IOSR Journal of Dental and Medical Sciences (IOSR-JDMS)
e-ISSN: 2279-0853, p-ISSN: 2279-0861.Volume 22, Issue 8 Ser.1 (August. 2023), PP 42-46
www.iosrjournals.org

Effect Of Kepyar Leaf Extract (Ricinus Communis) On Transversal Strength, Impact, Surface Hardness Of Heat Cured Acrylic

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Abstract:
Background*: The method of denture disinfection can be done mechanically because it is easy to do and can cover the entire surface of the denture. Clorhexidine is a non-tradiotional denture disinfection and castor leaf extract (Ricinus communis) is a traditional disinfection that has been extensively studied at this time, casator leaves contain compounds that work as antimicrobials but it is possible that these ingredients can effect the mechanical properties of acrylic resin.*
Materials and Methods*: The design of this study was a laboratory experimental design with a post test only design with a control group design. The research results were tested using the univariate test and one-way Anova test.*
Results*: The values of transverse strength, impact strength and surface hardness are still within normal limits and there is a decrease in value in the 2-year immersion simulation.*
Conclusion: *castor leave extract 50% has transverse strength, impact strength and surface hardness values greater than 0.2% chlorhexidine and in a 2 year simulation there is a decrease in value but still within standard limits.*
Key Word*: Heat-cured acrylic resin, desinfection, castor leaves extract*

Date of Submission: 25-07-2023 Date of Acceptance: 05-08-2023

I. Introduction

Dentures are devices used to replace missing teeth and soft tissue around them and function to restore the aesthetics, mastication, phonetics, and functional condition of the patient.[1,2] Chemical disinfection of dentures can be done by immersing them in a cleaning solution.[3] The advantages of chemical disinfection are full accessibility of chemical solutions to all denture surfaces and minimal abrasion, a method that is easy to perform every day.[4] Denture cleaning materials are divided into traditional and non-traditional. One of the most frequently used nontraditional disinfectants is chlorhexidine because it has broad-spectrum antibacterial properties and is the strongest and most stable basic disinfectant.[5] Chlorhexidine has disadvantages, namely it can cause discomfort and has a pH with an acidity degree of around 5.3-5.7 so that long-term use can cause structural changes in the denture such as transverse strength, impact strength, and surface hardness.[6]

The World Health Organization (WHO) recommends the use of materials and substances derived from minerals, animals and plants in maintaining public health, preventing and treating disease.[7] One of the materials that can be used as a denture base disinfectant is castor leaves because they contain tannins, saponins, flavonoid compounds, and ricinoleic acid which act as antimicrobials.[8] Research by Sukmawati et al (2017), states that castor leaves can inhibit growth *Candida albicans* at concentrations of 100%, 75%, 50% and 25% with an average inhibition zone formed at a concentration of 50%, namely 14.98 mm and at a concentration of 25%, namely 12.08 mm so that the inhibition zone belongs to the strong type antimicrobial classification, namely with an area of inhibition zone of 10-20mm.[9] The disinfectant must maintain the properties of the heat-polymerized acrylic resin in order to remain stable.[10] The content of tannins, flavonoids and ricinoleic acid in Castor leaves is a phenolic compound that dissolves in water and has weak acidic properties. Phenol contact on the surface of the acrylic resin will encourage diffusion and chemical destruction through hydrolysis reactions. This condition causes degradation of the polymer matrix resulting in a decrease in the mechanical properties of acrylic resin.[1] Based on this, the researchers wanted to examine the effect of immersing acrylic resin in castorella leaf extract on the transverse strength, impact strength and surface hardness of hot polymerized acrylic resin with a simulation of 1 year and 2 years of use.

