INTRODUCTION

Replacement of missing tooth or lost natural teeth is proficient by removable prosthesis to a great extent. In the past, many materials have been used for construction of these prosthesis. These materials include wood, ivory, and metals. In 1937, polymethylmethacrylate resins (PMMA) were introduced as denture base resins. Because of low cost and relative ease of manipulation, complete and partial dentures are fabricated from these acrylic resins. Dentures act as an indwelling dental device that creates an ideal environment for the growth of pathogenic and non-pathogenic microorganisms. There is a simultaneous increase in the occurrence of denture stomatitis due to an increase in the use of dentures. Contaminated dentures need to be disinfected as part of denture hygiene regimen. Cleaning of the dentures can be accomplished by three well known methods. These are: mechanical, chemical and combination of these two. Commercial denture cleansers may be classified according to their mechanism of action. By soaking the prosthesis in chemical solutions, the dentures can be chemically disinfected. Kumar et al. observed that denture cleansers were highly effective against Candida albicans. The effectiveness of commercial denture cleansers was significantly better than that of household denture cleansers. Chemical disinfection may cause adverse effect on the material, such as denture staining and compromised strength. To avoid adverse effects on the properties of denture base resins, disinfectant must be chosen that should have compatibility with the type of material to be disinfected. Color change of the dental material can lead to poor esthetics. To eradicate possible subjective errors in color assessment, spectrophotometric analysis is obtained as numerical values and it detects the visible light through color spectrum (400 - 700 nm). Interaction of denture cleansers with regard to colour stability of polymethylmethacrylate is important as colour change will lead to unaesthetic appearance of the prosthesis which will not be accepted by most of the patients. It is the prime responsibility of a dentist to prescribe only those cleansers that remove microbial load but would not compromise the color of prosthesis. The null hypothesis was that the denture cleansers did not affect the color stability of heat cure acrylic resin evaluated in the study.
The purpose of the study was to determine the influence of denture cleansers on the color stability of heat cure acrylic resins.

**METHODOLOGY**

It was an in-vitro experimental study conducted at Dr. Ishrat-ul-Ebad Khan Institute of Oral Health Sciences and testing was performed at Al-Karam Textiles, Karachi, Pakistan, from January to April 2012. The material tested in the study was heat-cure acrylic resin (Vertex rapid simplified, Holland).

Seventy two rectangular specimens 13.0 mm in length and 4.0 mm thickness were prepared from stainless steel mould.11 These dimensions were according to the American Society for Testing and Material Standard D 256-06a. Material was polymerized according to manufacturer’s instructions. After heat polymerization, specimens were removed from the mould, the flash was trimmed with a carbide bur and smoothened by the 200 grit sand papers with the help of sandpaper holder. The specimens were polished on a wet rag wheel with pumice slurry. After polishing, all specimens were placed in distilled water at room temperature for 24 hours.

The samples were divided into four groups: Eighteen specimens were measured at baseline (0 day) without immersion in any solution. This was the control group of the study. Eighteen specimens were measured after 60 days of immersion in distilled water; eighteen specimens were measured after 60 days of immersion in Fittydent denture cleaner solution for 10 minutes, (according to manufacturer's instruction) and eighteen specimens were measured after 60 days immersion in Dentipur denture cleaner solution for 10 minutes (according to manufacturer's instructions).

All specimens except the specimens in the control group (baseline) were placed in their respective containers and filled with distilled water. The specimens in the control group were measure at 0 day. After 24 hours the distilled water was discarded and the container was filled with their respective denture cleansers. All the specimens were immersed in solution for 10 minutes. The specimens were washed with distilled water and stored in distilled water. This was repeated twice a day for total of 60 days. Specimens were placed in distilled water during storage. After 60 days, color measurements were carried out using spectrophotometer (Data color 650 plus 9661). Standardization of spectrophotometer is: pulse xenon light source, multiple aperture sizes to accommodate samples of different sizes, and automated specular port. The measurements were performed according to the CIE L*a*b* system and mean values for the material was calculated. In this three-dimensional color space, the three axes are namely L*, a*, and b*. The L* value is a measure of the whiteness or brightness of an object. The a* value is a measure of redness (positive a*) or greenness (negative a*). The b* value is a measure of yellowness (positive b*) or blueness (negative b*). The advantage of the CIE L*a*b* system is that color differences can be expressed in units that can be related to visual perception and clinical significance.12 The level of color change has been quantified by the National Bureau of Standards (NBS). Critical marks of color difference according to NBS are shown in Table I. Following formula is used to express NBS units.13

\[
\text{NBS unit} = \Delta E \times 0.92; \text{ where } \Delta E \text{ stands for color change.}
\]

