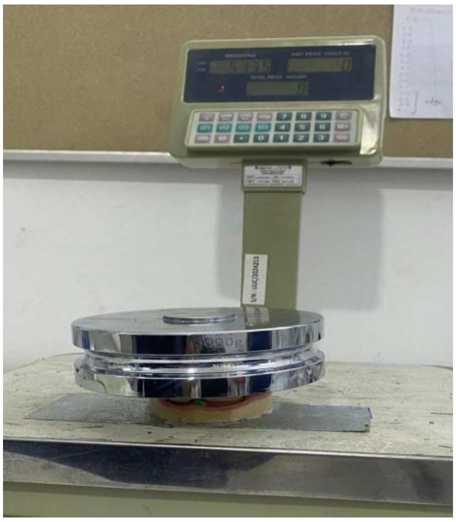


Figure 7 A. Mechanical load application

Figure 7B. front view of the printed key after load application

Then, to enable analysis, the polymerised silicone film was mapped using a black marker, delineating three distinct transverse sections. These sections were categorized as follows:

Zone 1: located one centimetre from the post-dam;

Zone 2: positioned two centimetres from the post-dam;

Zone 3: situated three centimetres from the post-dam.

For each zone, two measurement points were identified on the hard palate, along with two more points at the alveolar ridge, and then the fit checker films were cut with a surgical blade (no.15 Empire Stainless / Pakistan into transverse sections at the three designated zone[3]. The thickness of the silicone replica was measured at each reference point using a digital outside micrometre (Werka-IP65/China) with a resolution of 0.001 mm. Measurements were recorded, and statistical analysis was performed to determine the adaptation of the denture base to the edentulous cast.

The printed key plays a pivotal role in the adaptation assessment process, ensuring uniform force application during silicone replica formation and precise seating of the denture base on the edentulous cast.

2.8 Artificial Aging Protocol

To simulate the long-term effects of the oral environment on the mechanical properties of 3D-printed denture base resins, an accelerated aging protocol was implemented utilizing thermal cycling.[7]. This technique exposed the denture base samples to repeated cycles of alternating high and low temperatures, thereby mimicking the thermal fluctuations encountered in the oral cavity due to the consumption of hot and cold foods and beverages.[18,27]

The denture base samples were subjected to an accelerated ageing protocol involving thermal cycling[27]. They were placed in a thermal cycling machine and exposed to 2,500 cycles between temperatures of 5°C and 55°C, with a dwell time of 30 seconds at each temperature and a transfer time of 5 seconds between the temperature baths. This thermal cycling regimen has been demonstrated to expedite the aging process of dental materials, [28] . To accurately monitor the temperature of the baths, a thermocouple thermometer (HT-9815) was employed, with one probe positioned in the hot bath and another in the cold bath. The thermocouple probes were calibrated to ensure accurate temperature readings and maintain consistent thermal conditions throughout the cycling process.

3. STATISTICAL ANALYSIS

All statistical analyses were conducted using IBM SPSS Statistics version 29. A paired sample t-test was utilized to examine differences in retention force and adaptation before and after aging for Saremco print and Detax resins. Statistical significance was established at $p < 0.05$, with $p < 0.01$ and $p < 0.001$ denoting strong and highly significant results.

4. RESULTS

Both materials showed significant improvements in retention force after treatment. Detax demonstrated a notable increase, indicating enhanced performance following aging, while Saremco Print also exhibited marked improvement, reflecting the effectiveness of the treatment. Initially, Detax had superior retention compared to Saremco Print. However, after aging, no statistically significant difference was observed between the two, suggesting that both materials achieved comparable retention outcomes.

In terms of adaptation, both resins experienced significant reductions in adaptation values after treatment, highlighting the impact of aging on dimensional stability. Pre-treatment comparisons indicated no significant differences between the materials. Post-treatment results confirmed that both resins exhibited similar adaptation behavior, suggesting equivalent performance in maintaining conformity to the tissue surface. (Table 1) (Figures 7 and 8) illustrate the measurements taken before and after treatment.

