



Porosity of Heat Cured Acrylic After Adding Salvador Persica

Reem Ahmed Shihab

College of Dentistry, Tikriti University, Tikrit, Iraq

Abstract

Objective: This study aimed to evaluate the effect of incorporating Salvador Persica powder at different concentrations on the porosity of heat-cure acrylic resin. **Materials and Methods:** An in vitro experiment was conducted using heat-cure PMMA acrylic resin specimens fabricated through a conventional water-bath polymerization technique. Specimens were divided into three groups (n = 10): control group with no additive, group 2 (heat cure + 0.5% Salvador Persica), and group 3 (heat cure + 1% Salvador persica). The additive was incorporated using a weight replacement method while maintaining a standardize powder-liquid ratio. After polymerization specimens were put in a desiccation, specimens were weighed to obtain initial dry weight (Wd), followed by immersion in distilled water for 24 hours and reweighing obtain wet weight (Ws). **Results:** The control group administrated the lowest mean porosity value (0.281 ± 0.0202). Increase mean values were observed in both experimental groups (0.37 ± 0.32 for 0.5% and 0.36 ± 0.047 for 1%). No statically significant difference was found between the control and 0.5% groups ($p = 0.391$), whereas a high significant was observed between the control and 1% groups ($p = 0.0007$). No significant difference was detected between the 0.5% and 1% concentrations ($p = 0.924$). **Conclusion:** Incorporation of *Salvadora persica* powder influenced the porosity of heat-cure acrylic resin. Low concentration (0.5%) did not significantly affect porosity, while higher concentration (1%) significantly increased water sorption, suggesting increased internal porosity. Optimization of additive concentration is therefore essential to balance potential biological benefits with material performance.

Open Access

Citation: Shihab RA. (2026) Porosity of heat Cured Acrylic After Adding Salvador Persica. Dentistry 3000. 1:a001
doi:10.5195/d3000.2026.1289
Received: April 7, 2026
Accepted: April 11, 2026
Published: May 1, 2026
Copyright: ©2026 Shihab RA. This is an open access article licensed under a Creative Commons Attribution Work 4.0 United States License.
Email: reemshihab@tu.edu.iq

Introduction

Material made of acrylic resin is the most often utilized polymer for denture base because it satisfies most criteria for denture base material that is clinically appropriate [1,2]. The acrylic resins are a major revolution in the annals of advanced dentistry [3].

The fabrication of denture was revolutionized by the introduction of clinical acrylic resin, a material based on polymethyl methacrylate

(PMMA) that was developed in 1936. It is an ethylene derivative containing a vinyl group. Since 1948, 98 % of the dentures have been fabricated from PMMA and copolymers, and PMMA is today the best material for fabrication of removable partial and full bases for dentures. Because it's simple of fabrication, finishing and polishing, good fit, stability in the oral environments, easy repair, and aesthetics, it is

still used in implant-supported dentures most recently [4-6]. Acrylic resin has several benefits, including good aesthetics with color and texture analogous to the gingiva, low water absorption, easy processing, and the ability to be repaired without the need for laboratory professionals. It is superior to other materials because of it is easy to manipulate, non-toxic and light weight, but it has several drawbacks, one

of the main drawbacks is its low impact strength, which makes it susceptible to fracture when dropped on a solid surface [7,8]. One of the characteristics of PMMA is still the porosity of denture base resin, which is caused by a variety of causes such as air trapped during mixing, monomer contraction during polymerization, monomer vaporization accompanied by an exothermic reaction, and the existence of residual monomer. Absence of porosity is essential for retaining a smooth, clean, polishable surface.

In dentistry, three major types of acrylic resin are used: heat-cured, self-cured, and light-cured acrylic resins. Among these, heat-cured acrylic resin is the most widely utilized material for the construction of denture bases [8-11]. The porosity is an undesirable trait to the acrylic resin denture base. Increased internal stress and weakening of the prosthesis due to severe porosity can make it more prone to warpage and deformation. A porous surface promotes the colonization of oral microbes like *Candida albicans* and makes it easier for substances to be preserved and calculus to deposit, which results in discoloration and decreased aesthetic appeal [12].

Salvadora persica L. (SP) is also recognized as Arak (in Arabic) and Peelu (in Urdu). Its frequent use as a toothbrush (miswak) is highly suggested by Prophet Muhammad [13]. SP a member of the plant family Salvadoraceae. It is mainly allocated in dry and subtropical regions of Africa and the Middle East, as well as the Indian subcontinent. The fresh leaves, twigs and roots of its small tree can be added to the regular diet and are applied in conventional herbal therapy for asthma, scurvy, cough, rheumatic illnesses, oral hygiene and other conditions [14]. It has shown favorable antimicrobial properties [15]. Moreover, the antimicrobial, anti-inflammatory and several measurable chemicals in SP's natural extracts, including potassium and sodium chloride, as well as Salvadorene, vitamin C, Salvadorene, silica, saponins, and various minerals, have been authorized for antioxidant properties [14].

