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(RESEARCH ARTICLE)

The impact of soaking heat-cured acrylic resin's surface roughness in turmeric tamarind solution

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Abstract

Background: Dentures are a solution for the issue of tooth loss. Heat-cured acrylic resin is a common base material for dentures in dentistry. When exposed to acids frequently, the acrylic plate's surface becomes rough. Because of their health advantages, turmeric tamarind herb is commonly taken. *Turmeric rhizomes* and tamarind fruit are used to make herbal turmeric tamarind. The citric acid in tamarind fruit reduces the surface tension of acrylic resin that has undergone heat curing, increasing porosity and roughness.

Materials and Method: 24 heat-cured acrylic resin plates that were pretested and divided into two groups of packed and unpackaged tamarind turmeric herbs were used in the laboratory experiment. The pH value of each group was measured. Each group's 12 samples were soaked for 1, 3, 5, or 7 days before the roughness was gauged and examined.

Result: An analysis of the data using the two-way ANOVA test revealed a significant difference between the length of the immersion and the surface roughness of the heat-cured acrylic resin of 0.023 (0.005). However, the difference between the packaged and unpackaged turmeric tamarind groups was just 0.131 (> 0.005).

Conclusion: The harshness of the heat-cured acrylic resin was altered by the soaked time in the tamarind turmeric herb. The development of roughness can be affected by some factors, including the presence of acids, especially citric acid, liquid absorption, pH, the breaking down of polymer bonds, the level of hydrogen ions, and improper packing methods.

Keywords: Acrylic Resin; Surface Roughness; Turmeric Acid Herb

1. Introduction

Poor dental care and aging are two causes of tooth loss. According to the 2018 Riskesdas, the age increase between 35 and 44 years was 17.5%, and it was 30.6% at 65 years and older. A decline in masticatory function and quality of life, such as psychological issues, can be brought on by tooth loss. Losing teeth can be avoided by wearing dentures [1,2]. Poor dental care and aging are two causes of tooth loss. According to the 2018 Riskesdas, the age increase between 35 and 44 years was 17.5%, and it was 30.6% at 65 years and older. A decline in masticatory function and quality of life, such as psychological issues, can be brought on by tooth loss. Losing teeth can be avoided by wearing dentures [2,3,4]

Acrylic resin is used in 98% of denture bases. Based on how the polymer bonds are activated, there are two different types of acrylic resins: cold-cured and heat-cured. Because it satisfies the denture foundation requirements for being non-toxic, insoluble in mouthwash solutions, good-looking, simple to handle and repair, non-irritating, and modest dimensional changes, heat-cured acrylic resin is frequently utilized [5,6]. The high permeability of heat-cured acrylic

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resin, which makes the process of water absorption simpler, is one of its drawbacks. Because water will be absorbed through the pores of the acrylic resin, the chemical damage it might cause, especially in acidic drinks, can result in roughness [7,8]. Due to technical advancements and the qualities of herbal medicine, it is widely used by the populace in Indonesia. Currently, herbal medicine is available in the form of capsules, powders, and liquid drinks. Turmeric acid, often known as jamu, is a herbal medication that is frequently eaten. The ingredients for herbal turmeric tamarind includes tamarind fruit (*Tamarindus indica*) and turmeric rhizome (*Curcuma domestica* Val.). The tamarind in it gives the fresh flavor of this herb a sour flavor. However, it is believed that the tamarind turmeric herb's acidity level accelerates the polymer's erosion, which results in surface roughness [9,10,11,12].

2. Materials and method

Pre-test and post-test group designs are used in this kind of laboratory experimental study. The sample utilized in this study was a 10x10x2 mm square of heat-cured acrylic resin that had been soaked in both packaged and unpackaged tamarind turmeric herbs. There were 24 samples total, which were split into two groups of 12 each. Based on the variations in the herbs utilized and the soaking times for packaged and unpackaged turmeric tamarind herbs for 1, 3, 5, and 7 days, the sample groups were divided. To lessen the amount of leftover monomer, immerse the material in distilled water for a day prior to soaking for a predetermined amount of time. The samples were pre-tested for roughness after 1 day of soaking, then soaked for 1, 3, 5, and 7 days, before being measured once more to determine the post-test or final roughness value following immersion in packaged tamarind turmeric herbs and non-packaged. employing a surface roughness tester to measure roughness. The tamarind turmeric herb, which will be utilized in this study, was evaluated for its pH level beforehand to determine how much acid was present in the two soaking solutions.