Table 1. Comparative Analysis of Adaptation (µm) and Retention Force (N) Before and After Aging for Saremco Print and Detax Resins (Paired t-test, n = 10)

Comparison Pair	Measurement Type	Material	Before (Mean ± SD)	After (Mean ± SD)	t-value	p-value	Significance
Saremco Print (Before vs After)	Adaptation (µm)	Saremco	226.18 ± 33.85	205.03 ± 18.01	1.859	0.048	*
Detax (Before vs After)	Adaptation (µm)	Detax	252.18 ± 62.48	199.53 ± 20.13	2.244	0.026	*
Saremco vs Detax	Adaptation	—	226.18 ± 33.85 vs	—	-1.136	0.143	NS

(Before aging)	(µm)		252.18 ± 62.48				
Saremco vs Detax (After aging)	Adaptation (µm)	—	205.03 ± 18.01 vs 199.53 ± 20.13	—	0.540	0.301	NS
Detax (Before vs After)	Retention Force (N)	Detax	12.57 ± 1.22	13.47 ± 0.74	-3.009	0.007	**
Saremco Print (Before vs After)	Retention Force (N)	Saremco	9.79 ± 1.52	13.87 ± 0.83	-8.491	< 0.001	**
Detax vs Saremco (Before aging)	Retention Force (N)	—	12.57 ± 1.22 vs 9.79 ± 1.52	—	7.702	< 0.001	**
Detax vs Saremco (After aging)	Retention Force (N)	—	13.47 ± 0.74 vs 13.87 ± 0.83	—	-1.284	0.116	NS

Note: $p < 0.05$ is considered statistically significant (*), $p < 0.01$ is highly significant (**), NS: Not Significant.

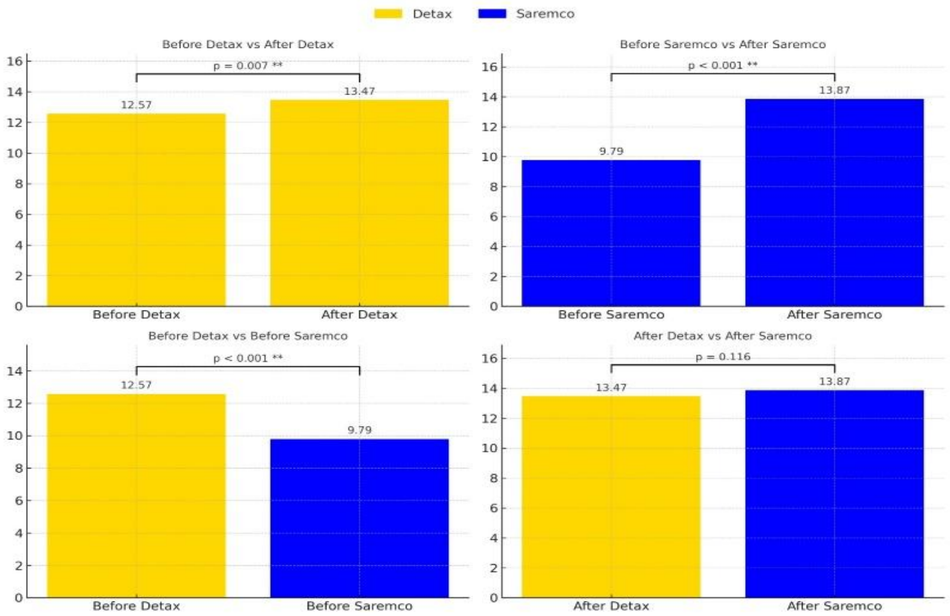


Figure 8.Retention test analysis between two materials before and after thermal cycling

