Spraying of Rosella Flower Extract on Polyvinyl Siloxane Mold to the Dimensional Stability of the Working Model

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Abstract

An important factor in the manufacture of dentures is the molding procedure. The ADA recommends implementing printed material desinfecion techniques aimed at reducing cross-contamination. The important thing to note is the whether there is a change in the dimensional stability of the work model. The disinfection method recommended is by spraying. This study aims to determine the effect of spraying roselle flower extract and sodium hypochlorite solution on the dimensional stability of the work model.

The sample was a master model made of stainless steel in the form of 2 dental crowns that had been prepared by occlusogingival 8.02 mm, diameter, buccolingual 6.33 mm, and the distance between 2 abutments was 28.25 mm. A total of 30 samples were randomized into 3 groups, namely A without spraying, B spraying with roselle flower extract, and C spraying with sodium hypochlorite The spraying effect on the dimensional stability of the work model was analysed using the one-way Anova test. The standard deviation and mean value of each group were analysed using the univariate test. A significant effect was observed after spraying the roselle flower extract and sodium hypochlorite solution on the dimensional stability of the PVS mold working model and interpretation obtained p-value = 0.0001

Keywords: • Roselle flower extract • Sodium hypochlorite solution • Spraying • Dimensional stability

Introduction

In the manufacture of dentures, the molding procedure is an important aspect. Molding materials have to obtain adequate molds in order to produce a good working model in terms of biologics, mechanics, function, and aesthetics on dentures to be used by patients [1]. Furthermore, elastomeric molding materials are often used to produce molds with accurate and stable dimensions. The ANSI/ ADA specification No. 19 declared it as a hydrophobic molding material. The American Dental Association (ADA) classifies elastomeric molding materials into three types, namely silicones, polyethers, and polysulfides. Silicone molding materials are further subdivided into 2, namely condensation and addition silicon.

One of the major problems frequently encountered in dentist practices is infection control. Cross infection may occur due to the transmission of infectious agents between patients and health workers in a clinic environment. Dental infections may also be transmitted through pathogenic organisms found in the oral cavity.

These microorganisms or pathogenic bacteria may interact with molding materials and become agents that cause infections, such as influenza, pneumonia, Tuberculosis (TB), herpes, hepatitis, and Acquired Immune Deficiency Syndrome (AIDS). One of the methods of preventing cross-infection is by means of self-protection [2]. Furthermore, molds need to be disinfected using appropriate disinfectants within a stipulated duration in order not to change the dimensional stability of the work model.

The American Dental Association (ADA) recommends that molds need to be washed first with water to remove the saliva and blood attached. Molding materials can also be disinfected using the recommended chemicals. The most common disinfecting agents with high effectiveness on pathogenic microorganisms include sodium hypochlorite, chlorhexidine, glutaraldehyde, and hydrogen peroxide.

Spraying of 0.5% sodium hypochlorite effectively prevents cross-infection caused by gram-positive and negative bacteria. Sequel to scientific discoveries, many natural medicinal plants are currently utilized as alternative treatments, such as roselle *(Hibiscus sabdariffa L)* petals. These vegetable active compounds have antioxidant activity due to the phenolics in them. Furthermore, flavonoids are polyphenolic compounds that are fungistatic, bacteriostatic, and function as antibacterials on gram-positive and negative. The spraying 15% concentration of roselle powder as a disinfectant for PVS molds effectively reduced the growth of microorganisms, where the higher the concentration, the less the number of microorganism growth.

Molding outputs and disinfection techniques are important factors which influence the dimensional accuracy of molding techniques. There are two disinfectant methods, namely spraying and immersion. The spraying technique effectively reduces the risk of imbibition in molds. The disinfection of molds by spraying techniques produced smaller dimensional changes than immersion. Recently, the Centers for Disease Control and Prevention also recommended the spraying procedure.

The important factors for consideration in the disinfection process are the efficiency and effect of disinfection on the dimensional accuracy of molding materials. Meanwhile, the factors that cause dimensional changes include hydrophilicity, shrinkage during polymerization, shrinkage caused by temperature changes or errors during material manipulation. In the model, changes in dimensional stability may occur by spraying roselle flower extract as a water-containing disinfectant. The extract will then be absorbed by molding materials with high wettability, Therefore, the material experiences dimensional changes and tends to expand.

The chemical composition contained in the sodium hypochlorite solution can also affect the mold through a complex chemical reaction, especially when high concentrations of disinfectant are used. The expansion setting is also a factor that influences the dimensional stability of measurements made on the work model. In accordance with the ADA specification no 19, a change less than 0.5% in the dimensions of a mold is considered insufficient to produce a distortion, or does not significantly affect the manufacture of dentures or restorations to be made.

Another thing that causes a greater change in dimensional stability is the ability of sodium hypochlorite to bind with sodium phosphate content in order to minimize the liquid or molding material absorption. Therefore, the sodium hypochlorite absorption of the molding material is much greater.