II. Material And Methods

Study Design: Laboratory experiment with a post test only research design with a control group design.
Study Location: Sampling was carried out at the Prosthodontics Research Laboratory Faculty of Dentistry USU.
Study Duration: January-March 2023.
Sample size: The samples in this study used heat cured acrylic resin measuring 10mm x 65mm x 2.5mm for the transverse strength and impact strength tests and cylindrical in shape with a diameter of 30 mm and a thickness of 5 mm for the surface hardness test according to ISO 1567: 1999 specifications.[11]
Sample size calculation: Total samples in this study were 90 samples. The sample was divided into 6 groups, with each group consisting of 5 samples. Group 1: samples soaked in distilled water (4 days); group 2: sample soaked in chlorhexidine (4 days); group 3: samples soaked in 50% castor leaf extract (4 days). Group 4: samples soaked in distilled water (8 days); group 5: samples soaked in chlorhexidine (8 days); group 6: samples soaked in 50% castor leaf extract (8 days). The immersion time for heat cured acrylic resin in this study was 4 and 8 days because it was assumed to soak 15 minutes a day for a year and two years.
Procedure methodology

The first is making a mold space using a master model in the shape of 10mm x 65mm x 2.5mm and cylindrical with a diameter of 30 mm and a thickness of 5 mm. The gypsum dough is made by mixing the gypsum with water in a rubber bowl, then stirring it using a spatula. The gypsum dough is put into the bottom cuvette that has been prepared and then vibrated so that the air bubbles come out of the cuvette. The main model is placed on the plaster dough until setting. The gypsum surface of the lower cuvette is smeared with Vaseline and the top cuvette is filled with gypsum dough and then vibrated again so that there are no air bubbles. After the cast is set, the main model is removed and a mold is formed. The plaster surface that has been cleaned is smeared with CMS (could mold seal). The heat cured acrylic resin mixture is stirred in a stelon pot with a monomer and polymer ratio of 3:1 according to the manufacturer's instructions, the acrylic resin is stirred until the dough stage phase and the mixture is put into the mold until it is full. Close the lower cuvette and the upper cuvette and place a plastic cellophane between the cuvettes. Press the cuvette using a hydraulic press with a pressure of 1000psi then the cuvette is opened and the excess acrylic is removed and then the cuvette closed again and carried out a second pressing with a pressure of 2200psi. The cuvette is placed on a manual press and a bolt is attached to the cuvette to keep the cuvette tight. The cuvette that has been filled with acrylic is then put into a water bath for curing for 90 minutes at 70ºC then the temperature is raised to 100ºC for 30 minutes. After the curing process is complete, the cuvette is allowed to cool at room temperature and the sample is removed from the cuvette. Next, the finishing and polishing stages are carried out using a rotary grinding machine using sandpaper under running water to produce a flat and smooth surface.

Preparation of 50% castor leaf extract was carried out by maceration technique. Castor leaves that have been washed with running water are then cut into small pieces and dried in a drying cabinet for 4 days. The dried leaves were ground to a powder using a blender and then the powder was mixed with 70% ethanol solvent with a ratio of 1:10 and soaked for 24 hours with occasional stirring. Then the soaking results were filtered using filter paper and the resulting maserate I was carried out. The same procedure was carried out to obtain macerate II. The filtration results were then evaporated using a rotary evaporator with a temperature of 40ºC. Castor leaves extract 50% is obtained by preparing a suspension solution starting with mixing 0.3% CMC Na 2.1 g in 100 ml of distilled water. CMC Na is sprinkled slowly onto the surface of the distilled water that has been put into the mortar. The mortar was closed and allowed to stand for 15 minutes after that, crushed until homogeneous and removed. Add 350gr of thick castor leaf extract into the mortar then add 0.3% CMC Na little by little until it is homogeneous. The remaining distilled water is added up to 248 ml and crushed until homogeneous. Prior to soaking the acrylic resin, it was soaked in distilled water and put in an incubator at 37ºC for 24 hours to remove residual monomer.

Statistical analysis (10 Bold)

Data was analyzed using SPSS version 22 (SPSS Inc., Chicago, IL). The data normality test was carried out first by using the Shapiro-Wilk test to find out whether the data was normally distributed.
the results are all p values> 0.05 this states that all data is normally distributed, after that homogeneity test was carried out using the Levene test and the results are p values > 0,05 this shows that the data are homogeneous. Because the data is normally distributed and homogeneous, the test is continued using the one-way Anova test to ascertain the significance the significance value of each variable. The level $P < 0.05$ was considered as the cutoff value or significance.

