Majalah Kedokteran Gigi Indonesia
Vol 10 No 3 – December 2024
ISSN 2460-0164 (print), ISSN 2442-2576 (online)
Available online at https://jurnal.ugm.ac.id/mkgi
DOI: http://doi.org/10.22146/majkedgiind.98582

RESEARCH ARTICLES

Effect of 10% lemongrass (*Cymbopogon citratus*) and 3% hydrogen peroxide solution immersion on the dimensional stability of alginate impression

Lenni Indriani*✉, Ike Damayanti Habar, Angelitha Patricia Sonda*****

*Department of Dental Materials and Technology, Faculty of Dentistry, Universitas Hasanuddin, Makassar, South Sulawesi, Indonesia
**Department of Prosthodontia, Faculty of Dentistry, Universitas Hasanuddin, Makassar, South Sulawesi, Indonesia
***Study program of Dentistry Education, Faculty of Dentistry, Universitas Hasanuddin, Makassar, South Sulawesi, Indonesia
*Jl Perintis kemerdekaan, Makassar, Indonesia; ✉ correspondence: lenniindriyani@unhas.ac.id

Submitted: 24th July 2024; Revised: 5th September 2024; Accepted: 16th November 2024

ABSTRACT

Pathogenic bacteria can easily spread through impression materials, especially alginate. One of the chemicals disinfection agents used is hydrogen peroxide and natural disinfection alternatives, such as the decoction of lemongrass leaves. The aim of this study is to determine the effect of immersing Alginate impression in a disinfection solution of lemongrass (*Cymbopogon citratus*) and 3% hydrogen peroxide on the dimensional stability. The samples of this research consisted of 27 alginate impression samples of the upper jaw teeth prepared by manipulating alginate powder with water according to the manufacturer's ratio and a lemongrass solution prepared by boiling 300 grams of lemongrass leaves 3000 ml of distilled water to obtain 300ml of lemongrass leaf decoction. The 27 samples were divided into three groups: the control group soaked in aquadest, one group soaked in 3% hydrogen peroxide, and one group soaked in 10% lemongrass decoction. The dimensional stability was measured by using a caliper for the horizontal dimension and then analyzed by using the Kruskal-Wallis test. This statistical analysis found a p-value of <0.05 in the horizontal dimension, indicating a difference in the horizontal dimensional stability of the alginate impression after immersion among the hydrogen peroxide, lemongrass leaves (*C. citratus*), and control groups. Further comparisons among the groups by using the Mann-Whitney Test resulted in a p-value of <0.05 for all the comparisons among the horizontal dimension of the groups. The dimensional changes of the alginate impression were slightly larger in the immersion of 10% lemongrass solution compared to the 3% hydrogen peroxide solution.

Keywords: alginate impression; dimensional stability; 3% hydrogen peroxide; 10% lemongrass (*C. citratus*) solution

INTRODUCTION

The use of impression materials in dentistry is extensive, especially in the fields of prosthodontics, orthodontics, conservation, and pedodontics. Impression materials are used to obtain detailed images of the condition of the teeth and soft tissue in a person's mouth. Alginate is one of the most common materials used to reproduce the form of teeth and soft tissue in the mouth. This impression material is used in studies and working models to determine the treatment plan to be carried out.[1] A factor that must be considered when using impression materials is the transmission of cross-infection. About 700 types of bacteria are found in the oral cavity.[2] These pathogenic bacteria can easily spread through impression materials, especially alginate as a gathering place for more bacteria than other impression materials. Therefore, it is recommended that impression materials are cleaned first with water to remove saliva and blood attached to the impression materials and then soaked in a disinfectant solution to avoid bacterial contamination before being sent to the laboratory.

One of the disinfection materials used to kill bacteria is hydrogen peroxide (H2O2). Hydrogen peroxide has been used in bleaching, cleansing, and disinfection processes for household and industrial needs. In households, hydrogen peroxide is used for cerumen removal, bleaching, mouthwash, and surface cleaning, and the concentration used is between 3% and 9%.[3] Research conducted by Hatta et al. shows that a significant imbibition

Majalah Kedokteran Gigi Indonesia. December 2024; 10(3): 209-216
ISSN 2460-0164 (print)
ISSN 2442-2576 (online)

effect was found in 0.5% sodium hypochlorite and 0.5% hydrogen peroxide. In comparison, 0.2% chlorhexidine did not showed a significant difference, indicating that chlorhexidine has less imbibition power, resulting in no dimensional changes.[4] The imbibition property of alginate impression is shown by its ability to absorb water when they are in contact, thus making the shape easier to expand. This can lead to changes in the shape or dimensions of the alginate impression, resulting in easy expansion which can cause inaccuracies in the alginate impression, and this is the disadvantage of alginate.[5] Therefore, the impression dimensional stability is paramount in the success of further gypsum model making.

