Research Article

Evaluating the physical properties of microwave-cured and heat-cured acrylic denture base materials after the addition of ZrO_2 nanoparticles.

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Received date: 02-05-2024
Accepted date: 20-06-2024
Published date: 15-09-2024

Article DOI

Abstract: Background: The structural, physical, and mechanical properties of denture-based acrylic resin are still compromised by water sorption, water solubility, and porosity. These issues have long called for improved techniques, and the use of nanoparticles is one of them. The main objective of the current investigation was to evaluate and contrast some physical parameters (water sorption, water solubility, and porosity) after the incorporation of ZrO2 nanoparticles (0%, 3% and 5%) into heat-cured acrylic denture base materials (Ivoclare, Major) and microwave-cured acrylic (Acron MC). Materials and methods: A total of 60 resin specimens were manufactured, including 5 specimens for each concentration of ZrO2 NP (30 for porosity and 30 for water sorption and solubility). Followed the manufacturer's directions for preparing the sample of each material. Results: The results were analysed with descriptive statistics, Analysis of Variance(ANOVA) test, Duncan multiple range test, and independent T test demonstrated that the addition of nanoparticles (3% and 5%) decreased water sorption, water solubility, and porosity of PMMA (polymethyl methacrylate) for both types (microwave-cured and heat-cured acrylic denture base materials). Where, at 3%, the ZrO2 nanoparticles showed the best values for all tests compared to the control group. Conclusions: ZrO2 (3% and 5%) nanoparticle reinforcement of acrylic resin can be a useful tactic for lowering water sorption, solubility and porosity, thereby enhancing the performance of the material in various applications for microwave-cured and heat-cured acrylic denture base materials.

Keywords: zirconium oxide NP, denture base, water sorption, Water solubility and porosity.

Introduction

Although it is the most commonly used denture base material, PMMA is still associated with several limitations. As a result, acrylic resin has undergone modifications to enhance its mechanical, physical and working qualities, as well as to simplify laboratory procedures [1-3]. However, there are several issues with the traditional water bath curing procedure for acrylic resin, including surface porosity, hypersensitivity, dimensional instability, residual monomer, poor strength, water absorption, colour instability, and easy breakage [4,5]. To solve these issues, many modified PMMAs (6-9) have been introduced. Furthermore, a variety of mechanical and physical attributes, including porosity, surface roughness, water sorption, and dimensional stability, are enhanced by microwave polymerisation [2,4,5].

The polymerisation reaction of PMMA is induced by microwave energy; therefore, to ensure proper functionality, it is necessary to add a nonmetallic fibre-reinforced plastic (FRP) flask. Additionally, it is crucial to apply a microwave processing resin that has been specifically designed for this purpose. PMMA (polymethyl methacrylate) cured by microwave radiation is superior to PMMA cured in a water bath because the substance's interior and exterior are heated equally and quickly, eliminating the need to wait for the resin to reach the flask's interior. Furthermore, microwave energy improves many mechanical and physical properties, including surface roughness, porosity, and dimensional stability [2-6,10].

Recently, the deliberate incorporation of nanoparticles in acrylic resin has attracted attention. such as zirconia nanoparticles (NZ) [11-14], strengthening and enhancing the mechanical and physical characteristics [15-17]. Bioceramic zirconia (ZrO_2) is a material widely used in dentistry for a variety of purposes, including crowns and bridges, maxillofacial materials, implant hardware, orthodontic brackets, and is abutments. and distinguished by outstanding biocompatibility and strong mechanical qualities [18-21].

Because it compensates polymerisation shrinkage, water sorption is considered a favourable feature as long as it remains within permitted bounds; if it is exceeded, however, unfavourable dimensional changes can result [22-24]. Acrylic resin is not dissolved by water; instead, its solubility refers to the amount of soluble material that is released from it [25]. The only soluble ingredients were the plasticiser, free monomer, and initiators. The mean mass changes during water saturation and dehydration are used to measure water sorption and solubility [26-29]. Porosity in acrylic resin is still a persistent problem that deteriorates the structural, mechanical, biological, and physical properties of denture base resins [30-32]. The enhancement of transverse strength and hardness by zirconia NPs is demonstrated by our earlier study. Furthermore, both heat-cured acrylic resin and microwave acrylic (MC) performed better in the FTIR test, showing no alterations in chemical architecture when 3% or 5% ZrO_2 NP were added compared to the control (0% ZrO_2 NP) [33].