III. Result

Based on the measurements that have been carried out, the following results are obtained:

Table no 1 : Effect of 50% castor leaf extract (*Ricinus communis*) on the transverse strength of denture base acrylic resin heat polymerization simulated 1 and 2 years

Group		Transversal Strength (MPa)		
		n	$\bar{x} \pm$ SD	p
A1	1 year simulation	5	169,89±20,54	p= 0,007*
B1		5	195,66±11,51	
C1		5	205,30±9,25	
A2	2 year simulation	5	152,51±42,88	p= 0,002*
B2		5	169,39±8,08	
C2		5	183,24±5,23	

Table no 2 : Effect of 50% castor leaf extract (Ricinus communis) and 0.2% chlorhexidine on the surface hardness of denture base heat polymerized acrylic resin

Group		S urface Hardness (VHN)		
		n	$\bar{x} \pm$ SD	p
A1	1 year simulation	5	17,07±0,18	p= 0,0001*
B1		5	17,48±0,19	
C1		5	17.96±0,068	
A2	2 year simulation	5	14,93±0,36	p= 0,0001*
B2		5	15,77±0,13	
C2		5	15,97±0,13	

Table no 3 : Effect of 50% castor leaf extract (Ricinus communis) and 0.2% chlorhexidine on the impact strength of denture base heat polymerized acrylic resin

Group		Impact Strength (x 10^{-3} J/mm$^{2)}$		
		n	$\bar{x} \pm$ SD	p
A1	1 year simulation	5	18,099 ± 2,754	p= 0,947
B1		5	18,575± 5,116	
C1		5	17,882 ± 0,796	
A2	2 year simulation	5	15,960 ± 0,984	p= 0,422
B2		5	17,406 ± 3,185	
C2		5	15,160± 3,134	

Prior to carrying out the one-way ANOVA test to see whether there was an effect of disinfection of denture base heat polymerized acrylic resin with distilled water, chlorhexidine and 50% castor leaf extract (Ricinus communis) on transverse strength, impact strength, and surface hardness, data normality tests were carried out first. formerly. The results of the normality test using the Shapiro-Wilk test obtained normally distributed data with a significance value of p> 0.05. Then a homogeneity test was carried out using the Levene test and it was found that the data obtained was homogeneous p>0.05. Furthermore, the analysis can be continued using one way Anova.

Tables 1, 2 and 3 can be seen the difference in the mean transverse strength and surface hardness after immersion for 4 and 8 days. It can be concluded that after the one way ANOVA test was carried out, the transverse strength and surface hardness values were significantly affected by distilled water, chlorhexidine, and 50% castor leaf extract, it was known that the p value <0.05. The results of the impact strength test stated that immersion in 50% castor leaf extract did not have a significant effect, it was known from the results of p value> 0.05.

IV. Discussion

Tables 1 and 2 show the results showing that there was an effect of soaking 50% castor leaf extract and 0.2% chlorhexidine on the transverse strength and surface hardness of immersion simulations of 1 year and 2 years. There is a difference in the value of each sample, this is due to the way the material is manipulated which causes a difference in thickness in each sample. When manipulating materials, there are things that cannot be predicted, namely during the polishing process there is depletion of the acrylic plate sample and manual stirring

techniques which cause the air in the polymerized acrylic resin matrix to be hot so that it becomes porous which can affect the mechanical properties of hot polymerized acrylic resin.[12] This is because 50% of castor leaves extract contains tannins, flavonoids, which are acid polyphenolic compounds that can react with polymethyl methacrylate ester compounds in acrylic resin, and then a hydrolysis reaction occurs from the meeting of the two compounds. Acid contact with acrylic resin can cause the surface of the acrylic resin to become weak and dissolve easily, this can cause pores on the surface of the denture and make it easier for phenol compounds to penetrate the acrylic resin. castor leaf extract also contains saponins which can affect the mechanical properties of acrylic resin. The content of saponins has a glycosyl group as a polar group and triterpenoids as a non-polar group that is active on its surface. This polar-non-polar group will form soap-like foam when in contact with water and also acts not only as a detergent but also as a detergent denture cleaners by releasing CO2. The release of CO2 results in an oxidation reaction which can disrupt the electron conjugation of the polymethyl-methacrylate bond chain and subsequently change the chemical structure of the acrylic resin. Changes in the chemical structure of acrylic resin resulted in a decrease in transverse strength and surface hardness but in 50% castor leaf extract the content of tannins, flavonoids, and saponins was only in small amounts so that it did not affect the transverse strength and surface hardness.[13] This is in accordance with Puspitasari's research (2019), the transverse strength value of acrylic resin in immersion of Mauli banana extract was 50% higher when compared to acrylic resin soaked in 0.2% chlorhexidine for 5 days (1 year immersion simulation). The mauli banana extract contains the same active compound as the castor leaf, namely tannins.[13]