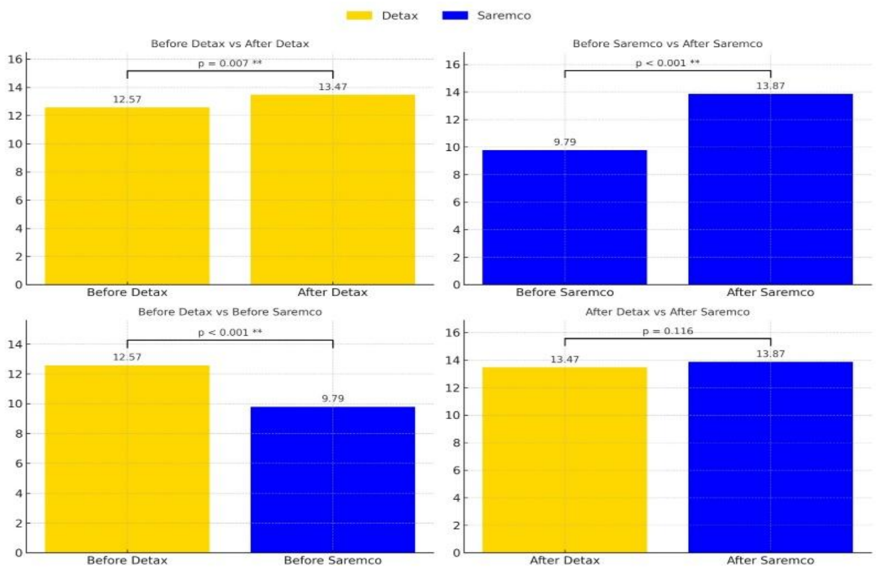


Figure 9. representing graphical analysis for adaptation of denture base materials before and after thermal cycling

5. DISCUSSION

The mechanical behavior and clinical performance of 3D-printed denture base resins are influenced by several factors, including material composition, interaction with artificial saliva, printing parameters, water sorption, and compatibility with the underlying tissue model[14,29-30]. These factors affect the adaptation and retention force of denture bases, which are critical for prosthetic stability and clinical effectiveness. This study evaluated the performance of Saremco Print DentureTec and Detax Freeprint Denture, simulating intraoral aging through thermal cycling to replicate real-world clinical conditions [11,31].Material composition plays a vital role in the differences observed between the two resins. Variables such as the degree of cross-linking, polymerization shrinkage, and monomer formulation determine the response of each material to clinical aging and thermal stress.[8,28,32] The Detax Freeprint denture showed more pronounced dimensional changes, possibly due to higher internal stress accumulation and shrinkage tendencies. In contrast, Saremco Print DentureTec demonstrated greater dimensional stability, indicating a more controlled polymerization mechanism.Cross-linking density directly impacts mechanical resilience. While a higher density improves strength, it may also result in post-curing deformation. Additionally, thermal cycling induces polymer relaxation and subtle structural adjustments over time [6-7,33]. Post-curing effects in methacrylate-based resins may also influence adaptation and retention by altering interfacial bonding and mechanical fit[6,34].

The artificial saliva used in this study was formulated with methyl cellulose, which enhances viscosity and surface tension. This formulation improves the cohesion of the saliva layer between the denture base and the model, enhancing mechanical interlocking and increasing retention values at baseline. The hydrophilic properties of methyl cellulose improve wettability and contact, which are critical in in vitro conditions lacking natural mucosal lubrication[15,18,21] .

This improved saliva simulation may explain the higher baseline retention forces observed before thermal aging. The artificial saliva supported better stabilization through enhanced adhesion, facilitating greater resistance to dislodgement [14,18].

DLP printing at a 45-degree angle and 100-micron layer thickness was selected for its balance between accuracy and strength. This build orientation reduces residual internal stress and improves overall consistency, supporting mechanical stability. The chosen layer thickness also ensures better resin curing and dimensional fidelity[35,36] .

Both materials produced under these parameters exhibited clinically acceptable adaptation and retention. The standardized printing protocol minimized variability and reinforced reproducibility across samples, which is critical for evaluating the true influence of material composition and artificial aging.

Water sorption is a known factor affecting denture base longevity. Absorbed water can soften polymers, induce dimensional changes, and reduce hardness. However, both Saremco and Detax materials demonstrated water absorption within clinically acceptable limits after thermal aging. This indicates that their formulations maintain stability under moisture exposure typical of oral conditions[8,14,28]

Water interacts with polymer chains, creating internal stress through swelling and expansion. These interactions can lead to slight adaptation changes, but in this study, they were beneficial. Improved tissue contact due to dimensional adjustments enhanced denture fit and retention.

