

The Effects of Natural Disinfectant Solutions on Dimensional Stability of Silicon Impression Material.

Mohammed T. Al-Khafagy

Head of Department of Prosthodontic; College of Dentistry; University of Kufa.

Abstract

Introduction

It is important to disinfect impression to prevent infection. Accuracy is directly proportion to adaptation of the future prosthesis to the oral mucosa. Most of chemical disinfectant solutions are irritant and, therefore inhalation of disinfectant vapor may present risks to the dental team.

Materials and methods

Thirty six high viscosity putty polysiloxane impression were obtained from special designed master model. The impression were grouped according to natural disinfectant solution into lemon juice and apple vinegar solution and then subgroup according to immersion time into 5, 10, 15 min immersion. All impressions were poured with type 4 dental stone then nine measurements were obtained from each cast.

Results

All casts obtained from high viscosity putty polysiloxane impressions which immersed in lemon juice were discarded due to bad surface texture and brittle casts. Statistical analysis reveals no significant differences between master model and casts obtained from pouring high viscosity putty polysiloxane impressions after 5 min with and without immersion in apple vinegar solution while, for 10 min group shows significant differences in 5 measurements and no significant differences in 4 measurement. The 15 min group shows highly significant differences between groups regarding all tested measurements.

Percentages of changes of all casts were increased with time of pouring the high viscosity putty polysiloxane impressions either with or without immersion in apple vinegar solution.

Discussion

Minimizing the risk of disease transmission in the dental workplace has today become a high priority for the dental profession. Dimensional stability of the impression materials used in prosthetics presents an important factor for the accuracy of dental devices.

Generally, the high viscosity putty polysiloxane impressions shows dimensional changes which increased with time of pouring. However, there were no significant differences between casts without immersion and casts immersed in apple vinegar solution for 5, 10, 15 min.

Conclusion

High viscosity putty polysiloxane impressions can be disinfected effectively for uses of primary impression for completely or partially edentulous arches, as well as producing opposing casts in prosthodontics treatment, making interocclusal devices, and surgical guides.

Key words: disinfection, polysiloxane impressions, apple vinegar

Introduction

Dental impressions are very important, because they expose the clinical situation to laboratory personnel, allowing

the fabrication of accurate and representative casts. Accuracy is directly proportional to the adaptation of the future prosthesis to the oral mucosa, which in turn reflects the success of such prosthesis.

During the process of dental treatment, it is important to disinfect impressions as well as equipment to prevent infection.^{1,2} Numerous contagious diseases such as AIDS, hepatitis, herpes simplex I and II, and tuberculosis can be prevented by simple and practicable infection control measures in dental offices and laboratories.^{3,4}

The American Dental Association (ADA) has issued guidelines regarding impression disinfection that stipulate which disinfectants should be used for different impression materials and also specify the dilution, time, and temperature needed for each agent's optimal performance^{5,6} because it has been observed that materials differ widely in terms of the properties of microbial absorption and retention.⁷ The guidelines recommend using an ADA-accepted spray or immersion technique with an approved disinfectant.^{5,6}

However, a recent review concluded that disinfection by immersion is preferred because sprayed disinfectant tends to pool and therefore the entire impression surface may not be adequately covered. This is especially true for hydrophilic and porous materials.^{5,7,8}

On the other hand, it is critical to weigh the effectiveness of the disinfection procedure against possible negative side effects on the material.⁹

Most of the disinfectants used for spray and immersion techniques are irritants and, therefore, inhalation of the disinfectant vapors may present health risks to the dental team; and toxic disinfectants may also result in the corrosion of metal trays or abnormal dislodgement of the impression from the tray.^{10,11}

Studies indicate that 1.2 g/L chlorhexidine is cytotoxic to human fibroblasts in vitro and is able to induce primary DAN damage in leukocytes and oral mucosal cells.¹²

Lemon juice is a natural disinfectant and antiseptic, prior to the development of modern antiseptics, it was used in hospital for this purpose. The juice can be applied directly to the skin, it is an astringent and a bactericide and it is a useful ingredient in home.

Apple vinegar can also use as a disinfectant in dental field, Spano et al.(2009) reported that the apple vinegar is the effective solution for removal of smear layer when used as root canal chelators.¹³

Estrela et al¹⁴ were found that vinegar had an antimicrobial effect against staphylococcus aureus when used in a ultrasonic cleaning system.