Many natural ingredients have been used as alternative materials besides the chemicals widely used in various needs in the health sector. One of them is the use of natural ingredient from lemongrass leaves (*Cymbopogon citratus*). Lemongrass plants are often used as an anti-inflammatory, antiseptic, and antiemetic agent. The kitchen lemongrass plant contains active ingredients in the form of essential oils, such as citronellal, citronellol, and geraniol.[6] The content of citronella compounds that are responsible for fighting bacteria and can cause protein denaturation are other phenolic compounds and their derivatives as well as polyphenol compounds. Flavonoids fight bacteria by building complex compounds with extracellular proteins. Research conducted by Paiva shows that lemongrass essential oil combined with nystatin can be used as an antifungal in the treatment of orai candidiasis by inhibiting fungal growth.[7] Several antibacterial tests have been conducted using lemongrass oil against various bacteria. Some studies show that lemongrass oil has a better antibacterial ability against gram-positive bacteria.[8] Research conducted by Dian Soraya Tanjung et Al. proves that lemongrass leaf extract at concentrations of 20%, 30%, 40%, and 50% has antibacterial effectiveness against Streptococcus mutans.[9]

Previous studies of changes in the dimensions of alginate impression soaked in such chemicals as 0.5% sodium hypochlorite have been carried out, but there is still a lack of research on changes in the dimensions of alginate impression with 3% hydrogen peroxide and lemongrass leaf solution at a concentration of 10%. Therefore, this study examines the extent of the dimensional changes that occur in alginate impression by immersion in both solutions.

MATERIALS AND METHODS

The research used a laboratory experiment method with 27 upper jaw teeth alginate impression samples divided into 3 groups of soaking materials: one group immersed in a 3% hydrogen peroxide disinfectant solution, one group immersed in a 10% kitchen lemongrass (*C. citratus*) decoction, and a control group, each consisting of 9 samples. Alginate (Hygedent, ISO 21563 EN21563) and lemongrass leaves were the impression materials used. This study has received ethical approval from the Health Research Ethics Committee of FKG-RSGM UNHAS with the number 0132/PL.09/KEPK FKG-RSGM UNHAS/2023.

Process of lemongrass leaf decoction

A total of 300 grams of lemongrass leaves was boiled with 3000 ml of distilled water in a saucepan and simmered until the decoction obtained was reduced to 300 ml. The result of lemongrass leaf decoction was a pure liquid with a concentration of 10% which would be used as a disinfectant, and the concentration was obtained using the following formula:[10]

$$\text{Concentration} = \text{Solute Weight} \times 100\%$$
$$\text{Solvent volume} = \frac{300\ \text{gr} \times 100\%}{3000\ \text{ml}}$$
$$= 10\%$$

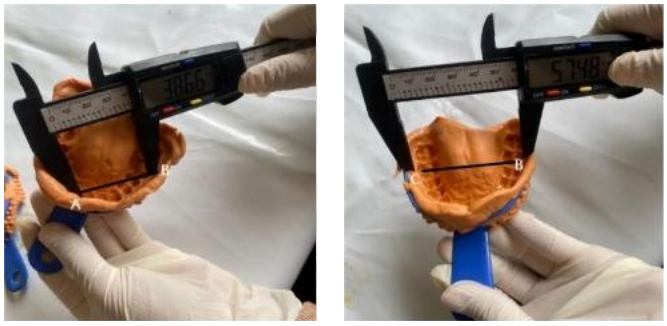
The alginate powder (Hygedent, ISO 21563 EN21563) and water were measured with a measuring spoon and measuring cup provided according to the manufacturer's instructions. The alginate powder and water were poured into a rubber bowl and stirred at a consistent speed with pressure stirring done in the shape of figure eight. The duration of stirring followed the instructions of the manufacturer. Impression of the upper jaw teeth was done until the setting time was reached.