3. Result

Tamarind, turmeric, and herbal soaking solutions, both packaged and unpackaged, were utilized to test the pH, and a pH meter was employed as the measuring device. Table 1 displays the test results.

Table 1 pH test results of packaged and non-packaged tamarind turmeric herbs

No.	Type	Unit	Result	Method
1	Turmeric Tamarind Solution Packaged	ml/150ml	3,1	pH Meter
2	Turmeric Tamarind Solution Non-Packaged	ml/150ml	2,8	pH Meter

According to Table 1's findings, packaged tamarind turmeric herbs had a pH value of 3.1 whereas unpackaged tamarind turmeric herbs had a pH value of 2.8. Table 2 displays the findings of evaluating the average roughness of heat-cured acrylic resin prior to immersion and following immersion for 1, 3, 5, and 7 days.

Table 2 Average of roughness result

Soaking Duration	Roughness (µm)	
	Turmeric Tamarind Solution	
	Non-Package	Package
Start	0.094	0.090
1 Day	0.096	0.092
3 Days	0.103	0.098
5 Days	0.127	0.112
7 Days	0.140	0.115

Once it is determined that the data is homogeneous and normally distributed, a two-way ANOVA design is used. It can be inferred from Table 3's data analysis results using the two-way ANOVA design test that there is a variation in the surface roughness outcomes of heat-cured resin depending on the length of soaking time (p 0.05).

There was no variation in the surface roughness findings of heat cured acrylic resin based on the types of herbal medicines, as indicated by the significant value of p>0.05 for the types of herbal medication. There is no difference in the results of the heat cured surface roughness based on the interaction between the duration of soaking and the type of herbal medicine, as indicated by the significance value of p>0.05 for the interaction between the soaking duration and the type of herbal medicine.

Table 3 Two-way ANOVA design test

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	0.006[a]	7	0.001	2.335	0.076
Intercept	0.292	1	0.292	832.768	0.000
Duration	0.004	3	0.001	4.199	0.023
Type of Solution	0.001	1	0.001	2.532	0.131
Duration * Type of Solution	0.000	3	0.000	0.406	0.751
Error	0.006	16	0.000		
Total	0.304	24			
Corrected Total	0.011	23			
a. R Squared = .505 (Adjusted R Squared = .289)					

4. Discussion

Due to its continued use in dentistry, the acrylic resin employed in this investigation was of the heat-cured variety. Sofya PA, et al. (2016) conducted study on heat-cured acrylic resin by soaking the material in tamarind solution for two days. It is believed that acidic broth exposure causes heat-cured acrylic resin to release the specimen's monomer more readily. Acidic solution also contributes to the increase in surface roughness of acrylic resin that has undergone heat curing because it will infiltrate between the thick polymer chains, weakening the bonds between them. Due to its continued use in dentistry, the acrylic resin employed in this investigation was of the heat-cured variety. Sofya PA, et al. (2016) conducted study on heat-cured acrylic resin by soaking the material in tamarind sauce for two days. It is believed that acidic broth exposure causes heat-cured acrylic resin to release the specimen's monomer more readily. Acidic sauce also contributes to the increase in surface roughness of acrylic resin that has undergone heat curing because it will infiltrate between the thick polymer chains, weakening the bonds between them [11].

The research conducted by Sofya PA, et al (2016), is also in line with the research conducted by Sundari I, et al (2017), who conducted research on heat cured acrylic resin soaked in Ulee Kareng coffee. Sundari I, et al (2017) stated that H+ ions in the acids contained in coffee would cause degradation of the polymer bonds so that some bonds would break away, causing the polymer chains to be disrupted and separated [13]. In the same year, another study was conducted by Sofya PA, et al (2017), the researchers measured the pH of the soft drink solution and obtained a pH of 3.0 which proved that there was a higher increase in roughness in heat cured acrylic resin soaked in soft drink compared to soaked with aquadest. It is believed that the acid component of the coke, which results in the low pH of the solution, is what causes the larger increase in roughness in the immersion of the coke solution. Research by Sofya PA, et al. (2017) is consistent with the findings of this investigation [14]. According to Table 2 of this study, which focused on heat-cured acrylic resin, immersion in non-packaged herbal turmeric caused the resin's surface roughness value to grow the most when compared to immersion in packed tamarind turmeric. This might happen because the non-packaged herbal turmeric solution has a lower pH. Packaged tamarind turmeric herbs have a pH value of 3.1 and non-packaged tamarind turmeric herbs show a pH value of 2.8 [4,6,11].