Our previous studies revealed that immersion of silicon impression in lemon juice for 20 min and apple vinegar for 5 min were effectively disinfect the silicon impressions against streptococcus and staphylococcus bacteria.²

Regarding the effect of natural disinfecting solutions on the wettability of silicon impression materials, it have been found that immersion disinfection of silicone impression materials in natural apple vinegar is recommended in preference to maintain wettability of silicone rubber impression materials for short disinfection time as well as improve the wettability when used the apple vinegar with Oromamax light. While the natural lemon juice solution may adversely affect the wettability, especially when used for 10, 15 min immersion to disinfect the putty silicon impression material.¹⁵

Several studies have concluded that there is no adverse effect of various disinfecting media on the different impression materials,^{16,17,18} but other studies have indicated adverse effects of disinfectants on the dimensional stability of some impression materials.^{19,20}

However, there have been no investigations on the effect of natural disinfectants on the dimensional stability of polysiloxane impression materials. It has been hypothesized that disinfection procedures will not significantly affect dimensional stability of the resultant stone casts. The objective of this study was to evaluate the dimensional stability of stone casts made from polysiloxane impression materials when these are immersed in natural

disinfectant solutions for different immersion time.

Materials and Methods

For the dimensional stability test, specimens were obtained from impressions of hot-cure acrylic master model that represented dental arch. Reference points for the measurements consisted of three cones, one of them located in the anterior region and two other symmetrical points in the left and right posterior regions. The master model was specially designed from modeling wax and converted to hot-cure acrylic by traditional flasking technique (figure 1) Special acrylic resin trays were fabricated on the artificial stone cast of the master model which provided a uniform 2-mm thickness of the impression material. To make special tray, 2 sheets of softened base-plate wax were adapted on the artificial stone cast to a thickness of approximately 2.5 mm and was then trimmed. The light cure sheet was adapted on the duplicate stone cast and was then trimmed. Photopolymerization of the materials was achieved with a Triad visible light curing unit (Vertex-Dental Netherland). The polymerized tray was trimmed, and the master model was tested for the tray to ensure a consistent surrounding space.

The materials used in this study are those that are commonly used in clinics and laboratories in our environment. These included master model hot-cure acrylic (Vertex-Dental Netherland), light-cure plastic special tray (TruTray, Vertex-Dental Netherland), very high viscosity polysiloxane condensation silicon impression material (Zetaplus, Zhermack clinical, Italy), dental stone type 4 (Elite Stone, Zhermack technical, Italy), electronic vernier caliper (Meter 8. Com, China). Natural disinfectant solutions include commercially available apple vinegar and lemon juice solution (Zer. Com, Turkey).

Polysiloxane impressions of the master model were made according to manufacturer's instructions and lifted on the master model for an extra minute before separation. The impressions were fabricated by one operator in a manner that closely approximated steps used in the clinical setting. Extreme care was taken to apply the same amount of material into the special tray for each sample. The same seating pattern of the master model was used for every impression, to achieve a consistent thickness of material.

In order to exclude the effect of time before pouring the impression, the tested samples were grouped as follow:

I/ Lemon juice groups:

A/ Five minutes groups:

1-Control group: three polysiloxane impressions were rinsed under tap water for one minute and air dried and kept for 5 min in well-sealed nylon pack before pouring.

2-Experimental groups: three polysiloxane impressions were rinsed under tap water for one minute, air dried and then immersed in lemon juice for 5 minutes and then washed with distill water before pouring.

B/ Ten minutes groups:

1-Control group: three polysiloxane impressions were rinsed under tap water for one minute and air dried and kept for 10 min in well-sealed nylon pack before pouring.

2-Experimental groups: three polysiloxane impressions were rinsed under tap water for one minute, air dried and then immersed in lemon juice for 10 minutes and then washed with distill water before pouring.

C/ Fifteen minutes groups:

1-Control group: three polysiloxane impressions were rinsed under tap water for one minute and air dried and kept for 15 min in well-sealed nylon pack before pouring.

2-Experimental groups: three polysiloxane impressions were rinsed under tap water for one minute, air dried and then immersed in lemon juice for 15 minutes and then washed with distill water before pouring.

II/ Apple vinegar groups:

A/ Five minutes groups:

1-Control group: three polysiloxane impressions were rinsed under tap water for one minute and air dried and kept for 5 min in well-sealed nylon pack before pouring.

2-Experimental groups: three polysiloxane impressions were rinsed under tap water for one minute, air dried and then immersed in apple vinegar for 5 minutes and then washed with distill water before pouring.