Compatibility between the denture base material and the model significantly affects initial retention performance. Since both the gingival model and Detax Freeprint denture base resin share similar formulations, their compatibility likely enhanced baseline adhesion through improved interfacial bonding and molecular interlocking [9].

This compatibility advantage may explain the higher pre-aging retention of the Detax samples. However, after thermal cycling, the performance between Detax and Saremco became statistically similar. This indicates that polymer relaxation and hydration effects neutralized the initial mechanical advantage of resin-matched interface [18,27-28].

Key Observations in This Study

A primary observation is that no statistically significant differences were found between Saremco and Detax after thermal aging in terms of retention and adaptation. Instead, thermal cycling produced material-specific internal changes, emphasizing the effect of aging on polymer relaxation and dimensional adjustment [7,28,37].

- Increased Retention Force After Thermal Cycling: Attributed to improved adaptation and polymer relaxation, leading to tighter contact and stronger mechanical retention [18,38].
- Adaptation Adjustments: Slight dimensional shifts during aging improved tissue contact, which likely contributed to enhanced denture stability [18,21].
- No Material Inferiority: Both resins remained clinically acceptable after aging, highlighting their suitability for long-term use when produced under optimized digital protocols[28].

Clinical Significance: Considerations for Denture Longevity

This study highlights the clinical potential of DLP-printed denture bases made from Saremco and Detax resins. Post-aging increases in retention suggest that thermal exposure, simulating intraoral conditions, may enhance adaptation and stability. Although material formulation initially influenced retention, aging effects tended to level the performance between both groups.

Moreover, the use of a **custom-printed key** allowed for consistent application of artificial saliva and dislodging force, enhancing the reproducibility and reliability of the test methodology. This approach supports a more standardized protocol for evaluating digital denture performance in vitro and could guide improvements in clinical workflow and patient outcomes.

6. CONCLUSION

Based on the findings of this in vitro study, it can be concluded that 3D-printed denture bases made from Saremco Print DentureTec and Detax Freeprint Denture resins exhibit clinically acceptable retention and adaptation characteristics. Thermal cycling leads to improved retention and stable adaptation. The use of a negative key enhances the reliability of testing by standardising saliva distribution and force application, refining research methodologies. Despite the limitations associated with in vitro research, the results of this study provide valuable insights into the behaviour of 3D-printed denture base materials. Further clinical studies are needed to validate these findings and assess the long-term performance of 3D-printed denture bases in diverse patient populations.

REFERENCES

[1] Altarazi AT, Haider J, Alhotan A, Silikas N, Devlin H. 3D Printed Denture Materials: Key Aspects of their Physico-Mechanical and Biological Properties. 2023.

[2] Charoenphol K, Peampring C. Fit Accuracy of Complete Denture Base Fabricated by CAD/CAM Milling and 3D-Printing Methods. European Journal of Dentistry [Internet]. 2022 Dec 13 [cited 2024 Nov 15];17(3):889. Available from: https://doi.org/10.1055/s-0042-1757211

[3] Grande F, Tesini F, Pozzan MC, Zamperoli EM, Carossa M, Catapano S. Comparison of the Accuracy between Denture Bases Produced by Subtractive and Additive Manufacturing Methods: A Pilot Study. Prosthesis [Internet]. 2022 Mar 28 [cited 2024 Nov 13];4(2):151. Available from: https://doi.org/10.3390/prosthesis4020015

[4] Kim KW, Kim SY, Kim SA, Jang HW, Lee K, Lee YS. Four Different Build Angles in 3D-Printed Complete Denture Bases: A Comparative In Vitro Study. 2024 Aug 30 [cited 2024 Dec]; Available from: https://doi.org/10.20944/preprints202408.2270.v1