The tamarind turmeric herb used in this study is made from turmeric rhizome (*Curcuma domestica* Val.) and tamarind fruit (*Tamarindus indica*). The herbs used are packaged tamarind turmeric herbs with the trademark Sido Muncul and non-packaged tamarind turmeric herbs. The content of tamarind in it makes the taste of this herb fresh sour. However, the level of acidity in the tamarind turmeric herbal solution is thought to accelerate the damage to the chemical structure on the surface of the acrylic resin. Fadriyanti O, et al (2018), in her research on heat cured acrylic resin soaked in sodium hypochlorite solution and endophytic mushroom extract proved that acids can cause porosity and affect the surface roughness of acrylic resin soaked for 6 days. In the study of Fadriyanti O, et al (2018), it was also stated that the cause

of roughness apart from the nature of water absorption and the acid content of the soaking solution, roughness can also occur due to an inappropriate acrylic packing process [5].

The study's findings, which were based on Table 2, showed that the surface roughness value of heat-cured acrylic resin increased as soaking times increased from one day to three days to five days to seven days in both packaged and non-packaged tamarind turmeric solution. Surface roughness did not differ between packaged and unpackaged turmeric tamarind herbs, though. The findings of this study are consistent with those of Astiningsih R, et al (2018), who used packaged and non-packaged tamarind turmeric solutions in their investigation on traditional GIC surfaces [15].

The results of this study are consistent with those of Astiningsih R, dkk (2018), who conducted research using packaged and non-packaged sour turmeric solution on conventional GICs. In Astiningsih's research, et al (2018), it was stated that the non-packaged solution contained citric acid sourced from tamarind, and the packaged solution contained a small amount of citric acid added by the manufacturer (Sido Muncul). Citric acid can increase the concentration of hydrogen ions (H+), thus lowering the pH value in the solution resulting in an increase in roughness [15].

In another study conducted by Rifdayanti G, et al (2019), examining the effect of soaking 25% mauli banana stem extract and 12.5% basil leaves on the surface roughness of heat cured acrylic resin, it was explained that acrylic resin is a polymer with a long poly ester form consisting of methyl repeated methacrylate with low polarity. Esters are easily hydrolyzed by acids so that they can cause cracks on the surface of heat cured acrylic resin types. These cracks cause surface irregularities and increase surface roughness. Research conducted by Dewi ZY, et al (2020), in her research on heat cured acrylic resin immersed in alkaline peroxide is in line with the research of Fadriyanti O, et al (2018), which states that acrylic resin has the property of absorbing liquids through a diffusion process, causing expansion on acrylic resins and can affect the polymer chain resulting in surface roughness [3,11,12].

By immersing heat-cured acrylic resin for 3 or 4 hours in Balinese arrack, Wirayuni K. et al.'s findings from a different investigation in 2021 demonstrated that the roughness of the resin changed. Due to the COOH group, which is polar and has hydrophilic qualities, heat-cured acrylic resin can change in roughness. Acrylic resins have a tendency to be very effective at binding or absorbing liquids due to their hydrophilic nature. In order to separate the polymer chains, water molecules will pierce the polymethyl methacrylate chain and fill spaces between the polymer chains. The split polymer chains will result in the formation of porosity, causing the surface of the acrylic resin to become uneven [8].

The latest research conducted by Nugraha P, et al (2022), is also in line with the research of Sofya PA, et al (2017), which says that the pH value affects the level of acidity. The more acidic a solution is, the more H+ ions it contains and causes the degradation of polymer bonds, this was also mentioned by previous research conducted by Sofya PA, et al (2016), and Sundari I, et al (2017). H+ ions will fill the gaps between the polymer chain bonds in the ester group (COOH) and damage the double bond from the C group (C=O) which is owned by the polymer chain. This resulted in the hydrolysis of the ester group and the formation of cracks. These cracks will make the surface of the acrylic resin irregular and increase the surface roughness of the acrylic resin [2,6,8,11]. Acrylic resin has good aesthetic benefits, is biocompatible in the mouth, is reasonably inexpensive, is simple to make, and is easy to clean, according to Noort RV (2013) in his book Introduction to Dental Materials. However, Anusavice KJ (2017) notes that heat-cured acrylic resin has one disadvantage: it has high permeability properties, which can make the process of absorbing water in this acrylic resin more difficult. Diffusion is often the mechanism by which water is absorbed. Water can be absorbed into the matrix by polymer-based materials via a controlled (continuous) diffusion process. Solution particles will penetrate as a result of water absorption, which will change chemical bonds [14].

