Color change measurements of heat cure fiber reinforced acrylic resin denture base. A comparative study

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ABSTRACT
Background: The aim was to find out the effect of different food beverages on fiber reinforced acrylic resin in comparison with conventional acrylic resin.
Materials and Methods: Acrylic blocks were made by incorporation of glass fibers into the polymer and flasked in stone models of special sizes then deflasked and divided into four groups each composed of five specimens stored into Tea, Coffee, Pepsi cola and Distilled water for different periods of time and compared with conventional acrylic resin by the use of visible light spectrophotometer.
Results: There were significant differences between the four groups of the same material compared with conventional acrylic resin especially with aging under visible light spectrophotometer.
Conclusion: It is better to use conventional acrylic without fiber reinforcement for fabrication of dentures to retain their colors for longer periods of time without changes in the oral environment.
Key words: acrylic resin, denture bases, fibers (J Bagh Coll Dentistry 2009; 21(4): 10-12)

INTRODUCTION
Complete dentures are fabricated by using acrylic resin, a low cost material that requires easy manipulation and construction method. However it is not an ideal material due to discoloration that results in esthetic problems. For the best esthetic effect, the material should be translucent and this translucency should be maintained during processing and not color change in clinical use. (1)

Several sources of discolouration have been suggested. External discolouration can be a result of plaque accumulation involving staining. Another reason is the degradation or staining within the superficial layer of resin related to dietary and smoking habits. (2)

Acrylic resin continues to be the most commonly used material for denture constructions, due to its strength, color stability and ease of manipulation. It has long been theorized that the addition of fibers to monomer/polymer mixture strengthen the resultant acrylic resin, several different types of fibers have been used with varying results. (3,4)

Color stability and stain resistance criteria may provide important information on the serviceability of resin-based materials. Most of these materials used for prosthetic treatment are prone to absorption and adsorption of liquids. (5)

Elastomeric materials or other chemicals have been added to the resin to enhance its strength, but, thus far, improvements have not been remarkable. (6,7)

Although many studies have been carried out on fiber reinforced plastic to improve the mechanical properties of acrylic resin, they have been hampered by difficulties in overcoming problems of aesthetics and manipulation, and have not gained popularity. (8,9) Among these, carbon fiber has been commonly used in laboratory studies, but is not popular for clinical use because of the aesthetic problems caused by the black color of the fibers. (10) Other fibers such as glass, polyethylene, and Kevlar fibers also have been used as strengtheners in roved or chopped strands, or in mat form, but none of these formats have found favor for clinical use. (11,12) Vallittu et al. used glass, aramid, and carbon fibers as acrylic resin strengtheners with the result that there were some air bubbles entrapped, which may have caused weakness of resin. (13) Vallittu used glass fibers as acrylic resin strengtheners and varied the ratio of PMMA-MMA in the mixture, finding that the less PMMA powder, the weaker the resin. (14)

The aim of this study was to find the effect of fiber incorporation on color of acrylic resin denture base material.

MATERIALS AND METHODS
One hundred twenty eight blocks of acrylic resin were divided into 2 groups the 1st group consisted of 64 specimens of acrylic resin, Major dent ISO 1567 Italy reinforced with glass fibers (GF), the fibers were cut into 2mm length and incorporated at concentration of 2% (W/W). (15)

The mixture of resin and fibers were cured at 70 C° in water bath for 9 hours then at 100 C° for one hour in die stone Zhermach Italy ISO 13485 molds which were enclosed by dental flasks. The same curing procedure was done to conventional
acrylic resin which is the 2nd group also consisted of 64 specimens. The acrylic resin specimens of both groups were cut into appropriate size 20 X 10 X 2mm dimensions and polished. Four specimens of each group were stored in four different conditions [Tea, Coffee, Pepsi, and Distilled water] to prepare a standard solution of coffee; 15 g of coffee (Knazler Coffee, Poland) was poured into 500 ml of boiling distilled water. After 10 minutes of stirring, the solution was passed through filter paper. The tea solution was prepared by immersing 5 tea bags (Lipton, London, UK) into 500 ml of boiling distilled water for 10 minutes. Both of these solutions have been found to be effective in staining dental resins. To prevent fungal growth the solutions were changed for both groups every week, for different periods of time 30 days 60 days 120 days and 180 days, figure 1 and their color change were measured by the use of "Shimadzu, uv-visible spectrophotometer, uv 160" Tokyo Japan.

**RESULTS**

The color difference of both groups were measured by the use of spectrophotometer under visible light between light wave length [500-600] The mean value and standard deviation of color difference of both groups were represented in Table 1, for different time intervals.