The objectives of this research are to evaluate and compare the water sorption, solubility and porosity of heat acrylic denture (Ivoclare, Major) and microwave-cured acrylic cured by microwave (Acron MC) at varying concentrations (control 0%, 3% and 5%) with zirconium oxide ZrO_2 NP. The null hypothesis posited that the inclusion of zirconium oxide ZrO_2 NP at 3% and 5% by weight into heat and microwave-cured acrylic denture base materials would have no impact on the water sorption, solubility, or porosity of the modified denture base materials.

Materials and Methods

The water sorption, solubility, and porosity of acrylic resin (Acron MC, Japan) cured using microwave energy (MW) were measured and compared with those of samples containing ZrO_2 nanoparticles at concentrations of 0%, 3%, and 5%. Nano-Zro_2, with a particle size of 50 nm [19], obtained from US Research Nanomaterials Inc. in Houston, USA.

Furthermore, the results were compared with those of heat-polymerised acrylic resin specimens (Major, Switzerland) cured using the water bath method (WB). A total of 60 resin specimens were collected (n = 30 specimens) for each water sorption, solubility, and porosity. Each concentration of ZrO_2 NP included 5 specimens. Experiments were conducted on two groups: one consisting of heat-polymerised acrylic resin specimens (major) and the other consisting of microwave-polymerized specimens (Acron MC).

The weight percentages of ZrO_2 NP used in this study were determined based on previous studies. The mixtures tested included concentrations of 1.5 wt%, 3.0 wt.%, 5.0 wt.%, 7.0 wt%, 10.0 wt.%, and 15 wt.% [12,19]. From these tests, it was found that the most effective percentages were 3 wt% and 5 wt.% ZrO_2NP [20,33,34]. Therefore, a decision was made to adopt those concentrations (0 wt%, 3.0 wt.%, and 5.0 wt.% of ZrO_2NP) in the present study.

Zirconium dioxide nanoparticles (ZrO_2NP) and acrylic powders were measured using an electronic balance with a precision of three decimal digits, following exact proportions. The ZrO_2NP powder was added to the acrylic monomer and thoroughly mixed by fully blending using manual agitation and ultrasonic vibration for approximately 10 minutes to achieve an even distribution of the powder throughout the monomer. Subsequently, the powder with the monomer. The mixing process persisted for roughly 20 minutes until the mixture reached a consistency similar to that of the dough. Once the mixture reached a state of uniform consistency, known as the homogeneous dough stage, it was manually placed in an FRP mould (GC, Tokyo174-8585, Japan) .

The packing and curing process adhered to the ISO 20795-1:2013 standards [35]. Heat-cured acrylic resin specimens were cured using standard polymerisation protocols, while the microwave-polymerised specimens (Acron MC) were prepared by mixing a powder/liquid ratio of 100 mg/43 ml. The mixture was then packed into a microwavable flask mould (FRP Flask H.K. TYPE) with inserted bolts. Constant pressure was applied using a supplied wrench, and the samples were subjected to 500 W microwave irradiation for 3 minutes in a microwave oven (EM M 553 T, Sanyo) for microwave curing of Acron MC specimens [36,37].

The samples were immersed in distilled water at a temperature of 37 ° C for 48 hours before testing. The addition of ZrO2NP at different weight percentages (0%, 3% and 5%) to the monomer of microwave acrylic monomer (Acron MC) and heat-cured acrylic denture base materials (Ivoclare, Major) was found to be more beneficial compared to the addition of it to the powder. This finding has been supported by other researchers who also mixed ZrO_2 NP with the monomer and observed similar advantages [38].