[5] Jeong M, Radomski K, López D, Liu JT, Lee JD, Lee SJ. Materials and Applications of 3D Printing Technology in Dentistry: An Overview. Dentistry Journal [Internet]. Multidisciplinary Digital Publishing Institute; 2023 Dec 19 [cited 2024 Dec];12(1):1. Available from: https://doi.org/10.3390/dj12010001

[6] Hassanpour M, Narongdej P, Alterman N, Moghtadernejad S, Barjasteh E. Effects of Post-Processing

Parameters on 3D-Printed Dental Appliances: A Review. Polymers [Internet]. Multidisciplinary Digital Publishing Institute; 2024 Oct 1 [cited 2025 Jan];16(19):2795. Available from: https://doi.org/10.3390/polym16192795

[7] Azpiazu-Flores FX, Elfana A, Yang C, Morton D, Lin W. Effect of artificial aging and different surface finishing protocols on the flexural strength and surface hardness of a photopolymer for manufacturing monolithic polychromatic complete dentures using PolyJet 3D printing. Journal of Prosthodontics [Internet]. 2024 Oct 8 [cited 2024 Oct 17]; Available from: https://doi.org/10.1111/jopr.13963

[8] Alqutaibi AY, Baik A, Almuzaini SA, Farghal AE, Alnazzawi A, Borzangy S, et al. Polymeric Denture Base Materials: A Review. Polymers [Internet]. Multidisciplinary Digital Publishing Institute; 2023 Jul 31 [cited 2024 Oct 5];15(15):3258. Available from: https://doi.org/10.3390/polym15153258

[9] Emera R, Shady M, Alnajih MA. Comparison of retention and denture base adaptation between conventional and 3D-printed complete dentures. Journal of Dental Research Dental Clinics Dental Prospects [Internet]. 2022 Nov 15 [cited 2024 Oct 4];16(3):179. Available from: https://doi.org/10.34172/joddd.2022.030

[10] Al-Bdrany AA, Sadoon M. Retention and support of implant retained 3D printed overdentures with different attachments types and implant positions. National Journal of Clinical Orthopaedics [Internet]. 2023 Jan 1 [cited 2024 Oct 9];7(4):1. Available from: https://doi.org/10.33545/orthor.2023.v7.i4a.419

[11] El-Sisy AhmedME, Naggar SE, Helal E, Khalil MaiFF, Gouda A. Comparative study of maxillary denture-base retention between CAD/CAM (3D printed) and conventional fabrication techniques: a randomized clinical study. Journal of The Arab Society for Medical Research [Internet]. 2022 Jan 1 [cited 2024 Oct 26];17(1):46. Available from: https://doi.org/10.4103/jasmr.jasmr_7_22

[12] Charoenphol K, Peampring C. An In Vitro Study of Intaglio Surface, Periphery/Palatal Seal Area, and Primary Bearing Area Adaptation of 3D-Printed Denture Base Manufactured in Various Build Angles. International Journal of Dentistry [Internet]. 2022 Nov 17 [cited 2025 Feb];2022:1. Available from: https://doi.org/10.1155/2022/3824894

[13] Maniewicz S, Imamura Y, El Osta N, Srinivasan M, Müller F, Chebib N. Fit and retention of complete denture bases: Part I - Conventional versus CAD-CAM methods: A clinical controlled crossover study. 2024.

[14] Altarazi A, Haider J, Alhotan A, Silikas N, Devlin H. Impact of Artificial Aging on the Physical and Mechanical Characteristics of Denture Base Materials Fabricated via 3D Printing. International Journal of Biomaterials [Internet]. 2024 Jan 1 [cited 2024 Oct 23];2024(1). Available from: https://doi.org/10.1155/2024/8060363

[15] Qadir GSM, Abdulkareem JF. An In Vitro Comparative Study of Maxillary Denture Base Retention Between Conventional Fabrication and 3D Printed Techniques. Sulaimani dental journal [Internet]. 2023 Aug 1 [cited 2024 Nov];10(2):9. Available from: https://doi.org/10.17656/sdj.10173