Data analysis was performed by using Statistical Package for Social Sciences (SPSS) version-16. Shapiro Wilk test was used to check the normality of the data. The data was analyzed by Kruskal Wallis test. One way ANOVA was applied on ranking data for Post Hoc. P-value less than 0.05 were considered as significant.

**RESULTS**

The mean and standard deviation values of the specimens at baseline (control) and when immersed in experimental solutions were shown in Table II. The Fittydent denture cleanser tablets showed highest value of color change as compared to baseline (control) specimens. This was followed by distilled water and by Dentipur denture cleanser tablets in which specimens were immersed for 60 days twice a day simulating 120

<table>
<thead>
<tr>
<th>Critical marks of color difference</th>
<th>Textile terms (NBS unit)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trace</td>
<td>0.00 - 0.5</td>
</tr>
<tr>
<td>Slight</td>
<td>0.5 - 1.5</td>
</tr>
<tr>
<td>Noticeable</td>
<td>1.5 - 3.0</td>
</tr>
<tr>
<td>Appreciable</td>
<td>3.0 - 6.0</td>
</tr>
<tr>
<td>Much</td>
<td>6.0 - 12.0</td>
</tr>
<tr>
<td>Very much</td>
<td>&gt; 12.0</td>
</tr>
</tbody>
</table>

## Table II: Mean and Standard Deviation (SD) regarding color measurement of material after exposure to different media.

<table>
<thead>
<tr>
<th>Groups (colour measurement)</th>
<th>Mean (\Delta E)</th>
<th>Standard deviation (SD)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline (control) n=18</td>
<td>0.0091</td>
<td>± 0.00557</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Distilled water n=18</td>
<td>1.5344</td>
<td>± 0.02833</td>
<td></td>
</tr>
<tr>
<td>Fittydent n=18</td>
<td>1.9428</td>
<td>± 0.04561</td>
<td></td>
</tr>
<tr>
<td>Dentipur n=18</td>
<td>1.5144</td>
<td>± 0.04232</td>
<td></td>
</tr>
</tbody>
</table>

## Table III: NBS values regarding color measurement of material after exposure to different media.

<table>
<thead>
<tr>
<th>Groups</th>
<th>NBS ((\Delta E \times 0.92))</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline (control)</td>
<td>0.008372 (trace)</td>
</tr>
<tr>
<td>Distilled water</td>
<td>1.411648 (slight)</td>
</tr>
<tr>
<td>Fittydent</td>
<td>1.787376 (noticeable)</td>
</tr>
<tr>
<td>Dentipur</td>
<td>1.393248 (slight)</td>
</tr>
</tbody>
</table>
cycles. Shapiro-Wilk test was used to check the normality of the data and it was found that data was not normally distributed. So Kruskal-Wallis test was applied which showed statistically significant difference but with very small p-value (< 0.001). One way ANOVA showed that significant difference was observed among all the groups (p < 0.001). It was further confirmed by post-Hoc Tukey test (Dunnett test) which stated that significant difference was observed when baseline (control) was compared with Fittydent denture cleanser tablets (p < 0.001) in which specimens were immersed for 60 days twice a day simulating 120 cycles. When baseline (control) was compared with Dentipur denture cleanser tablets, statistically significant difference was observed (p < 0.001) in which specimens were immersed for 60 days twice a day simulating 120 cycles. Statistically significant difference was observed when baseline (control) was compared with distilled water (p < 0.001) in which specimens were immersed for 60 days twice a day simulating 120 cycles. According to NBS system (Table III) marked changes were observed when specimens were immersed in Fittydent denture cleanser tablets whereas only slight changes were observed with Dentipur denture cleanser tablets and distilled water.