Materials and Methods

This research involved an experimental, laboratory, post-test only control group design. Furthermore, the research was approved by the Health Research Ethical Committee, Medical Faculty of North Sumatra University, and number 872 in 2020.

The population is constituted by the molding result of the master model made of stainless steel in form of 2 prepared crowns. This model was made in line with the provisions of ANSI/ADA specifications, with a height/occlusogingival of 8.02 mm, a diameter/buccolingual of 6.33 mm, and a distance between 2 abutments/interpretations of 28.25 mm. The sample size was the minimum estimation based on Ferdere's formula as follows: (t-1) (r-1) 15. Therefore, the number of samples for each group was determined as (3-1) (r-1) 15, 2 (r-1) 15, r8, 5, r 9, and then set to 10.

In this study, there were 3 sample groups, consisting of one control, and 2 treatments. The control group was A, while treatment group B was disinfected by spraying with 40% roselle flower extract. Furthermore, treatment group C was disinfected by spraying 0.5% sodium hypochlorite. The first stage was the manufacture of physiological molding spoons from self-polymerized acrylic resin on the wax-coated master model. The second involved the molding of the master model with a physiological molding spoon using elastomeric molding material PVS putty & light body/wash. The manipulation of PVS putty molding material was carried out in the same ratio of base and catalyst until the color was homogeneous and even. Molding on the master model was carried out using the two-step technique with cellophane spacers until the putty molding material was hardened. The third stage involved the removal of the cellophane spacer on the putty mold. Furthermore, the fourth stage consisted of filling the molding spoon until it was homogeneous with PVS wash molding material using a mixing gun, and placing it into a physiological molding spoon containing putty molds, and molded onto the master model.

In control group A, after the mold was hardened, it was removed and rinsed with water for 10 seconds then dried with air spray. In treatment group B with roselle flower extract, the mold was sprayed with 3 ml of 40% concentration and placed in a sealed plastic bag for 10 minutes. Afterwards, the mold was rinsed with water and then dried with an air spray. Furthermore, in treatment group C with sodium hypochlorite, the mold was sprayed with 3 ml of 0.5% solution and placed in a sealed plastic bag for 10 minutes. The mold was then rinsed with water and dried with an air spray. Subsequently, duration of 20 minutes was allowed for it to reach elastic recovery. The mold was then filled with type IV (Fuji Rock) hard cast according to the manufacturer's instructions and placed on the vibrator to prevent the formation of air bubbles. Afterwards, the cast model was left until setting for 1-2 hours. This molding was carried out until 10 samples were obtained from each group (A, B, and C), and numbered.

The next step was the measurement of the work model dimensional stability using digital calipers. Furthermore, the percentage change in stability was calculated by subtracting the size of the master model from the dimensions of the physiological model, multiplying by 100, and dividing by the size of the master model.

Results

The results in Table 1 show the dimensional stability value of the work model with varying mean and standard deviations. In the no-spraying or control group (A) the mean and standard deviations in terms of buccolingual, occlusogingival, and interpretation were 0.053% ± 0.048%, 0.051% ± 0.136%, and 0.057% ± 0.037%, respectively. Furthermore, in the 40% roselle flower extract spraying group (B) the mean and standard deviation in terms of buccolingual, occlusogingival, and interpretation were 0.275% ± 0.061%, 0.221% ± 0.136%, and 0.232% ± 0.032%, respectively (Table 1). The mean and standard deviation in 0.5% sodium hypochlorite solution spraying group (C) in terms of buccolingual, occlusogingival, and interpretation were 0.317% ± 0.079%, 0.320% ± 0.128%, and 0.264% ± 0.033%, respectively (Table 2).

The dimensional stability value in group A was smaller and more stable than in the other groups. However, in group C this value was greater compared to other groups, both measured by buccolingual, occlusogingival, and interpretation.

The results in (Table 1) using the one-way ANOVA test showed a significant change in the dimensional stability of the work model in the three groups. This was based on the buccolingual, occlusogingival, and interpretation with a significance value of p=0. 0001 (p<0.05), p=0.0001 (p<0.05), and p=0.0001 (p<0.05), respectively.

No	Dimensional Stability (%)								
	Without Spraying			With Spraying					
				40% Roselle Flower extract			0.5% Sodium Hypochlorite		
	Group A			Group B			Group C		
	(BL)	(OG)	(IP)	(BL)	(OG)	(IP)	(BL)	(OG)	(IP)
1	0.047	0.062	0.071	0.253	0.112	0.216	0.428 **	0.552 **	0.323 **
2	0*	0*	0*	0.269	0.25	0.234	0.317	0.375	0.252
3	0.111	0.1	0.099	0.333	0.388	0.263	0.333	0.225	0.273
4	0.016	0.025	0.028	0.190 *	0.075 *	0.181 *	0.285	0.25	0.241
5	0	0.012	0.007	0.206	0.1	0.192	0.397	0.489	0.302
6	0.063	0.075	0.074	0.397 **	0.438 **	0.284 **	0.349	0.375	0.288
7	0.142 **	0.125 **	0.113 **	0.269	0.125	0.245	0.349	0.263	0.288
8	0.095	0.062	0.081	0.317	0.35	0.256	0.253	0.2	0.22
9	0.047	0.037	0.057	0.285	0.275	0.248	0.317	0.325	0.253
10	0.016	0.012	0.042	0.238	0.1	0.206	0.142 *	0.150 *	0.213 *

Note: *=the smallest value, **=the greatest value

Table 1: Dimensional stability values of work models without spraying, spraying of 40% roselle flower extract and 0.5% sodium hypochlorite solution for 10 min test.