B/ Ten minutes groups:

1-Control group: three polysiloxane impressions were rinsed under tap water for one minute and air dried and kept for 10 min in well-sealed nylon pack before pouring.

2-Experimental groups: three polysiloxane impressions were rinsed under tap water for one minute, air dried and then immersed in apple vinegar for 10 minutes and then washed with distill water before pouring.

C/ Fifteen minutes groups:

1-Control group: three polysiloxane impressions were rinsed under tap water for one minute and air dried and kept for 15 min in well-sealed nylon pack before pouring.

2-Experimental groups: three polysiloxane impressions were rinsed under tap water for one minute, air dried and then immersed in apple vinegar for 15 minutes and then washed with distill water before pouring.

For all 36 impressions, the vacuum-mixed dental stone, obtained from one batch prepared with the recommended ratio of powder to water, was poured into the impressions in a standardized manner. The poured casts were left to set for 1 hour. After being removed from the impressions, casts were allowed to dry for 24 hours before measurements were obtained.

Totally nine different measurements were made in all three dimensions on master and stone models. The measurements were coded in to AB, AC, BC, which represents the distances between the tips of the three cones, and LA, LB, LC, which represents the length of the three cones, and DA, DB, DC, which represents the diameter of the base of the three cones. (Figure 2)

The dimensions of each sample of the master model and the 36 stone casts were measured by a single investigator using electronic vernier caliper. To eliminate any unintentional bias in the measurement process, the casts were coded, and the key coding was kept by a person not involved in performing the measurements.

The percent dimensional change (Δd) was calculated as follows:

$$\Delta d = \frac{\text{Cast measurement} - \text{Control measurement (master model)}}{\text{Control measurement (master model)}} \times 100$$

Statistical Analysis

All the collected data were subjected to computerized statistical analyses with SPSS statistical software for windows (version 22, SPSS Inc Chicago, IL) computer program. The statistical analysis included: **1) Descriptive Statistic** (Mean and Standard deviation). **2) Inferential Statistic** (ANOVA test, LSD test). All hypotheses were tested at $p=0.05$.

Results

General findings

For the all impression disinfected with lemon juice regarding all immersion times (5 min, 10 min, and 15 min) were discarded due to bad surface texture and brittle resulted cast.

The key cod of master model and tested groups shows in table (1).

Mean and standard deviation of the nine measurements of master model (control) and stone casts resultant from pouring the polysiloxane impression as well as stone casts resultant from pouring the polysiloxane impression after immersed in apple vinegar for 5, 10, and 15 min shows in (Table 2, figure 3). The standard deviation of master model was (0) because the numbers of measurements were repeated three times for statistical purpose.

One-way ANOVA test of 5 min groups reveals no significant differences between groups regarding all tested measurements except the length of cone (A) and (B). Table (3)

Multiple comparisons LSD test between master model and stone casts created after pouring polysiloxane impression after 5 min and stone casts created after immersion of polysiloxane impression for 5 min shows in table (4). LSD test reveals no significant differences except in length of cone (A) and (B).

One-way ANOVA test of 10 min groups shows significant differences between groups regarding all tested measurements except the length of (AC), (CB), (LC), and (DA) measurements. Table (5)

Multiple comparisons LSD test between master model and stone casts created after pouring polysiloxane impression after 10 min and stone casts created after immersion of polysiloxane impression for 10 min reveals highly significant differences between master model and stone casts poured after 10 min without immersion, while there were no significant differences between stone casts poured after 10 min without immersion and immersion in apple vinegar for 10 min except there were significant differences in measurements (LA), (DB) and (DC) measurements. Table (6)

ANOVA test of 15 min groups shows highly significant differences between groups regarding all tested measurements. Table (7)

Multiple comparisons LSD test between master model and stone casts created after pouring polysiloxane impression after 15 min and stone casts created after immersion of polysiloxane impression for 15 min reveals highly significant differences between master model and stone casts poured after 15 min without immersion, as well as master model and stone casts created after immersion of polysiloxane impression in apple vinegar for 15 min, while there were no significant differences between stone casts poured after 15 min without immersion and immersion in apple vinegar for 15 min regarding all tested measurements. Table (8)

Mean percentage of changes of tested stone casts regarding all groups shows that 15 min group were higher percentage of changes than 5 and 10 min groups. Table (9) Figure (4)