The samples prepared for the three tests were rectangular (12 x 10 x 4±0. 2 mm), according to ADA (2002) and Figuerôa *et al*. (2018) for water sorption and water solubility [22,23], and Figuerôa *et al*. (2018) and Pero *et al.* (2009) [23,29] for porosity test, which is achieved by using an electrical digital sensitive analytical balance measuring up to 0.0001 g. then applying these equations:

(A) Water sorption (mg/cm^2) = M2-M1 / V

(B) Solubility test: Solubility (mg/cm^2) = M1-M3 / V

Where M 1 = Conditioned mass, M2 = mass after immersion, M3 = Reconditioned mass in mg and V = surface area.

C) the porosity was calculated according to the following equations:

$$Vd = (md - m,d)/\varrho w \quad [1]$$

$$Vs\ wet = (ms - m,s)/\varrho w \quad [2]$$

$$Porosity\ \% = 100 \times (Vs - Vd)/Vd \quad [3]$$

The variables used in this equation are as follows: Vs dry (ml) represents the volume of the dry sample, md (g) represents the weight of the dehydrated samples measured in the presence of atmospheric air, m,d (g) represents the mass of the dry sample measured as soon as it is submerged in water, ϱw (g/mL) represents the density of water (1000 kg/m3), Vs dry (mL) represents the volume of the wet specimen, ms (g) represents the mass of the saturated sample recorded in air, and m,s (g) represents the mass of the saturated specimen immediately immersed in water.

The samples were dried using silica gel in a desiccator at a temperature of 37 ° C and weighed with a high precision of 0.0001 g using an electronic balance instrument (Shimadzu, Germany). The original weight of the samples (M1) was regarded as such. The samples were subsequently submerged in distilled water and each specimen placed in individual containers. After 1 week, the specimens were extracted from their container. By blotting the excess water with filter paper, it was possible to record the weight (M2). That is, the weight of the specimen after it has absorbed the distilled water. The samples were desiccated by being put in the desiccator. The receiver included a freshly prepared desiccated silica gel, which was kept at a temperature of 37±1°C for 24 hours. Subsequently, the receiver was allowed to cool on a bench for one hour until it reached the ambient temperature. The samples were weighed as a cyclic process, which continued daily for 24 hours until all samples reached their ultimate weight (M3) [26-29].

Results

The Shapiro-Wilk test, which was used to evaluate the distribution of the data, indicated that all variables had a normal distribution. Statistical analysis of all the data was conducted using the SPSS system (version 28). Figure (1) presents the average values and standard deviation (SD) of water absorption (mg/cm^3) for the heat-cured acrylic denture base materials Ivoclar and Major, as well as the microwave-cured acrylic denture base material, after the addition of ZrO_2 nanoparticles at concentrations of 0%, 3% and 5%. Heat-polymerised acrylic resin specimens in the control (0%) group of ZrO_2 nanoparticles show the highest value (0.49784 ± 0.00441), while specimens from the 3% ZrO_2 NP microwave-cured acrylic exhibit the lowest value (0.46312± 0.0024025).

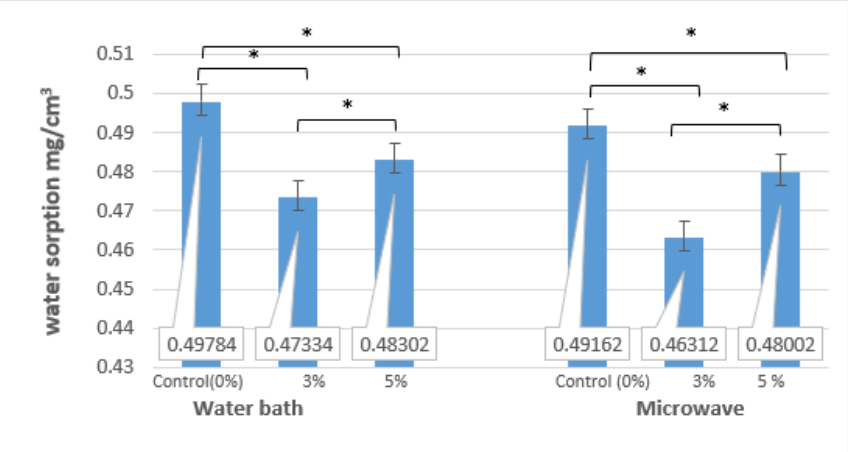

Figure 1: Mean values and standard deviation of water sorption for heat- and microwave-cured acrylic denture-based materials after adding ZrO_2 nanoparticles (control (0%), 3% and 5%). *Significant at (P-value <0.05), NS (nonsignificant) according to DMRT.