One way ANOVA test was done for both groups Table 2, comparing the subgroups together respectively such as the tea specimens of fiber reinforced with conventional ones. It was found that conventional acrylic resin color change with time is lesser than those of fiber reinforced group especially for the Tea and Coffee subgroups and also lesser but not significant for the Pepsi and Distilled water subgroups as shown in figures 2-5.

**DISCUSSION**

It was found that acrylic resin material whether fiber reinforced or conventional behaved differently when exposed to various staining solutions in this study. The Coffee solution stained the acrylic resin material of both groups more than Tea solution and Pepsi and Distilled water which agreed with Yu-Lin et al and Adriana et al. A possible source of color change may be associated with porosity caused by over heating or insufficient pressure during polymerization. Discoloration of resin-based materials by tea was mainly due to surface adsorption of the colorants. Discoloration by coffee was due to adsorption and also to absorption of colorants by some investigated materials. Absorption and penetration of colorants into the organic phase of the resin-based materials are probably due to compatibility of the polymer phase with the yellow colorants of coffee.

![Figure 1: fiber reinforced acrylic resin 180 days](image)

![Figure 2: Coffee mean differences between both groups.](image)

<table>
<thead>
<tr>
<th>Time days</th>
<th>Tea Mean &amp; SD</th>
<th>Coffee Mean &amp; SD</th>
<th>Pepsi Mean &amp; SD</th>
<th>Distilled water Mean &amp; SD</th>
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<tbody>
<tr>
<td></td>
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<tr>
<td>30</td>
<td>1.037 [0.3361]</td>
<td>1.712 [0.1463]</td>
<td>0.516 [0.3877]</td>
<td>0.945 [0.3413]</td>
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<td>60</td>
<td>1.314 [0.234]</td>
<td>1.643 [0.2848]</td>
<td>0.738 [0.1936]</td>
<td>0.957 [0.1185]</td>
</tr>
<tr>
<td>120</td>
<td>1.662 [0.18]</td>
<td>2.162 [0.0482]</td>
<td>0.854 [0.274]</td>
<td>1.026 [0.3598]</td>
</tr>
<tr>
<td>180</td>
<td>1.813 [0.1167]</td>
<td>2.062 [0.3728]</td>
<td>0.985 [0.425]</td>
<td>0.732 [0.4543]</td>
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</tbody>
</table>

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<tr>
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<th>Pepsi Mean &amp; SD</th>
<th>Distilled water Mean &amp; SD</th>
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<tr>
<td>30</td>
<td>0.741 [0.0979]</td>
<td>1.105 [0.3123]</td>
<td>0.322 [0.2369]</td>
<td>0.877 [0.1027]</td>
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<td>60</td>
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<td>1.326 [0.091]</td>
<td>0.546 [0.2889]</td>
<td>0.958 [0.4014]</td>
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<td>120</td>
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<td>1.675 [0.2824]</td>
<td>0.734 [0.3674]</td>
<td>1.034 [0.0283]</td>
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<tr>
<td>180</td>
<td>1.192 [0.5122]</td>
<td>1.984 [0.231]</td>
<td>0.842 [0.5173]</td>
<td>0.716 [0.5198]</td>
</tr>
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</table>
Table 2: ANOVA of both groups demonstrating the P-value between each subgroup.

<table>
<thead>
<tr>
<th>Time days</th>
<th>T1&amp;T2</th>
<th>C1&amp;C2</th>
<th>P1&amp;P2</th>
<th>W1&amp;W2</th>
</tr>
</thead>
<tbody>
<tr>
<td>30</td>
<td>0.1418 [NS]</td>
<td>0.0125 [S]</td>
<td>0.4259 [NS]</td>
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<td>60</td>
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<td>0.0782 [NS]</td>
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<td>0.9963 [NS]</td>
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<td>120</td>
<td>0.0519 [NS]</td>
<td>0.0355 [NS]</td>
<td>0.6193 [NS]</td>
<td>0.9661 [NS]</td>
</tr>
<tr>
<td>180</td>
<td>0.0559 [NS]</td>
<td>0.0449 [S]</td>
<td>0.6842 [NS]</td>
<td>0.9645 [NS]</td>
</tr>
</tbody>
</table>

T1= tea solution [fiber reinforced acrylic resin]
T2= tea solution [conventional acrylic resin]
C= Coffee, P= Pepsi, W= Distilled water.
P-value= <0.05 significant difference [S].
P-value= >0.05 no significant difference [NS].

REFERENCES

Figure 3: Tea mean differences between both groups.

Figure 4: Pepsi mean differences between both groups.

Figure 5: Distilled water mean differences between both groups.