Discussion

Minimizing the risk of disease transmission in the dental workplace has today become a high priority for the dental profession. Contaminated materials are routinely sent to dental laboratories thus creating an occupational hazard. Microbial contamination of dental materials and prosthesis has been documented by the work of Wakefeld.²¹ Such pathogenic contaminants include bacteria such as *E.coli*, *Staphylococcus aureus*, *Streptococcus mutans*, Yeast and *Candida albicans*.²²

Dimensional stability of the impression materials used in prosthetics presents an important factor for the accuracy of dental devices. Dental impression is the first phase of the complicated sequel of dental device manufacture. Each phase contributes to the overall error of the future work and can lead to poor quality and diminished accuracy. An error made in the early stages of production cannot be corrected in further process, but becomes the source of the new errors. That is why the knowledge of impression materials properties is imperative for dental practice, so that a therapist can choose appropriate mass that corresponds to the present situation.

The majority of this dimensional shrinkage of polysiloxane is due to continued polymerization occurring within the first three minutes of removal of the impression from the mouth.²³

Anusavice²⁴ stated that there are five main reasons to promote dimensional changes in elastomeric materials: polymerization shrinkage, by-product release during condensation reactions, thermal shrinkage due to temperature changes, sorption after exposure to water, disinfectants, or high humidity environments for long periods, and incomplete elastic deformation recovery due to viscoelastic behaviour.

The change in linear dimensions may not be due to change from impression material but rather from factors associated with setting expansion of the dental stone. Under ordinary conditions, low to moderate –strength dental stone have setting expansion of about 0.15% to 0.25%. Typically, over 75% of the setting expansion observed at 24 hours occurs during the first hour of setting.²⁵

Results of this study reveals that the lemon juice was contraindicated as disinfection solution due to bad surface texture and brittle stone cast while, all casts obtained from pouring very high viscosity polysiloxane impression after immersion in apple vinegar solution for 5, 10 and 15 min were have a good surface texture and strength cast like casts obtained from pouring impression without immersion.

Apple vinegar group for 5 min immersion generally, reveals no significant differences between master model and stone cast with and without immersion, while for 10 min group there were significant differences between groups but there were no significant differences between stone casts poured after 10 min with and without immersion in apple vinegar solution.

Same significant differences were observed in 15 min groups and still there were no significant differences between stone casts poured from very high viscosity polysiloxane impression with and without immersion in apple vinegar solution.

Change percentage results revealed that as time of pouring the impression increases, the change percentage increase regarding with or without immersion in apple vinegar solution.

In general over size casts may be related polymerization shrinkage of very high viscosity polysiloxane impression which increases with time, this agrees with Chee and Donovan,²³ and may be related to setting expansion of the dental stone.²⁵

Conclusion

Within the limits of this study it can be concluded that immersion of very high viscosity polysiloxane in lemon juice is not recommended due to bad surface texture and brittle cast, while immersion in apple vinegar solution was not affect such a properties.

Dimensional changes of very high viscosity polysiloxane impression were increased with time either with or without immersion in apple vinegar solution

Clinical significant

The very high viscosity polysiloxane impression can be disinfected with apple vinegar solution for purpose of primary impression for completely or partially edentulous arches, as well as producing opposing casts in prosthodontics treatment, making interocclusal devices, and surgical guides.