The disinfection technique performed in this study was the immersion disinfection technique using a 3% Hydrogen Peroxide disinfectant solution and a 10% concentration of lemongrass leaf decoction (*Cymbopogon citratus*) and aquadest until all parts of the alginate surface were submerged for 10 minutes.

Measurements were taken after the alginate experienced a setting time and was immersed in the solution. The measurement used a manual caliper with an accuracy of 0.5 mm taken at the printed points. Point A was on the incisor papilla, point B was on the mesial central pit of the right molar, and point C was on the mesial central pit of the left molar. The data analysis of this study used a normality test analysis, namely the Kruskal-Wallis Test and the Mann-Whitney Test.

RESULTS

All the results were collected and recorded, and the data were managed and analyzed using the 16th version of SPSS (SPSS Inc., Chicago, IL, USA). The results of the study are displayed in the distribution table as follows.



(A) (B)

Figure 1. (A) Vertical distance measurement Mesured from poin A to point B, (B) Horizontal distance measurement Mesured from poin B to point C

Table 1. Normality test of average values of vertical and horizontal dimensions by solution type Immersion Solution

Immersion solution type	n (%)	Vertical Dimension Mean + SD	p-value	Horizontal Dimension Mean + SD	p-Value
Hydrogen Peroxide	9 (33.3%)	32.28 ± 0.79	0.805	55.15 ± 0.63	0.663
Lemongrass	9 (33.3%)	32.94 ± 0.46	0.012	68.11 ± 0.65	0.368
Control	9 (33.3%)	32.71 ± 0.33	0.028	59.33 ± 0.96	0.007*
Total	27 (100%)	32.64 ± 1.58		60.86 ± 2.24	

*Shapiro Wilk Test: $p < 0.05$; Data Distribution is not Normal

Table 2. Difference in mean values of vertical and horizontal dimension measurements between hydrogen peroxide, lemongrass, and control solutions

Immersion solution type	Vertical Dimension Mean + SD	p-Value	Horizontal Dimension Mean + SD	p-Value
Hydrogen Peroxide	32.28 ± 0.79		55.15 ± 0.63	
Lemongrass	32.94 ± 0.46		68.11 ± 0.65	
Control	32.71 ± 0.33	0.101	59.33 ± 0.96	0.000*
Total	32.64 ± 1.58		60.86 ± 2.24	

Table 3. Further comparison test of mean values of vertical dimension measurements between hydrogen peroxide, lemongrass leaf, and controls

Immersion Solution (I)	Comparison (J)	Mean difference (I-J)	p-value
Hydrogen Peroxide (32.28)	Lemongrass (32.94)	-0.66	0.101
Lemongrass	Control (32.71)	-0.43	
	Control	-1.09	

*Mann Whitney test: p <0.05: significant

Table 4. Test for the mean values of horizontal dimension measurements between hydrogen peroxide 3%, lemongrass 10% solution and controls

Immersion solution (I)	Comparison (J)	Mean difference (I-J)	p-value
Hydrogen peroxide 3% (5115)	Lemongrass 10% (68.11)	-12.96	0.000*
	Control (59.33)	-4.18	
Lemongrass 10%	Control	-17.14	

*Mann Whitney test: p < 0.05: significant

The results showed that the vertical dimension of the alginate impression after 3% hydrogen peroxide immersion was 32.28 mm, while that in the lemongrass (*C. citratus*) leaf solution was 32.94 mm, and this dimension in the control was 32.71 mm. Meanwhile, the horizontal dimension of the group immersed in hydrogen peroxide solution reached 55.15 mm and 68.11 mm in 10% lemongrass (*C. citratus*) leaf solution while the control had a horizontal dimension of 59.33 mm.

Based on the results of the normality distribution test, or the Shapiro-Wilk test, with a sample of < 50, the p-value was < 0.05 in all the research data, indicating that the research data in the solution groups were not normally distributed. Therefore, non-parametric tests were used in this study.