The present study aimed to investigate the influence of incorporating *Salvadora persica* powder at varying concentrations of the porosity of heat-cure acrylic resin.

Materials and Methods

This in vitro experimental study was carried out to assess the effect of incorporating *Salvadora persica* powder on the porosity of heat-cure polymethyl methacrylate (PMMA) acrylic resin depending of its water sorption behavior. A rectangle plastic samples measuring 50 x 4 x 2 mm ± 1 mm in length, width, and thickness

were prepared for the porosity test in compliance with ASTM regulations was fabricated and used as a reference for specimen duplication. Plastic Samples are placed over dental stone to obtain molds according to specimen size. Standard denture flasks were used to produce uniform acrylic resin specimens. A piece of *Salvadora persica* is grinded mechanically (using Silver Crest SC-7880 - Spices Grinder) into the finest powder possible by the machine.

The specimens were divided into three groups based on the concentration of *Salvadora persica* powder incorporated into the acrylic resin powder. Group I served as the control group (0%), Group II contained 0.5% *Salvadora persica*, and Group III contained 1% *Salvadora persica*. The additive was incorporated using a weight replacement method to maintain a constant total powder weight. A standardized powder-liquid ratio of 23 g of powder and 14ml of monomer liquid was used for all specimens. In this experiment heat-cure acrylic resin from Shanghai New Century Dental Materials Co. brand is used. For the experimental groups, the required amount of *Salvadora persica* powder was accurately weighed using a precision analytical balance and substituted for an equivalent weight of acrylic resin powder prior to mixing. For the groups which contains the *Salvadora* powder the liquid monomer is mixed with *Salvadora persica* powder using Magnetic Stirrer with hot plate for 20 minutes. It worth to note that no additional heat is applied in this experiment during mixing.

Then the liquid monomer with *Salvadora persica* powder is added into the acrylic resin powder, and the Heat-cure PMMA acrylic resin was manipulated according to the manufacturer's instructions. Polymerization was performed using a conventional water-bath curing technique. The flasks were initially placed in cold water, followed by gradual heating until the boiling temperature was reached. The specimens were maintained at boiling temperature for one hour to complete the curing cycle. After deflasking and shaping, the specimens were placed in a drying container (desiccator) to eliminate residual moisture. Each specimen was weighed using a precision analytical balance, and the weights are recorded as the initial dry weight (W_d).

The specimens were subsequently immersed in distilled water and under standardized conditions, following immersion, the specimens were removed, gently blotted with absorbent paper to remove surface moisture, and reweighed using the same analytical balance. This value was recorded as the wet weight (W_s). Porosity can be calculated by the following:

$$P(\text{Porosity}) = \left[\frac{W_s - W_d}{W_d} \right] \times 100\%$$

Results

The control group demonstrated the lowest mean porosity value (0.281 ± 0.0202). Specimens containing 0.5% and 1% *Salvadora persica* showed higher mean values (0.37 ± 0.32 and 0.36 ± 0.047 , respectively) as shown in Table 1.

Statistical analysis shows no significant difference between the control and 0.5% groups ($p = 0.391$). However, a statistically significant increase in porosity was observed between the control and 1% groups ($p = 0.0007$). No significant difference was found between the 0.5% and 1% groups ($p = 0.924$).

Discussion

The present in vitro study evaluated the effect of incorporating *Salvadora persica* powder into heat-cure polymethyl methacrylate (PMMA) acrylic resin on water sorption behavior as an indirect indicator of material porosity. The findings reveals that the incorporation of *Salvadora Persica* resulted in increased water sorption values compared with control group, with a statistically significant increase seen at the 1% concentration.

PMMA denture base resin is widely employed due to its advantageous esthetic properties, ease of manipulation, and acceptable mechanical performance [5,6]. However, its polymeric structure allows water diffusion through intermolecular spaces, making porosity and water sorption important factors influencing longstanding clinical performance. Any modification of the behavior and internal structure, thereby affecting these properties [12].

In the present study, the control group exhibited the lowest mean water sorption value, indicating a more homogeneous polymer matrix with fewer internal voids. The addition of *Salvadora persica* powder produced higher mean values in both experimental groups. This increase may be attributed to incomplete interfacial bonding between the organic plant particles and the PMMA matrix. The presence of solid particles can interfere with polymer chain packing during polymerization, leading to the formation of micro-voids and internal irregularities that facilitate water penetration [16]. Although the 0.5% group showed an increase in mean water sorption compared with control group, the difference was not statistically significant. This finding suggests that low concentrations of *Salvadora persica* may not substantially disrupt the structural integrity of the acrylic resin matrix. At this concentration, the additive particles may be dispersed without

markedly affecting polymer continuity. In contrast, incorporation of 1% *Salvadora persica* resulted in a statistically significant increase in porosity compared with the control group. This outcome indicates that higher concentrations of the additive may exceed the capacity of the resin matrix to adequately encapsulate the particles, thereby increasing internal porosity. The formation of microscopic gaps around filler particles likely enhances water diffusion into the material [17].