References

- 1- Kotsiomiti E, Tzialla A, Hatjivasiliou K. Accuracy and stability of impression materials subjected to chemical disinfection —a literature review. *J Oral Rehabil* 2008; 35:291-299
- 2- Alkafagy MT, Alyasiri IK, Alquriani NT. Disinfection of silicon impression materials by using different natural solutions (in vivo study). *Kofa Med. J* 2010; 13 (1S): 45-51).
- 3- Kotsiomiti E, Tzialla A, Hatjivasiliou K. Accuracy and stability of impression materials subjected to chemical disinfection- a literature review. *J Oral Rehabil* 2008;35:291-9.
- 4- Yilmaz H, Aydin C, Gul B, Yilmaz C, Semiz M. Effect of disinfection on the dimensional stability of polyether impression material. *J Prosthet Dent* 2007;16:473-8.
- 5- Johnson GH, Chellis KD, Gordon GE, Lepe X. Dimensional stability and detail reproduction of irreversible hydrocolloid and elastomeric impressions disinfected by immersion. *J Prosthet Dent* 1998;79:446-53.
- 6- ADA Council on Scientific Affairs and ADA Council on Dental Practice. Infection control recommendations for the dental office and the dental laboratory. *J Am Dent Assoc* 1996;127:672-80.
- 7- Poulos JG, Antonoff LR. Disinfection of impression:methods and effect on accuracy. *N Y Dent J* 1997;63:34-6.
- 8- Rios MP, Morgano ST, Stein RS, Rose L. Effects of chemical disinfectant solutions on the stability and accuracy of the dental impression complex. *J Prosthet Dent* 1996;76:357-62.
- 9- Minagi S, Kojada A, Akagawa Y, Tsuru H. Prevention of acquired immunodeficiency syndrome and hepatitis B, Part III: disinfection of hydrophilic silicone rubber impression materials. *J Prosthet Dent* 1990;64:463-5.
- 10- Wakefield CW: Laboratory contamination of dental prosthesis. *J Dent Prosth.* 1980; 44:143-146.
- 11- Beall FE, Schuster GS, Ruggeberg F. Disinfection and distortion of alginate impression by hypochlorite[abstract] *J Dent Res.* 1990; 69-242.
- 12- Ribeiro DA, Bazo AP, da-silva- franchi CA, Marques ME, salvadori DM. Chlorhexidine induces DNA-damage in rat peripheral leukocyte and oral mucosal cells. *J Periodontal Res.* 2004; 39: 358-361.

- 13- Spano JC Silva RG, GnedesDf, Sousa- NetoMD, Estrela C, Pecora JD. Atomic absorption spectrometry and scanning electron microscopy evaluation of concentration of calcium ions and smear layer removal with root canal chelators. *J Endo.* 2009; 35(5): 727-730.
- 14- Estrela C, Estrela CR, Decurcio DA, Silva JA, Bammonn LL. Antimicrobial potential of ozone an ultrasonic cleaning system against *Staphylococcus aureus*. *Braz Dent J* 2006; 17(2): 134-138
- 15- Alkhafagy MT. Effect of natural disinfecting solutions on the wettability of silicone rubber impression materials. *JKU* 2013; 11 (1): 180-5
- 16- Langenwalter EM, Aquilion SA, Turner KA. The dimensional stability of elastomeric impression materials following disinfection. *J Prosthet Dent* 1990;63:270-6.
- 17- Matyas J, Dao N, Caputo AA, Lucatorto FM. Effects of disinfectants on dimensional accuracy of impression materials. *J Prosthet Dent* 1990;64:25-31.[PUBMED]
- 18- Merchant VA, Herrera SP, Dwan JJ. Marginal fit of cast gold MO inlays from disinfected elastomeric impressions. *J Prosthet Dent* 1987;58:276-9.[PUBMED]
- 19- Thouati A, Deveaux E, Lost A, Behin P. Dimensional stability of seven elastomeric impression materials immersed in disinfectants. *J Prosthet Dent* 1996;76:8-14.
- 20- Johnson GH, Drennon DG, Powell GL. Accuracy of elastomeric impressions disinfected by immersion. *J Am Dent Assoc* 1998;116:525-30.
- 21- Wakefield C W: Laboratory contamination of dental prostheses. *J. Prosthet. Dent.* 1980; 65: 143-146.
- 22- Aeran H, Jurel SK, Dhobhal A. Antimicrobial efficacy of spray disinfectants on dental impressions. *IJDS.* 2010; 2 (6): 10-13
- 23- Chee WWL, Donovan TE. Polyvinylsiloxane impression materials: A review of properties and techniques. *J Prosthet Dent* 1992;68:728-32.
- 24- Anusavice KJ: *Phillips' Science of Dental Materials.* 11th edition. Saunders; 2003:135-60.
- 25- Shaba OP, Adegbulugbe IC, and Oderinu OH. Dimensional stability of alginate impression material over a four hours time frame. *Nig. Ot J. Hosp. Med.* 2007; 17(1): 1-4.

Notes:



Fig 1: Master model



Figure 2: The tested measurements of stone cast in which measurements (AB), (AC), and (CB) represents the distance between the tips of the cons and (L) represent the length of the cone and (D) represent the measurement of the base of the cone.