Table 2 shows the differences in the mean values of vertical and horizontal dimension measurements between the 3% hydrogen peroxide, 10% lemongrass, and control solutions. The results showed that the highest vertical dimension of the alginate impression after soaking was in the 10% lemongrass leaf solution group, which was 32.94 mm. Meanwhile, the 3% hydrogen peroxide group had a lower value, with only 32.28 mm. In the horizontal dimension, the alginate impression after immersion in the lemongrass leaf solution had the highest among others, reaching 68.11 mm, and the alginate impression after soaking in hydrogen peroxide had a lower value, which was 55.15 mm. Based on the results of the statistical test, the Kruskal-Wallis test, a value of p > 0.05 was found in the measurement of the vertical dimension, while the horizontal dimension was found to have p < 0.05. This indicates a significant difference in the values of the horizontal dimension. In contrast, the vertical dimension of the alginate impression shows no differences after being immersed in 3% hydrogen peroxide solution, 10% lemongrass solution, and the control solution. However, the Mann-Whitney test was still conducted to examine further comparisons among the groups.

Table 3 shows the results of further comparisons of the mean values of the vertical dimension measurements among the 3% hydrogen peroxide, 10% lemongrass, and control solutions. The results showed that there was a difference in the size of the vertical dimension distance between the 3% hydrogen peroxide group and the 10% lemongrass decoction group of -0.66 mm as well as between the 3% hydrogen peroxide group and the control group of -0.43 mm. The difference in the size of the vertical dimension was also shown

between the 10% lemongrass decoction group and the control group, which was -1.09mm.

Based on the results of the Mann-Whitney test, the p value was 0.101 ($p > 0.05$) found in all group comparisons. Therefore, there were no differences in the mean value of the vertical dimension measurements among the groups.

Table 4 shows the results of further comparison of the mean values of the horizontal dimension measurements between the 3% hydrogen peroxide, 10% lemongrass, and control solution groups. The results showed that there was a difference in the size of the horizontal dimension distance between the 3% hydrogen peroxide group and the 10% lemongrass decoction group of -12.96 mm as well as between the 3% hydrogen peroxide group and the control group of -4.18 mm. The difference in the size of the vertical dimension was also shown between the 10% lemongrass decoction group and the control group, which was -17.14 mm.

Based on the results of the Mann-Whitney test, the p value < 0.05 was found in all the group comparisons. Therefore, there was a significant difference in the mean value of the horizontal dimension measurements among all groups.

DISCUSSION

Oral cavity is a gathering place for microorganisms, both pathogenic and non-pathogenic, making diseases enter the gastrointestinal area and several internal organ surfaces.[11,12] Therefore, after a jaw teeth impression, the disinfection process on alginate impression is a routine procedure that must be carried out in clinics and laboratories to kill microorganisms attached to the alginate impression.

One of the disinfection techniques used to prevent cross-infection of alginate impression is immersion, where the entire surface of the impression is in contact with the disinfectant solution. The problem that can arise after disinfection is the change in the dimensional accuracy of the impression material. Dimensional stability of the alginate impression is very important because it can have a major influence on the denture manufacturing process.[13] The accuracy and dimensional stability of alginate are paramount to the overall success of alginate impression. The accuracy of alginate can change due to some reasons, including errors during manipulation of the alginate and errors during impression and after impression, such as prolonged soaking and leaving in the open air.[14]

Chemical disinfectants such as sodium hypochlorite, glutaraldehyde, chlorhexidine, and others have been widely used.[15] Many studies have been conducted to observe the dimensional changes that occur after immersion with disinfectants from chemicals. Another commonly used chemical disinfectant is hydrogen peroxide. The results of research by Lepaus et al. show that the use of 3% hydrogen peroxide is effective in reducing Salmonella enterica enteritidis in strawberries.[16] Mohammad Nadjib suggests that lemongrass can inhibit the growth of Candida albicans.[17] The results of the study by Ahmad et al. shows that *C. citratus* extract and its fractions are able to inhibit the tested bacteria, including Gram negative bacteria (Escherichia coli and Pseudomonas aeruginosa) and Gram positive bacteria (Bacillus cereus and Staphylococcus aureus).[18] This study uses lemongrass solution as a natural disinfectant.

Another study of the dimensional changes with immersion of alginate impression in Aloe vera solution and measurements is conducted on a gypsum model. The results show a dimensional change in the anteroposterior of the plaster model.[19] The same results were shown in this study where the size difference in the horizontal dimension of the three research groups was 55.15 mm in the alginate impression soaked in 3% Hydrogen Peroxide solution, 68.11 mm in 10% lemongrass leaf solution, and 59.33 mm in the control (distilled water). Then, the size difference in the vertical dimension of the 3% hydrogen peroxide solution group was 32.28 mm, while in the 10% lemongrass solution it was 32.94, and in the control it was 32.71 mm.

