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SOLUBILITY OF TISSUE CONDITIONER AFTER IMMERSION IN PLANT EXTRACT DENTURE CLEANSER CONTAINING CINNAMALDEHYDE

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ABSTRACT

Tissue conditioner (temporary soft denture liner material) could be susceptible to contact with solutions, such as denture cleanser during clinical use, continuous penetration of solution will lead to hydrolysis and dissolution of material components. The functional material could be adversely affected by this solubility. The alternative of plant extract denture cleanser containing cinnamaldehyde, such as cinnamon plant extract (*Cinnamomum burmani*), which has antibacterial and antimicrobial effects, is expected to have less effect on mechanical properties.The aim of this study was to determine the influence of immersion time in cinnamon extract solution on the solubility of tissue conditioner.Twenty-four cylindrical tissue conditioner samples (15 mm x 2 mm (ADA 12)), were immersed in 6 groups: groups A and B, alkaline peroxide immersion (for 7 and 14 days); groups C and D 1.5% cinnamon extract immersion (for 7 and 14 days); and groups E and F, aquadest immersion (for 7 and 14 days). The solubility of tissue conditioner material was evaluated by measuring the weight of the samples after 7 and 14 days of immersion.There was a significant difference between all groups ($p<0.05$). The highest average solubility of the samples was shown by groups B and D followed by groups A, C, F, and E, respectively.There was an effect of immersion time in 1,5% cinnamon extract denture cleanser on the solubility of tissue conditioner.

Keywords: tissue conditioner, solubility, denture cleanser, cinnamaldehyde

1. INTRODUCTION

Coating a temporary soft liners or tissue conditioner on the denture fitting surface allows alveolar mucosal trauma to heal during fabrication of a new denture. During clinical use, this material are vulnerable to contact with several liquids, which is chemical denture cleanser, such as alkaline peroxide.[1] When the tissue conditioner is in contact with the solution, there is continuous liquid penetration, causing hydrolysis and dissolution of the material components.[1,2] As some of the components such as monomers (ethyl methacrylate), softening agents (dibutyl phthalate) and ethyl alcohol dissolve, the functional capabilities of the material may be reduced.[1]

Palasuk et al. found that the immersion of tissue conditioner in alkaline peroxide solution for 1, 7 and 14 days significantly increased their solubility, with the greatest increase in solubility occurring on day 14.[3] The higher concentration of ions (potassium and sodium) in denture cleanser compared to water causes ions to penetrate more polymers, releasing more components.[3,4] This resulting can affect the physical and mechanical properties of material, such as reducing the durability period of the tissue conditioner.[1,2,5]

Cinnamon (Cinnamomum burmannii) is a natural ingredient that can be used as an alternative denture cleanser. Cinnamon essential oil is the major source of cinnamaldehyde, which is an antifungal agent. [6-8] Pristianingrum et al found that a concentration of 1.5% cinnamon extract denture cleanser is a recommended to inhibit the growth of Candida albicans.[9] This extract can also affect the physical and mechanical properties of tissue conditioner material. Oliveira et al. found that cinnamon extract had less effect on acrylic resin hardness compared to the chemical test group (nystatin).[7]

This study aims to determine solubility of tissue conditioner after immersion in cinnamon extract denture cleanser containing cinnamaldehyde. It can be used potentially as an alternative denture cleaning agent that has antifungal and less effect on the solubility of tissue conditioner.

2. METHOD

This study was an experimental laboratory study with *post test only control group design* approach. The sample size is based on the following Federer formula:

$$(t-1)(r-1) > 15$$
$$(6-1)(r-1) > 15$$
$$(5r-5) > 15$$
$$5r > 20$$
$$r > 4$$

Description:
t = Sample size
r = Sample size for each group

In this study, the number of samples were 4 subjects for each groups, the total samples were 24 subjects. Twenty-four cylindrical tissue conditioner samples (15 mm x 2 mm (ADA 12)) (GC Soft liner Co, Tokyo, Japan) (Figure 1).

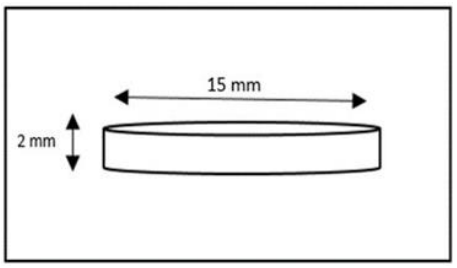

Figure 1. Sample design.[2]

All samples were dried in a desiccator for 24 hours and then weighed on an analytical balance until a constant weight was reached. This was taken as the initial weight of the sample (W1) when a stable result was obtained.

Samples were immersed in 30 ml artificial saliva/group, soaked for 16 hours (daily clinical denture use) and rinsed with distilled water for 1 minute.