[16] Unkovskiy A, Schmidt F, Beuer F, Li P, Spintzyk S, Fernandez PK. Stereolithography vs. Direct Light Processing for Rapid Manufacturing of Complete Denture Bases: An In Vitro Accuracy Analysis. Journal of Clinical Medicine [Internet]. 2021 Mar 4 [cited 2024 Dec];10(5):1070. Available from: https://doi.org/10.3390/jcm10051070

[17] Jaiswal N, Patil PG, Gangurde A, Parkhedkar RD. Wettability of 3 different artificial saliva substitutes on heat-polymerized acrylic resin. Journal of Prosthetic Dentistry [Internet]. 2018 Oct 31 [cited 2024 Dec];121(3):517. Available from: https://doi.org/10.1016/j.prosdent.2018.03.037

[18] Hanno KI, Metwally NA. The wettability of complete denture base materials constructed by conventional versus digital techniques: an in-vitro study. BMC Oral Health [Internet]. 2024 Sep 13 [cited 2024 Dec];24(1). Available from: https://doi.org/10.1186/s12903-024-04800-x

[19] Swapna BV, Nayak VM, Sulaya K, Shetty SS. A comparative evaluation of retention of record bases fabricated digitally in various types of posterior palatal seal area. Journal of Oral Biology and Craniofacial Research [Internet]. 2024 Nov 26 [cited 2024 Dec];15(1):11. Available from: https://doi.org/10.1016/j.jobcr.2024.11.004

[20] Akram BL, Hasan RM ameen. The Comparison of Retention between Hot Curing and Fluid Denture Base Acrylic Resin (In Vivo). Al-Kitab Journal for Pure Sciences [Internet]. 2021 Nov 26 [cited 2025 Mar];2(2):150. Available from: https://doi.org/10.32441/kjps.02.02.p10

[21] Mendes J, Mendes JM, Barreiros P, Aroso C, Silva AS. Retention Capacity of Original Denture Adhesives and White Brands for Conventional Complete Dentures: An In Vitro Study. Polymers [Internet]. 2022 Apr 26 [cited 2025 Feb];14(9):1749. Available from: https://doi.org/10.3390/polym14091749

[22] Ciocca L, Maltauro M, Cimini V, Breschi L, Montanari A, Anderlucci L, et al. Analysis of the trueness and precision of complete denture bases manufactured using digital and analog technologies. The Journal of Advanced Prosthodontics [Internet]. 2023 Jan 1 [cited 2025 Apr];15(1):22. Available from:

https://doi.org/10.4047/jap.2023.15.1.22

[23] Behairy N, Kabeel S, El-Sadany H. Evaluation of Retention for Maxillary Complete Denture Constructed by Conventional and 3D Printing Techniques. Al-Azhar Dental Journal for Girls [Internet]. 2022 Apr 1 [cited 2025 Jan];9(2):245. Available from: https://doi.org/10.21608/adjg.2022.102156.1423

[24] AlHelal A, AlRumaih HS, Kattadiyil MT, Baba NZ, Goodacre CJ. Comparison of retention between maxillary milled and conventional denture bases: A clinical study. Journal of Prosthetic Dentistry [Internet]. 2016 Oct 19 [cited 2025 Feb];117(2):233. Available from: https://doi.org/10.1016/j.prosdent.2016.08.007

[25] AlGhamdi MA, Gad MM. Impact of Printing Orientation on the Accuracy of Additively Fabricated Denture Base Materials: A Systematic Review. Dentistry Journal [Internet]. Multidisciplinary Digital Publishing Institute; 2024 Jul 22 [cited 2025 Jan];12(7):230. Available from: https://doi.org/10.3390/dj12070230

[26] Chebib N, Imamura Y, El Osta N, Srinivasan M, Müller F, Maniewicz S. Fit and retention of complete denture bases: Part II - conventional impressions versus digital scans: A clinical controlled crossover study. 2024.