Several factors cause greater dimensional changes in lemongrass leaf solution compared to other solutions, including the compound content in lemongrass leaves, phenol, which can affect the changes in the dimensional stability of the alginate impression. When phenol is in contact with alginate impression materials, an ester formation reaction will occur through bonding with carboxylic acids. The esterification reaction will produce esters and carbon dioxide, while alginate has imbibition properties that can cause expansion in the impression if lemongrass leaves come into contact with alginate. Imbibition (absorption of fluid by a colloid that results in swelling), evaporation, and syneresis (expulsion of a liquid from a gel) result in dimensional changes.[20] In addition, the existence of varying measurement results on each sample in one group can be caused by the measuring instruments used such as the calipers that allow scratches to occur on the distance between the lines to be measured on the impression, resulting in measurement inaccuracies. Permanent deformation can also occur due to pressure during the impression process and when removing the tray from the model.[21]

Alginate is a hydrophilic material that can absorb water in the disinfecting solution and may result in the distortion of the impression. Alginate contains ions such as Na- and So4; therefore, when alginate is immersed in water, osmosis potential will occur, allowing the alginate to absorb water or solution. This osmosis pressure between alginate and solution can cause the alginate to expand or swell.[22] As a result, the difference in the dimensional changes among the 3% hydrogen peroxide solution, 10% lemongrass solution, and control can occur due to osmosis pressure.

The concentration of lemongrass leaf solution used in this study still needs to be further studied to investigate the effectiveness of inhibition against bacteria and fungi and to examine the appropriate length of time for soaking alginate impression to maintain the dimensional accuracy of the impression. This is also considered ass the limitation of this study. However, herbal plants, such as lemongrass, are easy to find and widely used in everyday life, and they have antibacterial properties that can be made into alternative disinfectants if usual disinfectants are not found.

CONCLUSION

The difference in the dimensional changes of alginate impression at vertical distances is insignificant among the immersion in 3% hydrogen peroxide, 10% lemongrass solution, and control. Meanwhile, at horizontal distances, the dimensional changes are greater in the 10% lemongrass solution compared to the other solutions. However, because lemongrass leaf solution has antibacterial properties, it can be used as an alternative material for alginate impression disinfectant.

CONFLICT OF INTEREST

The authors declare no conflicts of interest with the data contained in the manuscript.

REFERENCES

1. Punj A, Bompolaki D, Garaicoa J. Dental impression materials and techniques. Dent Clin North Am. 2017; 61(4): 779-796. doi: 10.1016/j.cden.2017.06.004
2. Kilian M, Chapple ILC, Hannig M, Marsh PD, Meuric V, Pedersen AML, et all. The oral microbiome - an update for oral healthcare professionals. Br Dent J. 2016; 221(10): 657-666. doi: 10.1038/sj.bdj.2016.865
3. Nelson AL, Porte L. Hydrogen peroxide toxicity. StatPearls Publishing. 2023.
4. Hatta LI, Mudrikah M. Imbibition effect on the alginate impression in sodium hypochlorite, chlorhexidine and hydrogen peroxide solutions. Makassar Dent J. 2019; 8(2): 118-120. doi: 10.35856/mdj.v8i2.282
5. Muhammad Arif Malik. Solution in Introduction to general chemistry. Hampton University: Libretext; 2024.
6. Singer L, Karacic S, Szekat C, Bierbaum G, Bourauel C. Biological properties of experimental dental alginate modified for self-disinfection using green nanotechnology. Clin

