CORROSION RESISTANCE OF 18 CARAT GOLD IN ARTIFICIAL SALIVA IN PRESENCE OF D-GLUCOSE

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Keywords: corrosion of metals, artificial saliva (AS), D-glucose, 18 carat gold and mild steel (MS)

Corrosion resistance of two metals namely 18 carat gold and mild steel (MS) has been evaluated in artificial saliva in the presence of D-glucose. Potential dynamic polarization study has been used to investigate the corrosion behaviour of two metals. The order of corrosion resistance of metals in artificial saliva in the presence of D-glucose is 18 carat gold > MS. The decrease order of corrosion resistance of metals in artificial saliva only is: 18 carat gold>mild steel

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INTRODUCTION

Corrosion is a natural, spontaneous and thermodynamically favourable process. One of the most important problems caused by the defects in the components of implants and their manufacturing process is corrosion. Corrosion can be defined as the destruction of a certain substance, especially metal, in reaction with the environment.

In dentistry, metallic materials are used as implants in reconstructive oral surgery to replace a single teeth or an array of teeth or in the fabrication of dental prostheses such as metal plates for complete and partial dentures, crowns and bridges, essentially in patients requiring hypoallergenic materials. Corrosion of metallic implants is of vital importance, because it can adversely affect the biocompatibility and mechanical integrity of implants. Many metals and alloys have been used in dentistry.2

Corrosion resistance of metals and alloys in various body fluids such as Artificial Saliva, Artificial Sweat, Artificial Urine, Artificial Blood and blood plasma has been investigated.

The present work was under taken to study the corrosion behavior of 18 carat gold and mild steel in artificial saliva in the presence of 100 ppm and 200 ppm D-glucose, by a polarization study corrosion parameters such as corrosion potential, corrosion current, linear polarization resistance have been derived from these studies.

Medium

Usually corrosion behaviour metals and alloys have been studied in artificial saliva where composition is given Table 1.

<table>
<thead>
<tr>
<th>Content</th>
<th>Quantity g L⁻¹</th>
</tr>
</thead>
<tbody>
<tr>
<td>KCl</td>
<td>0.4</td>
</tr>
<tr>
<td>NaCl</td>
<td>0.4</td>
</tr>
<tr>
<td>CaCl₂.2H₂O</td>
<td>0.906</td>
</tr>
<tr>
<td>NaH₂PO₄.2H₂O</td>
<td>0.690</td>
</tr>
<tr>
<td>Na₂S.9H₂O</td>
<td>0.005</td>
</tr>
<tr>
<td>Urea</td>
<td>1</td>
</tr>
</tbody>
</table>

In electrochemical studies, the metal specimens were used as working electrodes. Artificial saliva was used as the electrolyte. Commercially available D-glucose [Indian pharmacopeia’s grade] was used in this study. 100 and 200 ppm of D-glucose was used in artificial saliva.

MATERIALS AND METHODS

The 18 carat gold and mild steel were used in the present study. Their composition is given in Table 2 and 3.

<table>
<thead>
<tr>
<th>Composition of 18 carat gold²¹</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gold</td>
</tr>
<tr>
<td>Copper</td>
</tr>
<tr>
<td>Silver</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Composition of mild steel²²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sulphur</td>
</tr>
<tr>
<td>Phosphorous</td>
</tr>
<tr>
<td>Manganese</td>
</tr>
<tr>
<td>Carbon</td>
</tr>
<tr>
<td>Iron</td>
</tr>
</tbody>
</table>
Corrosion resistance of gold (18 carat) in saliva in presence of D-glucose

**Section B**

**Research Paper**


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Corrosion resistance of gold (18 carat) in saliva in presence of D-glucose