**DISCUSSION**

For the assessment of aging or damage dental material, color change is a useful indicator for dental operators. Color stability of dental material can be determined by its color stability. Color stability has previously been studied in vitro for a variety of aesthetic restorative materials. Staining can be evaluated visually and by instrumental techniques (colorimeter and spectrophotometer). Color evaluations by visual comparison has been shown to be unreliable as a result of inconsistencies in color perception specifications among observers. Instrumental measurements eliminate the subjective interpretation of visual color comparison. Most commonly used methods to measure color change in dental materials are Colorimeters and spectrophotometers. Spectrophotometers have been shown to be more accurate in measuring the color change than colorimeters as spectrophotometers contain monochromators and photodiodes that measure the reflectance curve of a product's color every 10 nm or less. To eradicate possible subjective errors in color assessment, the present study used a spectrophotometer for color measurements. Color changes were characterized using the CIE L*a*b* system. The CIE L*a*b* color space is currently one of the most popular and widely used color spaces and it is well suited for the determination of small color differences. Based on the data obtained through the spectrophotometer measurement procedure, the null hypothesis tested in this study was rejected. In the present study, the color of heat cure acrylic resins showed noticeable change in Fittydent denture cleanser tablets and slight change in color was observed in distilled water and Dentipur denture cleanser tablets.

The results of present study are in consistent with Peracini et al., who also detected a significant discoloring effect on heat polymerized acrylic resins with denture cleansing agents. Whereas the results are not consistent with the study conducted by Durkan et al. in which the authors did not detect color changes in the PMMA based acrylic resins with the use of denture cleansers. These difference in the results might be due to the fact that the samples were immersed with denture cleansers for 20 days whereas in the present study samples were immersed for longer period of time that is for 60 days. After immersion for 60 days simulating 120 cycles, the results of this study indicate that heat cure acrylic resin was affected more by Fittydent denture cleanser tablets as compared to Dentipur denture cleansers tablets. Fittydent denture cleansers tablet is alkaline peroxide denture cleaner. Paranhos et al. discovered in their study that color alterations were “noticeable” according to NBS, for the alkaline peroxide denture cleansers. However, they immersed the sample in denture cleanser solution for one and half year period. The results of the present study opposes the results of the study conducted by Peracini et al., in which authors found that when samples of heat cure acrylic resins were immersed in denture cleanser tablets statistically significant changes in colour were observed. The denture cleansers tablets used in the study were Corega tablets and Bony Plus tablets. Thirty immersions were performed over a period of 6 days simulating 180 days of cleansing by the patient.

In the present study, heat cure acrylic resin was affected not only by the experimental groups but also by the distilled water, although the color change by distilled water is less than by Fittydent denture cleanser tablets and more than by baseline measurements. This might be due to the fact that the water may ultimately cause irreversible damage to acrylic by the formation of microcracks as a result of repeated sorption/desorption cycles. This results in hydrolytic degradation of the polymer by causing damage to the ester linkages and slow weakening of the infrastructure of the polymer. This leads to the formation of the acrylic zones with different optical properties, which can be esthetically undesirable and can be detected visibly. This could be the possible reason why heat cure resin was affected by distilled water in spite of the fact that like denture cleansers distilled water does not contain any sort of aromatic and preservative agents.

The results of this study indicate that the color stability of denture base resins was influenced by denture cleansers and distilled water. The present study did not
simulate clinical behaviors as it was an in vitro study conducted at room temperature. To overcome this limitation, in vivo study should be conducted in future. Influence of denture cleansers on other properties of heat cure resins should be explored in future. Additionally, relationship between the composition of denture base resin and color stability should be studied in future to appreciate the effect of aging of cleansers solutions on the color change mechanism.

CONCLUSION

Within the limitations of this study, it can be concluded that by immersing the Specimens in distilled water and Dentipur denture cleanser tablets for 60 days simulating 120 cycles can cause slight change in the color of denture base resins. There was noticeable change in color when heat cure resin was immersed in Fittydent denture cleansers solution for 60 days simulating 120 cycles of immersion.

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REFERENCES