Oral Investig. 2023; 27(11): 6677–6688. doi: 10.1007/s00784-023-05277-8
7. Eid Abdelmagyd HA, Ram Shetty DS, Musa Musleh Al-Ahmari DM. Herbal medicine as adjunct in periodontal therapies- A review of clinical trials in past decade. J Oral Biol Craniofac Res. 2019; 9(3): 212–217. doi: 10.1016/j.jobcr.2019.05.001
8. De Paiva LF, Teixeira-Loyola ABA, Schnaider TB, De Souza AC, Lima LMZ, Dias DR. Association of the essential oil of Cymbopogon citratus (DC) Stapf with nystatin against oral cavity yeasts. An Acad Bras Cienc. 2022; 94(1): e20200681. doi: 10.1590/0001-3765202220200681
9. Oladeji OS, Adelowo FE, Ayodele DT, Odelade KA. Phytochemistry and pharmacological activities of cymbopogon citratus: a review. Scientific African. 2019; 6: 6-7. doi: 10.1016/j.sciaf.2019.e00137
10. Tanjung DS, Wijaya S, Silaen M. Efektifitas antibakteri ekstrak daun serai (Cymbopogon citratus) konsentrasi 20%, 30%, 40%, dan 50% terhadap Streptococcus mutans. Prima Journal of Oral and Dental Sciences. 2022; 5(1): 17-22. doi: 10.34012/primajods.v5i1.2536
11. Aas JA, Paster BJ, Stokes LN, Olsen I, Dewhirst FE. Defining the normal bacterial flora of the oral cavity. J Clin Microbiol. 2005; 43(11): 5721–5732. doi: 10.1128/JCM.43.11.5721-5732.2005
12. Sampaio-Maia B, Caldas IM, Pereira ML, Pérez-Mongiovi D, Araujo R. The oral microbiome in health and its implication in oral and systemic diseases. Adv Appl Microbiol. 2016; 97: 171–210. doi: 10.1016/bs.aambs.2016.08.002
13. Ningrum WC, Wulansari LK, KusdhanyLS. Dimensional stability of alginate impression materials in the use of electrolyzed oxidizing water as an environmentally friendly disinfectant. J Int Dent Med Res. 2023; 16(1): 8-12.
14. Sastrodiharjo S. Desinfeksi hasil cetakan. Jurnal Material Kedokteran Gigi. 2016; 5(2): 45-51. doi: 10.32793/jmkg.v5i2.251
15. Guiraldo RD, Berger SB, Siqueira RM, Grandi VH, Lopes MB, Gonini-Junior A, Caixeta RV, de Carvalho RV, Sinhoreti MA. Surface detail reproduction and dimensional accuracy of molds: influence of disinfectant solutions and elastomeric impression materials. Acta Odontol Latinoam. 2017; 30(1): 13–18.
16. Lepaus BM, Rocha JS, de SÃO JOSÉ JFB. Organic acids and hydrogen peroxide can replace chlorinated compounds as sanitizers on strawberries, cucumbers and rocket leaves. Food Sci Technol. 2020; 40(Suppl 1): 242-249. doi: 10.1590/fst.09519
17. Boukhatem MN, Ferhat MA, Kameli A, Saidi F, Kebir HT. Lemon grass (*Cymbopogon citratus*) essential oil as a potent anti-inflammatory and antifungal drugs. Libyan J Med. 2014; 9(1): 1-10. doi: 10.3402/ljm.v9.25431
18. Tazi A, Moujahed SE, Jaouad N, Saghrouchni H, Al-Ashkar I, Liu L, et.al. Exploring the bioactive potential of moroccan lemon grass (*Cymbopogon citratus L.*): investigations on molecular weight distribution and antioxidant and antimicrobial potentials. *Molecules.* 2024: *29*(17): 1-22. doi: 10.3390/molecules29173982
19. Trivedi R, Sangur R, Bathala LR, Srivastava S, Madhav S, Chaubey P. Evaluation of efficacy of Aloe Vera as a disinfectant by immersion and spray methods on irreversible hydrocolloid impression material and its effect on the dimensional stability of resultant gypsum cast - an in vitro study. J Med Life. 2019; 12(4): 395–402. doi: 10.25122/jml-2019-0050
20. Guiraldo RD, Moreti AFF, Martinelli J, Berger SB, Meneghel LL, Caixeta RV, Sinhoreti MAC. Influence of alginate impression materials and storage time on surface detail reproduction and dimensional accuracy of stone models. Acta Odontol Latinoam. 2015; 28(2): 156-161. doi: 10.1590/S1852-48342015000200010
21. Bidaya EE, Ritonga PW. Effect of alginate impression disinfection with sodium

hypochlorite and castor oil on Candida albicans counts and dimensional stability of the study model. Indonesian Journal of Prosthodontics. 2022; 3(1): 48-51. doi: 10.46934/ijp.v3i1.36

22. Iwasaki Y, Hiraguchi H, Iwasaki E, Yoneyama T. Effects of immersion disinfection of agar-alginate combined impressions on the surface properties of stone casts. Dent Mater J. 2016; 35(1): 45–50. doi: 10.4012/dmj.2015-163