### Table 4

<table>
<thead>
<tr>
<th>Metal</th>
<th>System</th>
<th>$E_{corr}$, mV vs SCE</th>
<th>$b_a$, mV decade$^{-1}$</th>
<th>$b_c$, mV decade$^{-1}$</th>
<th>$LPR$, ohm cm$^2$</th>
<th>$I_{corr}$, A cm$^{-2}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>mild steel</td>
<td>AS</td>
<td>-549</td>
<td>177</td>
<td>248</td>
<td>15943.4</td>
<td>2.819x10$^{-6}$</td>
</tr>
<tr>
<td></td>
<td>AS+100ppmD-glucose</td>
<td>-564</td>
<td>123</td>
<td>262</td>
<td>13787.1</td>
<td>2.644x10$^{-6}$</td>
</tr>
<tr>
<td></td>
<td>AS+200ppmD-glucose</td>
<td>-562</td>
<td>127</td>
<td>253</td>
<td>15309.6</td>
<td>2.412x10$^{-6}$</td>
</tr>
<tr>
<td></td>
<td>AS</td>
<td>-20</td>
<td>104</td>
<td>434</td>
<td>928374.9</td>
<td>3.952x10$^{-8}$</td>
</tr>
<tr>
<td>gold 18</td>
<td>AS</td>
<td>-20</td>
<td>112</td>
<td>681</td>
<td>1094619.5</td>
<td>3.831x10$^{-8}$</td>
</tr>
<tr>
<td></td>
<td>AS+100ppmD-glucose</td>
<td>-20</td>
<td>120</td>
<td>526</td>
<td>1271961.1</td>
<td>3.346x10$^{-8}$</td>
</tr>
<tr>
<td></td>
<td>AS+200ppmD-glucose</td>
<td>-18</td>
<td>120</td>
<td>526</td>
<td>1271961.1</td>
<td>3.346x10$^{-8}$</td>
</tr>
</tbody>
</table>

**Polarization study**

Polarization studies were carried out in a CHI-Electrochemical work station with impedance, Model 660A. A three electrode cell assemblies was used. The working electrode was one of the three test materials. A saturated calomel electrode [SCE] was the reference electrode and platinum was the counter electrode. From the polarization study corrosion parameters such as corrosion potential ($E_{corr}$), liner polarization resistance ($LPR$), corrosion current ($I_{corr}$) and Tafel slopes (anodic $= b_a$ and cathodic $= b_c$) were calculated.

**RESULT AND DISCUSSION**

Corrosion resistance of two metals namely mild steel and 18ct gold in AS in the presence of D-glucose has been investigated by polarization study. Polarization study has been used to investigate the formation of protective film formed on the metal surface during corrosion process. If corrosion resistance increases, linear polarization (LPR) value increases and corrosion current ($I_{corr}$) decreases.$^{17,22-40}$

The corrosion parameters of mild steel and 18 carat gold immersed in artificial saliva (AS) are given in Table 4.

**Corrosion behaviour of metals in AS containing D-glucose**

**Mild steel (MS)**

When mild steel is immersed in artificial saliva, LPR value is 15943Ωcm$^2$, and corrosion current is 2.819x10$^{-6}$A cm$^{-2}$and corrosion potential is -549mV vs SCE. When mild steel is immersed in artificial saliva in presence of 100 ppm and 200 ppm D-glucose LPR value is 13787Ωcm$^2$ and 15309Ωcm$^2$, the corrosion current is 2.644x10$^{-6}$A cm$^{-2}$ and 2.412x10$^{-6}$A cm$^{-2}$. It is interesting to note that in the presence of D-glucose, the Linear Polarization Resistance value (LPR) increased. It seems that a protective layer (probably iron glucose complex and oxides of iron) had formed on the metal surface.

**Figure 1.** Polarization curve of ms immersed in artificial saliva (AS)

**Figure 2.** Polarization curve of ms immersed in AS + 100 ppm D-glucose

**Figure 3.** Polarization curve of ms immersed in AS + 200 ppm D-glucose

It is observed for Table 4 that corrosion resistance of ms in artificial saliva decreases when D-glucose is added. However it is noted that as the concentration of D-glucose increases, the corrosion resistance of ms increases.
When 18 carat gold is immersed in AS LPR value is 928374Ω cm², corrosion current is 3.952x10⁻⁸ A cm⁻² and corrosion potential is -20mV vs SCE. In the presence of 100 and 200 ppm D-glucose LPR value is (1094619Ω cm² and 1271961Ω cm²) increased corrosion current is decreased (3.831x10⁻⁸ A cm² and 3.346 x10⁻⁸ A cm²). It is observed that the corrosion potential shifted to the anodic side. It is indicated that 18 carat gold is more resistant than mild steel.

It is well known to everyone that mild steel should not be implanted in the body, because it will undergo corrosion due to the electrolytes present in AS. However in the present study, mild steel is used just for comparison.

CONCLUSION

The corrosion behaviour of two metals namely mild steel and 18 carat gold has been studied in artificial saliva in the presence of D-glucose. This is due to the variation in composition of various types of gold. Corrosion resistance of metals in AS is in the decreasing order: 18 carat gold>mild steel

In the absence of D-glucose (in presence of AS only) the decreasing order of Corrosion resistance of metals is: 18 carat gold>mild steel

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REFERENCES

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