According to Sakaguchi R (2022), in his book titled Craig Dental Restoration Materials, the hygroscopic expansion process connected to immersion causes water absorption in agreement with Anusavice KJ (2017)'s idea regarding the absorption of water in heat cured acrylic resin. Acrylic resin in a solution that has absorbed water can lessen the stress during polymerization. Roughness is caused by acrylic resin's characteristics, which are affected by its increased water absorption and solubility when it is not adequately polymerized [14,16].

5. Conclusion

This study suggests that the length of time whereby acrylic resin is soaked within 1, 3, 5, and 7 days causes roughness change in resin after heating. Heat-cured acrylic resin soaked with unpackaged tamarind turmeric herbs exhibited the highest increase in surface roughness because of the low pH level. Heat-cured acrylic resin's hydrophilic qualities, hydrolyzed esters, monomer release, polymer chain diffusion process, polymer bond degradation, pH, liquid absorption, incorrect packing, elevated hydrogen ion levels, acid content, especially citric acid in tamarind, and these elements are probably to blame for the resin's rough surface.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

References

[1] Indonesian Ministry of Health. Dental and Oral Health Situation 2019. https://www.kemkes.go.id [Accessed October 5, 2022]

[2] Nugraha PW, Arifin R, Wardhana AS. Effect of kelakai paste (*Stenochlaena palustris*) 30% on surface roughness of heat-cured Aarylic. *Jurnal Kedokteran Gigi.* 2022; 6(2): 66, 68.

[3] Dewi ZY, Isnaeni RS, Rijaldi MF. Differences in surface roughness change of hot polymerized acrylic resin plates and thermoplastic nylon plates after being soaked in alkaline peroxide. *Padjajaran Journal of Dental Researchers and Students.* 2020; 4(2): 154-156.

[4] Sundari I, Rahmayani L, Serpita D. Study of surface roughness between heat cured acrylic resin and nylon thermoplastic soaked in ulee kareng coffee (*Coffea robusta*). *Cakradonya Dent J.* 2019; 11(1): 68-71.

[5] Fadriyanti O, Putri FI, Surya LS. Differences in surface roughness of acrylic resin soaked in sodium hypochlorite solution and endophytic fungal extract *Aspergillus sp* (*Rhizopohora Mucronata*). *Jurnal B-Dent.* 2018; 5(2): 154, 158-159.

[6] Sofya PA, Rahmayani L, Purnama RR. The effect of soft drinks on the surface roughness of heat-cured acrylic resin denture bases*. Jurnal Kedokteran Gigi Padjajaran.* 2017; 29(2): 58, 60-61.

[7] Wirahadikusumah A, Pratiwi D, Andany HC. The effect of packaged drinks on the roughness of removable partial denture bases. *Jurnal Kedokteran Gigi Terpadu.* 2020; 2(1): 27-29.

[8] Wirayuni KA, Saputra IM. Soaking the denture base in hot polymerized acrylic resin in balinese arak drink against surface roughness. *Interdental Jurnal Kedokteran Gigi.* 2021; 17(1): 23, 25.

[9] Army R. Traditional Herbal Medicine is Rich in Benefits: Language Development and Development Agency, Ministry of Education and Culture. 2018: 2-3.

[10] Hamida F, Herdini, Oktaviani R. Microbial contamination on jamu gendong turmeric asam in Pancoran Mas, Depok, West Java. *Jurnal Ilmu Kefarmasian.* 2022; 15(2): 50.

[11] Sofya PA, Ningsih DS, Octaviani Y. The effect of Keu Eung sour sauce on the surface roughness of heat-cured acrylic resin denture bases. *Dentika Dental Journal.* 2016; 19(1): 52-54.

[12] Rifdayanti GU, Arya IW, Sukmana BI. Effect of soaking 25% mauli banana stem extract and 12.5% basil leaves on surface roughness values. *Jurnal Kedokteran Gigi.* 2019; 3(3): 78-79.

[13] Anusavice KJ. PhillipsPhillip's Science of Dental Materials. 10th Ed*.* EGC; 2017: 198-217.

[14] McCabe JF, Walls AW. Applied Dental Materials, 9th Ed. EGC; 2014: 157-175.

[15] Astiningsih R, Irawan B, Noerdin A. The effect of turmeric acid solution on the surface roughness of conventional glass ionomer cement. *Journal of Physics.* 2018; 1073(3): 2-5.

[16] Sakaguchi R, Ferracane J, Powers J. Material Restorasi. Elsevier; 2022: 161-164.