Analysis of variance (ANOVA) of water sorption (mg/cm^3) in Table (1) demonstrated that there were statistically negligible variations between the tested groups of acrylic denture base materials. (Ivoclar,

Major) heat-polymerised acrylic resin and Acron MC microwave-cured acrylic denture base materials after adding ZrO_2Nanoparticles (0%,3% and 5%) at (P value≤0.05).

Table 1: ANOVA for acrylic denture base materials cured with water sorption (mg/cm³) for (Ivoclar, Major) and Acron MC after adding ZrO_2Nanoparticles (0%, 3%, and 5%),

Groups		Sum of Squares	DF	Mean Square	F value	Sig
Heat-cured acrylic	Between groups	0.002	2	0.001	29.496	0.000**
	Within groups	0.000	12	0.000		
	Total	0.002	14			
Microwave-cued acrylic	Between groups	0.002	2	0.001	23.805	0.000**
	Within groups	0.001	12	0.000		
	Total	0.003	14			

*significant at (P value <0.05).

Duncan's multiple range test (DMRT) of water sorption for heat and microwave-polymerised acrylic resin material. It shows that there is a substantial reduction in water sorption between all tested groups (3% and 5%) of ZrO_2 nanoparticles, with the control group at (P value <0.05, as revealed in Figure (1).

Figure (2) shows the mean values and standard deviation of water solubility (mg/cm³) for (Ivo-clar, Major) heat-polymerised acrylic resin and Acron MC microwave-cured acrylic denture base materials after mixing ZrO_2 nanoparticles (0%, 3%, and 5%) to heat- polymerized acrylic resin specimens. The control (0%) ZrO_2 nanoparticles group exhibited the highest value (0.49878 ± 0.00592), while the sample 3% ZrO_2 nanoparticles microwave-cured acrylic group exhibited the lowest value (0.4749 ± 0.00866).

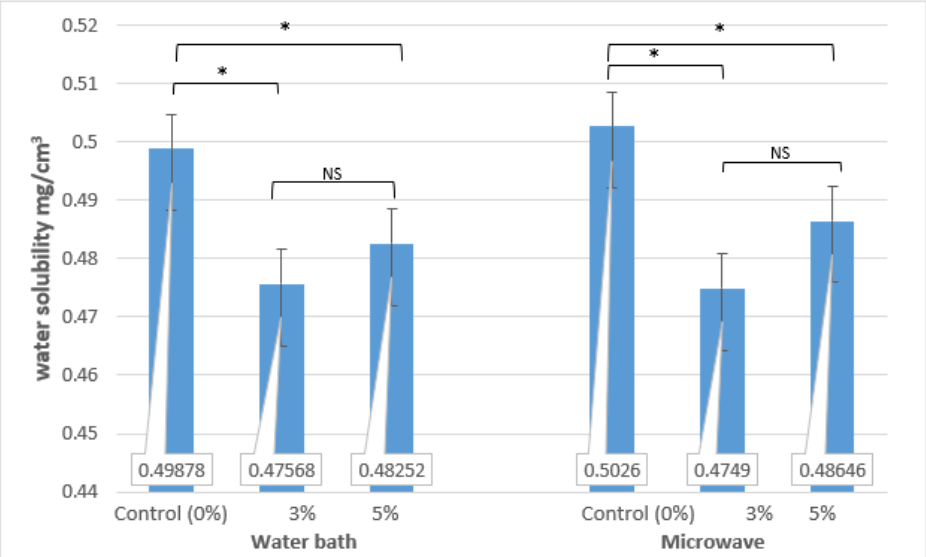

Figure 2: Mean and standard deviation of water solubility for heat and microwave-cured acrylic denture-based materials cured in microwave after adding ZrO_2 nanoparticles (Control (0%), 3%, 5%). *Significant at (P-value <0.05), NS (nonsignificant) according to DMRT.