Figure 3: Histogram of means of tested groups regarding all measurements

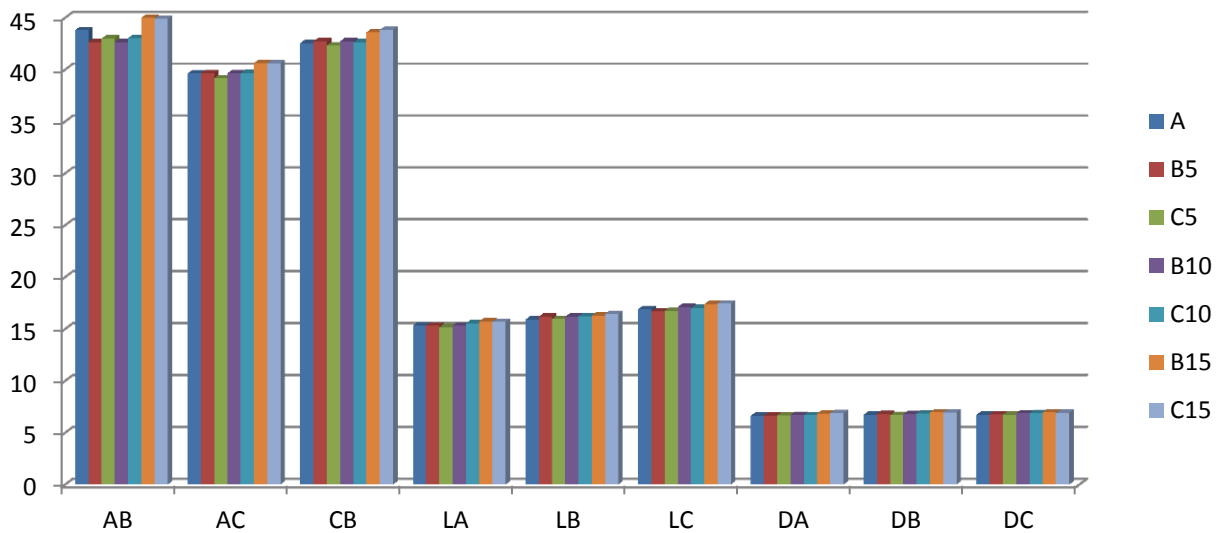
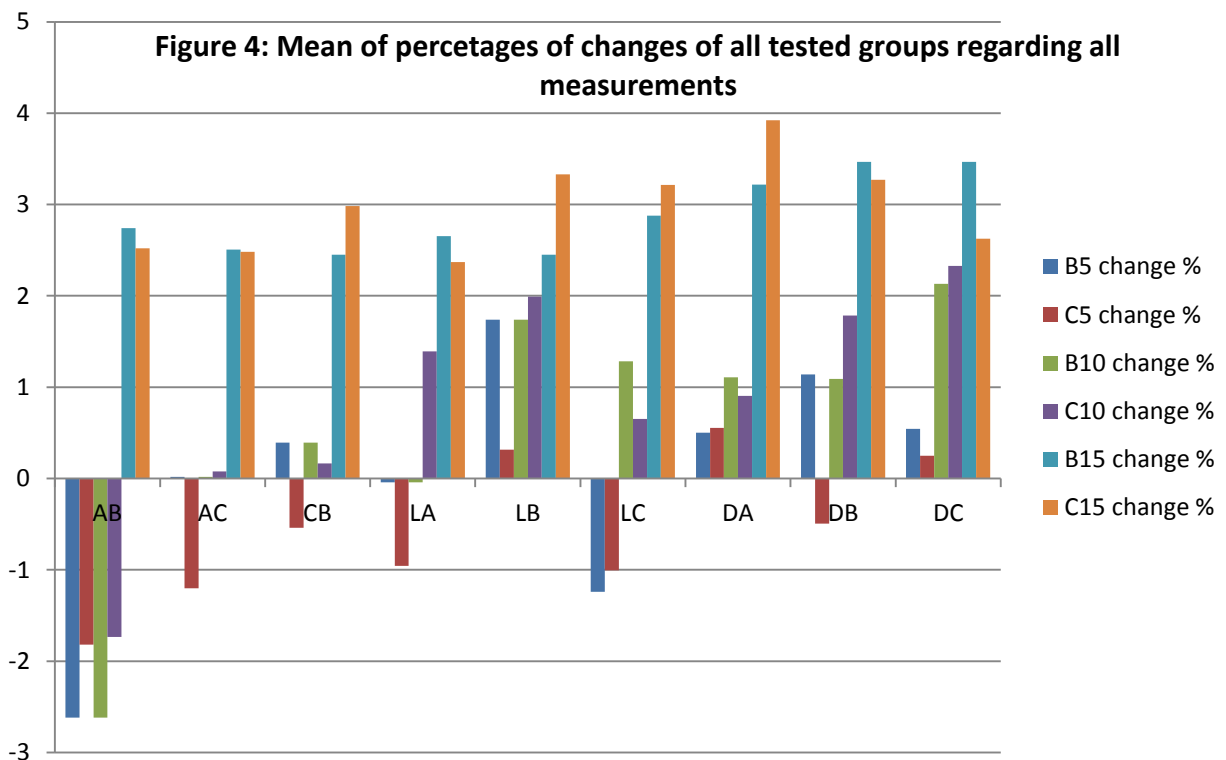