Conclusions

- Incorporation of *Salvadora persica* powder influenced the porosity of heat-cure acrylic resin.
- Low concentration (0.5%) did not significantly affect porosity.
- While higher concentration (1%) significantly increased suggesting increased internal porosity.

References

1. Abdel-Rahman HK, Al-Sammarai SA. Effect of adding magnesium oxide nanoparticles on the antimicrobial activity of a denture soft liner. *Polytechnic Journal*. 2020 Dec 30;10(2):132-7.
2. Antony A, Dipoyono HM, Ismiyati T. The effect of adding zirconium dioxide nanoparticle to acrylic denture base on porosity and candida albicans adhesion. *Majalah Kedokteran Gigi Indonesia*. 2021;7(3):152-9.
3. Altarazi A, Haider J, Alhotan A, Silikas N, Devlin H. Assessing the physical and mechanical properties of 3D printed acrylic material for denture base application. *Dental Materials*. 2022 Dec 1;38(12):1841-54.
4. H Alfahdawi IH. Modified Processing Technique for Acrylic Resin Denture Base. *Tikrit Journal for Dental Sciences*. 2018;6(1):28-32.
5. Al-Shakarchi MN, Hasan RH. Comparative Evaluation to Surface Roughness of Modified Heat Cured Acrylic Resin by Zinc Oxide Nanoparticles and CAD/CAM Denture Base Materials-In Vitro Study. *Tikrit Journal for Dental Sciences*. 2023 Jan 10;11(2):162-9.
6. Abdulsattar MH. Assessment the mechanical and color changes properties of denture base material after reinforcement with nanoparticles material. *Tikrit Journal for Dental Sciences*. 2023 Jun 30;11(1):10-6.
7. Hameed TM, Al-Dabbagh BM, Jasim RK. Mechanical properties of heat cured acrylic resin reinforced with natural sisal fibers powder. In *Journal of Physics: Conference Series* 2021 Dec (Vol. 2114, No. 1, p. 012023). IOP Publishing.
8. Lubis MA, Sari IF, Batubara MD, Samad R, Elveny M, Syah R, Husein I, Dur S, Hilda L. Different Polymerization Methods for Dentistry Amount Internal Porosities: A Systematic Review. *Systematic Reviews in Pharmacy*. 2020 Dec 1;11(12).
9. Taqa AA, Nazhat MN, Basshi TY. The effect of autoclave on the powder of (PMMA) on the water sorption, solubility and porosity. *Int. Res. J. Basic Clin. Stud*. 2014;2(7):87-91.
10. Chhabra M, Kumar MN, RaghavendraSwamy KN, Thippeswamy HM. Flexural strength and impact strength of heat-cured acrylic and 3D printed denture base resins-A comparative in vitro study. *Journal of Oral Biology and Craniofacial Research*. 2022 Jan 1;12(1):1-3.
11. Ahmed ES, Oudah LM. Acrylic resin denture base material enhancement by fiber, filler, and nano filler addition: a systematic review. *Tikrit Journal for Dental Sciences*. 2024 Jun 30;12(1):11-20.
12. Figuerôa RM, Conterno B, Arrais CA, Sugio CY, Urban VM, Neppelenbroek KH. Porosity, water sorption and solubility of denture base acrylic resins polymerized conventionally or in microwave. *Journal of Applied Oral Science*. 2018 May 7;26:e20170383.
13. Farag M, Abdel-Mageed WM, El Gamal AA, Basudan OA. *Salvadora persica* L.: Toothbrush tree with health benefits and industrial applications—An updated evidence-based review. *Saudi Pharmaceutical Journal*. 2021 Jul 1;29(7):751-63.
14. Mekhemar M, Geib M, Kumar M, Radha, Hassan Y, Doerfer C. *Salvadora persica*: Nature's gift for periodontal health. *Antioxidants*. 2021 Apr 30;10(5):712.
15. Muhammed NM, Arab LN, Shihab RA, Ahmed RS. *Himalayan Journal of Dental Science and Research*.
16. Chaaben R, Taktak R, Mnif B, Guermazi N, Elleuch K. Innovative biocomposite development based on the incorporation of *Salvadora persica* in acrylic resin for dental material. *Journal of Thermoplastic Composite Materials*. 2022 Nov;35(11):1815-31.
17. Kondo Y, Takagaki T, Okuda M, Ikeda M, Kadoma Y, Yamauchi J, Okada K, Sadr A, Nikaido T, Tagami J. Effect of PMMA filler particles addition on the physical properties of resin composite. *Dental Materials Journal*. 2010;29(5):596-601.

Table 1. Mean and standard deviation for 3 groups of heat cure acrylic.

Types	n	Mean	SD
Control group (acrylic resin)	10	0.281g	0.0202
0.5% S.P. + acrylic resin	10	0.37g	0.32
1% S.P. + acrylic resin	10	0.36g	0.047