Table (2) Analysis of variance (ANOVA) of water solubility (mg/cm³) highlighted that there was a statistically significant variation between all groups tested of acrylic denture base materials heat-polymerised

acrylic resin and Microwave-cured acrylic denture base materials after the addition of ZrO_2 nanoparticles (0% 3%, and 5%) at (P value≤0.05)

Table 2: ANOVA for water solubility (mg/cm^3) for the base materials of acrylic dentures (Ivoclar, Major) and Acron MC cured acrylic denture base materials after adding ZrO_2 Nanoparticles (0%, 3%, and 5%),

Groups		Sum of Squares	DF	Mean Square	F value	Sig
Heat cured acrylic	**Between groups**	0.001	2	0.001	17.559	0.000**
	Within groups	0.001	12	0.000		
	Total	0.002	14			
Microwave cued acrylic	**Between groups**	0.002	2	0.001	8.648	0.005**
	Within groups	0.001	12	0.000		
	Total	0.003	14			

*significant at (P value <0.05).

The Duncan multiple range test (DMRT) was conducted to assess the water solubility of heat and microwave-polymerised acrylic resin material. The results indicate a substantial decrease in water solubility between the control group and the tested groups (3% and 5%) treated with ZrO_2 nanoparticles, with a p-value of <0.05, as shown in Figure 2.

Figure (3) shows the mean values and standard deviation of the percentage of porosity for two types of acrylic resin materials. Ivoclar and Major. These materials were heat-polymerised and microwave-cured, and ZrO_2 nanoparticles were added at different concentrations (0%, 3% and 5%). In heat-polymerized acrylic resin samples, the control group with 0% ZrO_2 nanoparticles had the highest porosity value of 0.8595 ± 0.031663. On the other hand, the microwave-cured acrylic group with 3% ZrO_2 nanoparticles had the lowest porosity value of 0.72425 ± 0.037453.

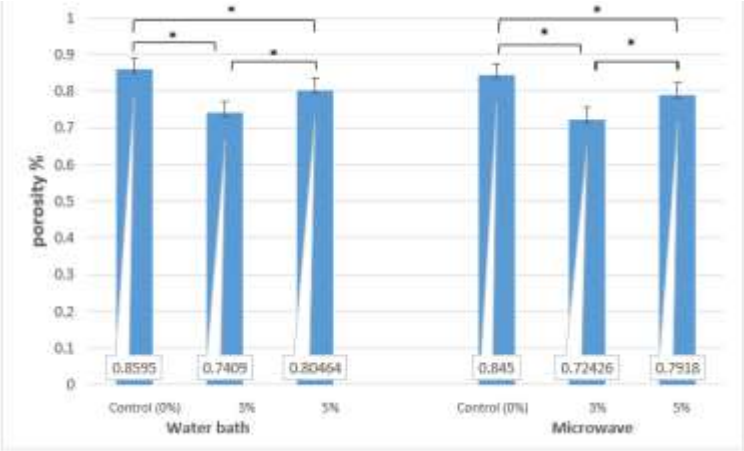

Figure 3: Mean and standard deviation of porosity % for heat and Acron MC microwave-cured acrylic denture-based materials after adding ZrO_2 nanoparticles (Control (0%),3%, 5%). *Significant at (P-value <0.05), NS (nonsignificant) according to DMRT.

Analysis of variance (ANOVA), Table (3) of porosity % demonstrated that there were statistically significant differences between all tested groups of acrylic denture base materials heatpolymerised acrylic resin and Microwave acrylic denture base materials after mixing with ZrO_2 nanoparticles (0% 3%, and 5%) at (P value≤0.05)

Table (3): ANOVA for acrylic denture base materials porosity % for (Ivoclar, Major) and Acron MC cured after mixing ZrO_2 Nanoparticles (0%, 3%, and 5%),

Groups		Sum of Squares	DF	Mean Square	F value	Sig
Heat-cured acrylic	**Between groups**	0.035	2	0.018	21.489	0.000**
	Within groups	0.010	12	0.001		
	Total	0.045	14			
Microwave-cued acrylic	**Between groups**	0.037	2	0.018	33.002	0.000**
	Within groups	0.007	12	0.001		
	Total	0.043	14			

*significant at (P value <0.05).