Figure 4: Mean of percentages of changes of all tested groups regarding all measurements



Groups	Cod
Master model	A
Stone cast poured after 5 min (without immersion)	B5
Stone cast poured after immersion in apple vinegar for 5 min	C5
Stone cast poured after 10 min (without immersion)	B10
Stone cast poured after immersion in apple vinegar for 10 min	C10
Stone cast poured after 15 min (without immersion)	B15
Stone cast poured after immersion in apple vinegar for 15 min	C15

Measurements	A		B5		C5		B10		C10		B15		C15	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
AB	43.8	0	42.65333 333	0.035118 85	43.003 33	0.23 1805	42.653 33	0.03 5119	43.04 2062	0.29	45	0.1	44.9 0333	0.09 5044
AC	39.64	0	39.64666 667	0.046188 02	39.163 33	0.20 9841	39.646 67	0.04 6188	39.67 2693	0.24	40.6 3333	0.1357 69	40.6 2333	0.06 3509
CB	42.56	0	42.72666 667	0.030550 5	42.33 4206	0.20	42.726 67	0.03 0551	42.63 688	0.28	43.6 0333	0.1850 23	43.8 3	0.14
LA	15.33	0	15.32333 333	0.040414 52	15.183 33	0.07 0238	15.323 33	0.04 0415	15.543 33	0.01 1547	15.7 3667	0.0472 58	15.6 9333	0.05 7735
LB	15.91	0	16.18666 667	0.005773 5	15.96 6458	0.02	16.186 67	0.00 5774	16.226 67	0.03 0551	16.3	0.0866 03	16.4 4	0.01 7321
LC	16.91	0	16.7 56	0.121243	16.74	0.01	17.126 67	0.02 0817	17.02	0.07 9373	17.3 9667	0.1415 39	17.4 5333	0.05 5076
DA	6.63	0	6.663333 333	0.011547 01	6.6666 67	0.06 6583	6.7033 33	0.00 5774	6.69	0.03 6056	6.84 3333	0.0642 91	6.89 6458	0.02
DB	6.73	0	6.806666 667	0.005773 5	6.6966 67	0.07 2342	6.8033 33	0.01 5275	6.85	0.02 6458	6.96 3333	0.0115 47	6.95	0.03
DC	6.73	0	6.766666 667	0.015275 25	6.7466 67	0.04 9329	6.8733 33	0.02 0817	6.8866 67	0.01 1547	6.96 3333	0.0115 47	6.90 6667	0.03 7859

Table 3: ANOVA test between groups of master model and tested groups regarding 5 min treatment.

Measurements	Sum of Squares	df	Mean Square	F	Sig.
AB	.039	2	.019	.410	.681
AC	.238	2	.119	8.375	.018
CB	.238	2	.119	8.375	.018
LA	.061	2	.031	18.079	.003*
LB	.130	2	.065	266.773	<.0001*
LC	.003	2	.001	2.048	.210
DA	.002	2	.001	.810	.488
DB	.019	2	.010	5.437	.045
DC	.003	2	.001	8.643	.017

Table 4: LSD test between master model and tested groups regarding 5 min treatment.

Measurements	Groups	B5	C5
AB	A	.440	.491
	B5		.928
AC	A	.138	.056
	B5		.007
CB	A	.138	.056
	B5		.007
LA	A	.214	.005
	B5		.001*
LB	A	<.0001*	.008
	B5		<.0001*
LC	A	.318	.090
	B5		.387
DA	A	.336	.294
	B5		.920
DB	A	.066	.368
	B5		.018
DC	A	.011	.011
	B5		1.000

Table 5: ANOVA test between groups of master model and tested groups regarding 10 min treatment.