[27] Abdul-Monem MM, Hanno KI. Effect of thermocycling on surface topography and fracture toughness of milled and additively manufactured denture base materials: an in-vitro study. BMC Oral Health [Internet]. 2024 Feb 23 [cited 2025 Apr];24(1). Available from: https://doi.org/10.1186/s12903-024-03991-7

[28] Gad MA, Abdel-Hamid AM, ElSamahy M, Abolgheit S, Hanno KI. Effect of aging on dimensional accuracy and color stability of CAD-CAM milled and 3D-printed denture base resins: a comparative in-vitro study. BMC Oral Health [Internet]. 2024 Sep 26 [cited 2024 Oct 17];24(1). Available from: https://doi.org/10.1186/s12903-024-04848-9

[29] Majeed HF, Hamad TI, Bairam L. Enhancing 3D-printed denture base resins: A review of material innovations. Science Progress [Internet]. SAGE Publishing; 2024 Jul 1 [cited 2024 Oct 1];107(3). Available from: https://doi.org/10.1177/00368504241263484

[30] Lee HE, Alauddin MS, Ghazali MIM, Said Z, Zol SM. Effect of Different Vat Polymerization Techniques on Mechanical and Biological Properties of 3D-Printed Denture Base. Polymers [Internet]. 2023 Mar 15 [cited 2024 Dec];15(6):1463. Available from: https://doi.org/10.3390/polym15061463

[31] Gad MM, Fouda SM, Abualsaud R, Alshahrani FA, Al-Thobity AM, Khan SQ, et al. Strength and surface properties of a 3D-printed denture base polymer. 2022.

[32] Lourinho C, Salgado H, Correia A, Fonseca P. Mechanical Properties of Polymethyl Methacrylate as Denture Base Material: Heat-Polymerized vs. 3D-Printed—Systematic Review and Meta-Analysis of In Vitro Studies. Biomedicines [Internet]. Multidisciplinary Digital Publishing Institute; 2022 Oct 13 [cited 2024 Oct 8];10(10):2565. Available from: https://doi.org/10.3390/biomedicines10102565

[33] Batisse C, Nicolas E. Comparison of CAD/CAM and Conventional Denture Base Resins: A Systematic Review. Applied Sciences [Internet]. Multidisciplinary Digital Publishing Institute; 2021 Jun 28 [cited 2024 Nov];11(13):5990. Available from: https://doi.org/10.3390/app11135990

[34] Shin SH, Doh R, Lim JH, Kwon J, Shim J, Kim J. Evaluation of Dimensional Changes According to Aging Period and Postcuring Time of 3D-Printed Denture Base Prostheses: An In Vitro Study. Materials [Internet]. 2021 Oct 18 [cited 2024 Oct 18];14(20):6185. Available from: https://doi.org/10.3390/ma14206185

[35] Alshamrani A, Raju R, Ellakwa A. Effect of Printing Layer Thickness and Postprinting Conditions on the Flexural Strength and Hardness of a 3D-Printed Resin. BioMed Research International [Internet]. 2022 Feb 21 [cited 2024 Oct 10];2022:1. Available from: https://doi.org/10.1155/2022/8353137

[36] Li P, Fernandez PK, Spintzyk S, Schmidt F, Yassine J, Beuer F, et al. Effects of layer thickness and build angle on the microbial adhesion of denture base polymers manufactured by digital light processing. Journal of Prosthodontic Research [Internet]. 2023 Jan 1 [cited 2025 Jan];67(4):562. Available from: https://doi.org/10.2186/jpr.jpr_d_22_00126

[37] Gad MM, Alshehri SZ, Alhamid SA, Albarrak A, Khan SQ, Alshahrani FA, et al. Water Sorption, Solubility, and Translucency of 3D-Printed Denture Base Resins. Dentistry Journal [Internet]. 2022 Mar 9 [cited 2024 Oct 5];10(3):42. Available from: https://doi.org/10.3390/dj10030042

[38] 38. Kumar H, Surapaneni H, Ravikiran V, Chandra B, Balusu S, Reddy V. Retention of denture bases fabricated by three different processing techniques — An in vivo study. Journal of International Society of Preventive and Community Dentistry [Internet]. 2016 Jan 1 [cited 2024 Dec];6(3):245. Available from: https://doi.org/10.4103/2231-0762.183106