(DMRT) of porosity % for heat- and microwave-polymerised acrylic resin material. It shows that there is a significant decrease in porosity % between all tested groups (3% and 5%) of ZrO_2 nanoparticles, with the control group at (P value <0.05), as shown in Figure 3.

A detailed explanation of the independent T test (Tables 4-6) was performed to analyze the water sorption, solubility and porosity of two groups: (Ivoclar, Major) heat-polymerised acrylic resin and Acron MC microwave-cured acrylic denture base materials Acron MC. The test was carried out following the addition of ZrO_2 nanoparticles at three different concentrations: 0%, 3% and 5%. No notable distinctions seen between the two types of acrylic denture base materials after the introduction of ZrO_2 nanoparticles (5%) at a significance level of p <0.05.

Table 4. Independent T-test for water sorption(mg/cm^3) of heat-polymerised acrylic resin (Ivoclar, Major) and Acron MC Microwave-cured acrylic denture base materials after adding ZrO_2 Nanoparticles (0%,3%, and 5%),

Groups		N	Mean	Std. Deviation	F	Sig
Control heat-cured		5	0.49784	.0.00441	2.748	0.136
	Microwave-cured	5	0.49162	0.01059		
3%	**heat-cured**	5	0.47334	0.00426	7.977	0.220
	Microwave-cured	5	0.46312	0.00240		
5%	**heat-cured**	5	0.48302	0.00630	3.702	0.910
	Microwave-cured	5	0.48002	0.00336		

*significant difference at P <0.05

Table 5. Independent T-test for solubility(mg/cm^3) of (Ivoclar, Major) and Acron MC Microwave-cured acrylic denture base materials after adding ZrO_2 Nanoparticles (0%, 3% and 5%),

Groups		N	Mean	Std. Deviation	F	Sig
Control heat-cured		5	0.498780	0. 00592	0.589	0.465
	Microwave-cured		0.502600	0.00995		
3%	**heat-cured**	5	0.475680	0.01033	0.032	0.863
	Microwave-cured	5	0.474900	0.00866		
5%	**heat-cured**	5	0.482520	0.00412	4.238	0.074
	Microwave- cured	5	0.486460	0.01059		

*significant difference at P <0.05

Table (6). Independent T-test for the porosity of (Ivoclar, Major) heat-polymerised acrylic resin and Acron MC microwave-cured acrylic denture base materials after adding ZrO_2 nanoparticles (0%, 3%, and 5%),

Groups		N	Mean	Std. Deviation	F	Sig
Heat-cured control		5	0.85950	0.03166	0.262	0.622
	Microwave cured	5	0.84500	0.03005		
3%	**heat- cured**	5	0.74090	0.02603	1.599	0.242
	Microwave- cured	5	0.72426	0.03745		
5%	**heat- cured**	5	0.80464	0.00734	0.325	0.584
	Microwave- cured	5	0.79180	0.009121		

*significant difference at P <0.05

Discussion

In dentistry, the latest recommendations involve improving the properties of acrylic resin by adding fibres, fillers, and nanofillers. Among them, ZrO_2 nanoparticles are the most often suggested to strengthen PMMA [11–13,18-20]. A pair of techniques used during the mixing process helps to explain the dispersion of ZrO_2 nanoparticles inside the PMMA matrix: When ZrO_2 nanoparticles have been added to the monomer instead of powder, physical and chemical approaches can be used, which offers more benefits [28]. Physical methods include melt mixing, ultrasonic vibration, and high-energy ball milling. The chemical technique involves the combination of nanoparticles with the monomer, where the inorganic ZrO_2 nanoparticles form the core and the monomer forms a shell structure through a process called grafting.