Measurements	Sum of Squares	df	Mean Square	F	Sig.
AB	2.667	2	1.333	210.159	<.0001*
AC	.088	2	.044	11.655	.009
CB	.139	2	.069	11.126	.010
LA	.073	2	.036	251.385	<.0001*
LB	.178	2	.089	276.862	<.0001*
LC	.094	2	.047	5.709	.041
DA	.011	2	.005	7.806	.021
DB	.022	2	.011	35.286	<.0001*
DC	.031	2	.016	26.547	.001*

Table 6: LSD test between master model and tested groups regarding 10 min treatment.

Measurements	Groups	B10	C10
AB	A	<.0001*	<.0001*
	B10		.188
AC	A	.011	.004*
	B10		.357
CB	A	.007	.006
	B10		.843
LA	A	.001*	<.0001*
	B10		<.0001*
LB	A	<.0001*	<.0001*
	B10		.034
LC	A	.026*	.026*
	B10		1.000
DA	A	.014	.014
	B10		1.000
DB	A	.002*	<.0001*
	B10		.018
DC	A	.001*	.001*
	B10		.872

Table 7: ANOVA test between groups of master model and tested groups regarding 15 min treatment.

Measurements	Sum of Squares	df	Mean Square	F	Sig.
AB	2.667	2	1.333	210.159	<.0001*
AC	1.954	2	.977	130.444	<.0001*
CB	2.753	2	1.376	76.704	<.0001*
LA	.299	2	.150	80.641	<.0001*
LB	.453	2	.226	87.038	<.0001*
LC	.535	2	.268	34.808	<.0001*
DA	.115	2	.058	35.779	<.0001*
DB	.103	2	.052	149.548	<.0001*
DC	.099	2	.050	66.552	<.0001*

Table 8: LSD test between master model and tested groups regarding 15 min treatment.

Measurements	Groups	B15	C15
AB	A	<.0001*	<.0001*
	B15		.188
AC	A	<.0001*	<.0001*
	B15		.892
CB	A	<.0001*	<.0001*
	B15		.084
LA	A	<.0001*	<.0001*
	B15		.264
LB	A	<.0001*	<.0001*
	B15		.015
LC	A	<.0001*	<.0001*
	B15		.459
DA	A	.001*	<.0001*
	B15		.204
DB	A	<.0001*	<.0001*
	B15		.413
DC	A	<.0001*	<.0001*
	B15		.335

Table 9: Mean percentage of changes of tested stone casts regarding all groups

Measurements	B5 change %	C5 change %	B10 change %	C10 change %	B15 change %	C15 change %
AB	-2.61796	-1.81887	-2.61796	-1.73516	2.739726	2.51902588
AC	0.016818	-1.20249	0.016818	0.075681	2.505886	2.48065927
CB	0.391604	-0.54041	0.391604	0.164474	2.451441	2.98402256
LA	-0.04349	-0.95673	-0.04349	1.391607	2.652751	2.37008045
LB	1.738948	0.314268	1.738948	1.990362	2.451288	3.33123821
LC	-1.24187	-1.00532	1.281293	0.650503	2.877981	3.2130889
DA	0.502765	0.553042	1.106083	0.904977	3.217697	3.92156863
DB	1.139178	-0.49529	1.089648	1.783061	3.467063	3.26894502
DC	0.544824	0.247647	2.129767	2.327885	3.467063	2.62506191

The IISTE is a pioneer in the Open-Access hosting service and academic event management. The aim of the firm is Accelerating Global Knowledge Sharing.

More information about the firm can be found on the homepage:

<http://www.iiste.org>

CALL FOR JOURNAL PAPERS

There are more than 30 peer-reviewed academic journals hosted under the hosting platform.

Prospective authors of journals can find the submission instruction on the following page: <http://www.iiste.org/journals/> All the journals articles are available online to the readers all over the world without financial, legal, or technical barriers other than those inseparable from gaining access to the internet itself. Paper version of the journals is also available upon request of readers and authors.

MORE RESOURCES

Book publication information: <http://www.iiste.org/book/>

Academic conference: <http://www.iiste.org/conference/upcoming-conferences-call-for-paper/>

IISTE Knowledge Sharing Partners

EBSCO, Index Copernicus, Ulrich's Periodicals Directory, JournalTOCS, PKP Open Archives Harvester, Bielefeld Academic Search Engine, Elektronische Zeitschriftenbibliothek EZB, Open J-Gate, OCLC WorldCat, Universe Digital Library, NewJour, Google Scholar