Disinfectant 0.2% chlorhexidine has an acidic pH of about 5.3-5.7. The acidic nature of chlorhexidine shows that it contains more H+ ions. Absorption of water by the resin matrix causes H+ ions from chlorhexidine to be absorbed into the resin matrix and will react with the ester group on the dimethacrylate monomer to form alcohol and carboxylic acid molecules which can increase the degradation of the acrylic resin matrix. Dimethacrylate monomers that bind to H+ ions will be disconnected from the polymer chain resulting in the induction of hydrolysis of the resin matrix components and expansion of the material so that the polymer separates into monomers and oligomers cause softening of the matrix. This degradation resulted in a decrease in surface hardness. Another component of chlorhexidine that also affects the surface hardness of the hot polymerized acrylic resin base is the chlorite component. Chlorite has a chemical damaging effect which causes degradation of ethylene glycol dimethacrylate as a cross-linking agent in acrylic resin which affects the decrease in the surface hardness of the acrylic resin base.[14]

The transverse strength and surface hardness values of the acrylic resin group disinfected with distilled water (A1, A2) were lower than the 50% castor leaf extract and 0.2% chlorhexidine disinfection group. This is because distilled water is pure water with a water content of 100% which only consists of H2O molecules, while the castor leaf extract has a water content of 49%, chlorhexidine has a water content of 99.8% and acrylic resin has one property that is easy to absorb liquids which is supported by Annusavice's statement that acrylic resin will experience saturation when immersed in water.[15] In table 3, the results of the study showed that there was no significant effect on the impact strength of the acrylic resin in immersion simulations of 1 and 2 years. The impact strength value of the heat polymerized acrylic resin in group C1 was lower than group B1 and the impact strength value in group C2 was lower than group B2, this was due to the presence of phenolic compounds contained in the castor leaf extract (Ricinus communis). The tannins contained in the Castor castor leaf extract are ingredients which is antiseptic by the presence of pyrogallol groups and galoil groups which are phenol groups. Phenol in contact with acrylic resin will show an increase in weight due to water absorption and chemical effects on the surface morphology of the acrylic resin. Phenol will penetrate into the acrylic resin plate and cause the termination of long polymer chains. Long polymer chains that break will result in decreased intermolecular bonds thereby reducing the strength of the acrylic resin including impact strength. This is in line with Setyohadi's research (2017) that the tannin and chloride compounds contained in miswak powder can penetrate into acrylic resin plates and degradation of long chains of acrylic resin polymers occurs. Chloride contained in miswak can inhibit the growth of calculus, remove stains and can affect polymer chain bonds.[16]

In this study it was also seen that there was a decrease in the 50% castor leaf extract disinfection group simulated 1 year (C1) with the 50% castor leaf extract group simulated 2 years (C2). This is because heat polymerized acrylic resin has water-absorbing properties of 0 .69% mg/cm2 and solubility in various solvents, in this study acrylic resin absorbed various substances contained in 50% castor oil leaf extract and 0.2% chlorhexidine for 4 days and 8 days.[17] According to research by Chintya et al (2017), acrylic resin immersed in a disinfection will be affected by its physical and mechanical properties. The solution will be absorbed into the microporosity space in the acrylic resin and the intermolecular bonds will be affected. The longer the immersion time, the more solution particles will be absorbed into it microporosity space of hot polymerized acrylic resin and will cause progressively reduced mechanical strength.[17]

V. Conclusion

Based on the values obtained from this study, it can be concluded that the castor leaf extract 50% extract has a transverse strength value and a surface hardness value greater than 0.2% chlorhexidine and there is a disinfection effect on the transverse strength and surface hardness of the denture base heat polymerized acrylic resin simulations of 1 and 2 years but which had a significant effect on reducing the transverse strength and surface hardness values were disinfection with 0.2% chlorhexidine and there was no significant effect of disinfection of 50% castor leaf extract on impact strength. In the 2 year simulation, there was a decrease in the values of transverse strength, impact strength and surface hardness but were still within the standard limits.

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