The surface of ZrO_2 nanoparticles is chemically changed by the monomer, resulting in a uniform dispersion of ZrO_2 nanoparticles into the polymer. This enables a combined physicochemical preparation and improves the dispersion of ZrO_2 nanoparticles, minimising particle aggregation and phase separation. Several other studies mix ZrO_2 with the monomer to obtain these advantages [16,17].

The water sorption of denture base resin is a crucial characteristic that directly impacts the quality of a prosthesis, the effectiveness of therapy, and ultimately the patient's quality of life. Both the control and experimental groups in this study exhibited levels of water sorption that fell within the standard ADA value No. 12 (2002) [22] for water sorption of denture base materials, which is 32 $\mu g/mm^3$. The process of water molecules being taken up by a polymer is made easier by the polarity of the polymer's molecules, the presence of unsaturated molecules, or the unbalanced intermolecular interactions of the polymer [7, 24]. Water sorption is influenced by the qualities of the water-based environment, the molecular composition of the polymer, and the presence of various additives, resulting in varying degrees of water sorption [24]. The study findings indicate a decrease in water absorption.

This decrease can be attributed to the replacement of hydrophilic resin with zirconia nanoparticles. The presence of these nanoparticles reduces the uptake of water because the diffusion of water molecules through this material is significantly lower compared to that of the PMMA matrix. This reduced water absorption can be attributed to the insolubility of ZrO_2 in water, the improved degree of conversion in the experimental group, the reduction in residual monomer release, the increase in physical cross-linking or the decrease in porosity within the resin matrix [8,9,25].

The water solubility of the denture-base acrylic resin is a crucial characteristic as it signifies the amount of soluble substances that seep out of the polymer matrix. This property directly impacts the quality of the prosthesis and, subsequently, the quality of life [7,32]. The low solubility of the acrylic resin is crucial due to its ability to prevent the leaching and diffusion of excess monomers and additives into the surrounding tissue [21]. The water solubility of a filler in a resin matrix is determined by factors such as the type, size, and distribution of the filler particles, as well as the strength of the bonding between the filler and the resin matrix.

The solubility of a polymeric substance is influenced by the uniformity of its structure. The higher the homogeneity, the lower its solubility [14]. The decrease in solubility is mainly attributable to the reduced development of pores within the polymeric, which may be driven by an accelerated conversion rate and a decrease in monomer concentration [28].

Porosity in acrylic resin is a persistent issue that compromises the structure and diminishes the biological, physical, and mechanical qualities of acrylic resins [30, 31]. The decrease in porosity observed in the experimental group, compared to the control group at a significance level of $p < 0.05$, may be attributed to the interfacial entanglements between PMMA and the incorporated Np. This phenomenon likely contributes to a reduction in microvoids, an improvement in crystallinity, and an increase in polymer dimensional stability [10,12]. Porosity in acrylic resin is caused by various potential problems including air trapping of air during the mixing process, the contraction of monomers during polymerization, the vaporization of monomers during exothermic processes, residual monomer, insufficient mixing, processing temperature exceeding 74°C, and low flask compression [4,5,21].

When comparing the impact of different concentrations of incorporated Np, it was found that the lowest levels of porosity were observed when Np was incorporated at a concentration of 3%. This reduction in porosity can be attributed to the uniform distribution of the incorporated particles, which leads to minimal porosity compared to higher concentrations [10,12,18].

Statistical analysis demonstrated that the inclusion of 3 wt% nano-ZrO_2 yielded the most favourable outcomes in terms of water sorption, solubility, and porosity in the primary hot and microwave acrylic resin. According to studies, the addition of a significant amount, such as 10% ZrO_2 NP or more, leads to an increase in water sorption compared to the control group [16]. One possible reason for the decrease in water absorption, solubility, and porosity might be the capacity of zirconia to undergo a phase shift from tetragonal to monoclinic, known as transformation toughening, which leads to the absorption of energy from cracks.

The growth of ZrO_2 crystals will stop propagation. Research has shown that the presence of pits and fissures in the lamella leads to improved surface characteristics compared to the control group. Furthermore, there is no evidence of nanoparticle aggregation, resulting in a homogeneous distribution of nanoparticles [19,28] and indicating a successful dispersion of ZrO_2 nanoparticles within the matrix.