Dimensions	Dimensional Stability (%)			
	Group	Number (n)	X	p
Buccolingual	A	10	0,053 ± 0,048	0,0001*
	B	10	0,275 ± 0,061	
	C	10	0,317 ± 0,079	
Occlusogingival	A	10	0,051 ± 0,136	0,0001*
	B	10	0,221 ± 0,136	
	C	10	0,320 ± 0,128	
Interpretation	A	10	0,057 ± 0,037	0,0001*
	B	10	0,232 ± 0,032	
	C	10	0,264 ± 0,033	

Note: *significant

Table 2: The effect of spraying 40% roselle flower extract and 0.5% sodium hypochlorite solution on the dimensional stability of the work model.

Discussion

The results of this study indicate that the dimensional change value of the work model in group A was smaller than in groups B and C. Meanwhile, in group C, the dimensional change was greater than in groups A and B, whether measured from buccolingual, occlusogingival, or interpretation [3]. This variation in value occurred because rinsing in group A was only carried out with running water. Therefore, the dimensional change that occurred was insignificant.

Differences in the measurement results of dimensional changes in the model may also be due to several factors. Dimensional changes occur because water-absorbing PVS molding materials have high wettability compared to water-repellent molding materials [4]. This high wettability property causes the molding material to absorb more water, thereby leading to an expansion of the molding material in all directions. Consequently, this expansion becomes larger and the sample size of the model becomes smaller, which causes dimensional changes.

The pressure that occurs during molding is another contributing factor, specifically the occurrence of human error. In (Table 2), the one-way ANOVA showed that there was a significant effect of the samples sprayed with roselle flower extract and sodium hypochlorite solution seen from the buccolingual, occlusogingival, and interpretation. The existing changes in dimensions were insignificant (less than 0.5%), and still in accordance with the provisions of ADA No. 19. Based on this provision, it is not sufficient to produce a major distortion or effect on the manufacture of dentures or restorations to be made.

The effect on the dimensional stability of the work model can be seen from smaller sample dimensions. This is due to other contributing factors, such as the length of time the disinfectant is in contact with the mold after disinfection, which also causes dimensional changes. Furthermore, these changes occurred due to the re-rinsing of the PVS mold with running water after disinfection using roselle flower extract and sodium hypochlorite, which increased the quantity of liquid absorbed. Another factor involved the expansion of molding materials due to humidity, storage and absence of expansion setting of the cast. The expansion when the hemihydrate becomes dehydrate when the setting builds pressure results in expansion, or the evaporation of water in the gypsum, which reduces its volume. Furthermore, the room temperature of the study site that cannot be controlled during molding and disinfection may have caused the roselle flower extract and sodium hypochlorite to affect dimensional stability.

Group B or the roselle flower extract spraying group experienced a dimensional change because the extract contained water which could be absorbed by molding materials with high wettability. Another cause was the presence of flavonoids in roselle flowers acting as a phenolic compound. Due to the ability of the phenol to evaporate, the extract absorbed by the molding material is reduced and the dimensional changes that occur are smaller [5]. This agrees with previous studies that also utilized natural ingredients as disinfectants in PVS molds where there was an effect in conjunction with betel leaf infusion, on dimensional stability. Betel leaves and roselle flowers have similar contents such as water and flavonoids, but the dimensional changes that occur are tolerable. Meanwhile, group C or the sodium hypochlorite solution spraying group experienced a dimensional change because it worked by releasing hypochlorous acid.

Another factor is that a small sodium hypochlorite concentration of only 0.5% can affect the absorption of sodium hypochlorite. Furthermore, the chlorine present in sodium hypochlorite can degrade important proteins in microorganisms, thereby reducing their attachment to the PVS mold surface.

Conclusion

The results of this study signify that there is a significant effect of spraying 40% roselle flower extract and 0.5% sodium hypochlorite solution on the dimensional stability of the work model molds, but the resulting dimensional change value was less than 0.5%. According to the American Dental Association (ADA) provision No. 19, changes in the dimensions less than 0.5% in value is considered insufficient to produce a distortion in denture manufacturing.

Conflict of Interest

The chlorine works by attaching to the cytoplasm of the microorganism's cells which then destroys the microorganisms themselves.

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