Samples were immersed (5 minutes/day) in 6 groups: groups A and B, alkaline peroxide immersion (for 7 and 14 days); groups C and D 1.5% cinnamon extract immersion (for 7 and 14 days); and groups E and F, aquadest immersion (for 7 and 14 days). After immersion, samples were rinsed with aquades for 1 minute and then placed in 30 ml distilled water for 8 hours (storage overnight). Immersion in artificial saliva, aquades and treatment groups were changed daily. After the final immersion, the samples were rinsed with water and dried. The last solubility test (W2) was performed after soaking in each group (same procedure as W1).[5,10]

Sample solubility was calculated using the American Dental Association (ADA) formula. [5,10]

Formula of solubility:

$$\text{Solubility (mg/cm}^2) = \frac{W1 - W2}{\text{Surface area}}$$

W1 : initial weight of the sample
W2 : Weight after soaking and drying

Surface area calculation:

$$2\pi r\,(h + r)$$

π = 3,14
r : the radius of the specimen
h : the specimen thickness

3. RESULTS

The results of this study showed that the highest average solubility of tissue conditioner was identified in group B (alkaline peroxide for 14 days) and the lowest was identified in group E (aquades for 7 days). Data normality test were used the Shapiro-Wilk test with the results of normally distributed data (p> 0.05). After that, Levene's test were used and the results of homogeneous data were obtained (p> 0.05). The data was forwarded to the one way ANOVA test (Table 1).

Table 1. Results of the one-way ANOVA test for solubility between groups

Group	n	$\underline{X} \pm$ Sd (mg/cm^2)		Sign.
		7 days	14 days	
A & B	8	1,5978 ± 0,1175	2,1175 ± 0,1584	
C & D	8	1,3017 ± 0,0460	1,7152 ± 0,0760	0,000
E & F	8	0,8827 ± 0,0902	1,2794 ± 0,1005	

Based on table 1, the results of the study showed differences between the groups (p<0.05). Bonferroni's post hoc test showed that there were significant differences on solubility of tissue conditioner between groups (p<0.05). (Table 2).

Table 2. Results of the *post hoc* test for solubility between groups

Group	A	B	C	D	E	F
A	-					
B	0,000*	-				
C	0,001*	0,000*	-			
D		0,000*	0,000*	-		
E	0,000*	0,000*	0,000*	0,000*	-	
F	0,000*	0,000*		0,000*	0,000*	-

4. DISCUSSION

The weakness of clinical tissue conditioners is that on contact with liquids, such as the commonly used alkaline peroxide cleanser, the material components can dissolve.[2,11] This study was found a significant difference in solubility between immersion groups. All groups had significant weight loss after desiccator drying. Solubility can be caused by the presence of similar compounds, for example a polar solvent will readily dissolve with polar materials, raising the pH and adding a solvent. [12] Solvent molecules penetrate the polymer chains, occupying the space between the polymer chains, causing them to separate.

Based on degradation theory, material immersed in water absorbs water molecules and penetrates the intermolecular spaces of the polymer chains, reducing polar interactions. At this point, there is a significant decrease in material weight due to dissolved material components. [13] The highest average solubility was found in the 14 days immersion group. The longer the immersion time, the more water penetrates the material, weakening the bonds between the materials and increasing solubility. [2, 3, 14]

The solubility of the tissue conditioner was highest in the alkaline peroxide immersion group for both 7 and 14 days. The high concentration of ions (potassium and sodium) from the alkaline peroxide solution causes more ions to penetrate the polymer, releasing more material components. [4] The alkaline peroxide in tablet form used in this research, when mixed with water, will produce hydrogen peroxide. The peroxide decomposes and oxygen bubbles are released, it breaks down and dissolves organic deposits and kills microbes, penetrating into the polymer bonds and weakening the polymer bonds, resulting in the decomposition (breaking down of macromolecular bonds into simple molecules) of the material surface.[10] This may explain why the solubility of this group was significantly higher than the other groups.

The next highest average solubility was the cinnamon immersion group for 7 and 14 days. Cinnamon extract is phenolic compounds containing cinnamaldehyde

and eugenol.[15] Phenolic are polar compounds and dissolve readily in polar solvents, so the polar phenol solution can reduce the chemical bonds of the tissue conditioner and weaken the secondary polymer chains, causing the polymer chains to separate and dissolve material components.[14,16] Phenolic compounds are acidic compounds. They can release H+ ions from their hydroxyl groups in water. H+ ions cause degradation of polymeric bonds, resulting in dissolution of the tissue conditioner components. [13,15] Choure et al. showed that the solubility of the tissue conditioner material was affected by immersion in a solution with phenolic compounds as the major component.[14]

The lowest average tissue conditioner solubility was found in the aquadest immersion group for both 7 and 14 days. Aquades breaks down into OH- ions and H+ ions. OH- ions will diffuse to the surface of the tissue conditioner causing relaxation between the polymer chains, resulting in hydrolytic degradation and dissolution of the material components. The solubility of this group was lower than the other groups because aquadest is a neutral pH solution , so the rate of hydrolysis in solution is lower.[13]

The standard solubility of tissue conditioner samples, based on ADA Specification #12, should not exceed 0.04 mg/cm2 after 7 days.2 In this study, the average solubility of cinnamon in the 7-day immersion group was 1.301, which is higher than the specification. In this study, the area of the sample was smaller than the clinical application of tissue conditioner on the denture base fitting surface. The smaller area, the more surface area in contact with the fluid, resulting in faster dissolution. [17] In clinical use, the wetting (wettability) of the tissue material conditioner between the denture base fitting surface and the mucosa is only lubricated by a thin layer of saliva, but in this study the sample was soaked in saliva, which may also affect the solubility of the tissue conditioner. [4,18] Saliva is ionic and based on polar solvents (water), which can promote diffusion of ionic processes and polar components dissolved in saliva solution. [2,5]

4. CONCLUSIONS

There was an effect of immersion time in 1,5% cinnamon extract denture cleanser on the solubility of tissue conditioner. Further study is needed on the solubility of material with suitable sizes for clinical use of tissue conditioner applied to denture bases.

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