Additionally, their nanoscale size enables them to effectively occupy the spaces between matrix particles, thereby reducing agglomeration. This may be related to the minimal amount of leftover monomers, which improves the quality of the acrylic resin [15-17]. The microwave-curing approach produces acrylic denture

bases with reduced water sorption, solubility, and porosity compared to the heat-curing method. However, earlier research [5, 31] did not find significant differences between the two methods.

Conclusion

Enhancing the performance of acrylic resin can be achieved by reinforcing it with ZrO_2 nanoparticles. This strategy effectively reduces water sorption, solubility and porosity, observed in both (Ivoclar and Major) as well as Acron MC acrylic denture-based materials based on Acron MC, with concentrations of ZrO2NP of 3% and 5% compared to the control group. The addition of 3% ZrO_2NP results in decreased water sorption, solubility, and porosity compared to the addition of 5% ZrO_2NP. Therefore, it is crucial to disprove the null hypothesis.

Conflict of interest

The authors have no conflicts of interest to declare.

Authors' contributions

RHH & RRA. studied conception and design, methodology, statistical analysis and interpretation of results, original draught manuscript preparation, writing - review & editing. MMS& JA. supervised the work. All authors reviewed the results and approved the final version of the manuscript to be published.

Acknowledgement and funding

No grants or financial support were received from any government or private sector for this study.

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تقييم بعض الخصائص الفيزيائية لإضافة جسيمات أكسيد الزركونيوم (ZrO_2) إلى مواد قواعد الأطقم السنية المصنوعة من الأكريليك الحراري والأكريليك المعالج بالميكروويف

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المستخلص: الخلفية: لايزال امتصاص الماء وذوبانه في الراتنج الأكريليكي لقواعد الأطقم السنية والمساميه مشكلة طويلة الأمد تؤثر على هيكل وخصائص المواد الفيزيائية والميكانيكية للراتنجات الأكريليكية لقواعد الأطقم السنية ، مما يتطلب طرق لتحسين الماده, واضافة الجزيئات النانوية تمثل احدى هذه الطرائق. تهدف هذه الدراسة إلى تقييم ومقارنة بعض الخصائص الفيزيائية (امتصاص الماء وذوبانه والمساميه) بعد إضافة جزيئات ZrO_2 النانوية (0٪ و 3٪ و 5٪) إلى الراتنج الأكريليكي المعالج بالميكروويف (Acron MC)والراتنج الأكريليكي لقاعدة الأسنان المعالج **بـ**الحرارة.(Ivoclare Major) ، تم جمع مجموعة من 120 عينة راتنجية 60 عينة لامتصاص الماء وذوبانه، 60 عينة والمساميه ، n = 10 عينات لكل تركيز لجزيئات ZrO_2 النانوية **.**تم اتباع تعليمات الشركة المصنعة لإعداد العينات لكل مادة. تم تحليل النتائج باستخدام الإحصاءات الوصفية وتحليل التباين (ANOVA) واختبار المدى المتعدد دانكان واختبار **T** المستقل، وأظهرت النتائج أن إضافة جزيئات النانو (3٪ و 5٪) يقلل من امتصاص الماء وذوبانه والتجاويف في البولي ميثيل الميثاكريليت لكل من الأنواع المعالجة بالميكروويف والحرارة من راتنج قاعدة الأسنان الأكريليكية. حيث تُظهر جزيئات ZrO_2 النانوية بتركيز 3٪ أفضل قيم لجميع الاختبارات مقارنةً بالمجموعة الضابطة. الاستنتاجات: يمكن أن يكون تقوية الراتنج الأكريليكي بجزيئات النانو ZrO_2 (3٪ و 5٪) استراتيجية فعالة لتقليل امتصاص الماء والذوبانيه والمساميه ، مما يعزز أداء المادة في تطبيقات مختلفة لكل من راتنج قاعدة الأسنان الأكريليكية المعالج بالميكروويف و المعالج بالحرارة (Acron MCوIvoclar Major).