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.[1] Corrosion of metallic implants is of vital importance, because it can adversely affect the bio-compatibility 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,[3-9] Artificial Sweat,[10-12] Artificial Urine, [13-15] Ringer Solution [16-18] and blood plasma [19-20] has been investigated.

The present work was under taken to study the corrosion behavior of 18 carat gold and ms in artificial saliva in the presence of 100 ppm and 200ppm 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 1. Composition of artificial saliva used as the electrolyte.[3-9]

Content	Quantity gL^{-1}
KCl	0.4
NaCl	0.4
$CaCl_2.2H_2O$	0.906
$NaH_2PO_4.2H_2O$	0.690
$Na_2S.9H_2O$	0.005
Urea	1

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 ms where used in the present study. Their composition is given in Table 2 and 3.

Table 2. Composition of 18 carat gold[21]

Gold	75%
Copper	5-15%
Silver	10-20%

Table 3. Composition of mild steel[2, 10,22]

Sulphur	0.026%
Phosphorous	0.06%
Manganese	0.4%
Carbon	0.1 %
Iron	Balance

Table. 4 Corrosion parameters of metals immersed in AS in the presence of D-glucose, obtained by polarization study.

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

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.

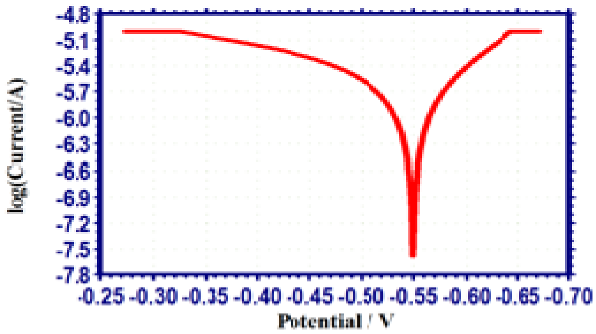

Figure 1. Polarization curve of ms immersed in artificial saliva (AS)

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 -549mVvs 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.

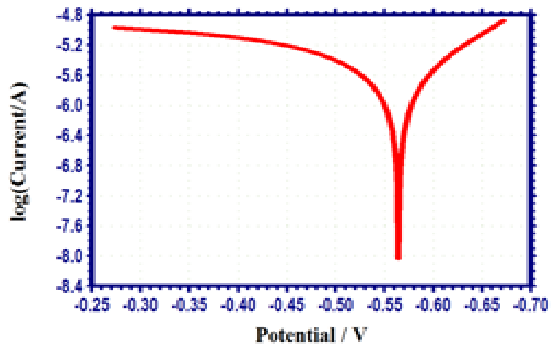

Figure 2. Polarization curve of ms immersed in AS + 100 ppm D-glucose

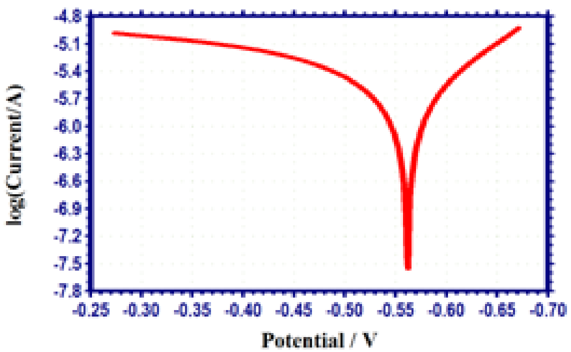

Figure 3. Polarization curve of ms immersed in AS + 200ppm D-glucose

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.

18 carat gold

When 18 carat gold is immersed in AS LPR value is 928374Ωcm^2, corrosion current is 3.952×10^{-8} A cm^{-2} and

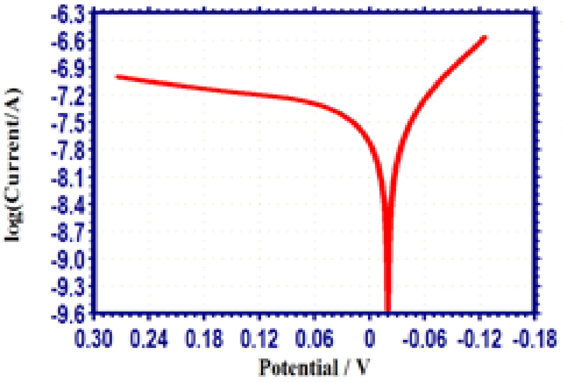

Figure 4. Polarization curve of 18 carat gold immersed in AS

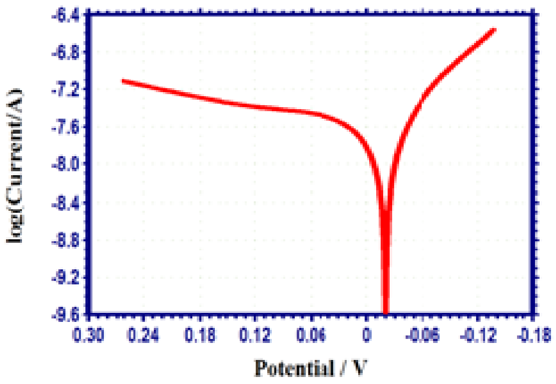

Figure 5. Polarization curve of 18 carat gold immersed in AS + 100ppm D-glucose

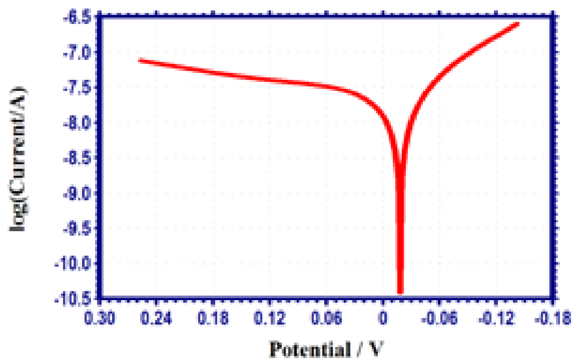

Figure 6. Polarization curve of 18 carat gold immersed in AS +200 ppm D-glucose

corrosion potential is -20mVvs SCE. But in the presence 100 and 200 ppm D-glucose LPR value is (1094619Ωcm^2 and 1271961Ωcm^2) increased corrosion current is decreased (3.831×10^{-8} A cm^{-2} and 3.346×10^{-8} A cm^{-2}). 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. So 18 carat gold nobler than mild steel, due to the formation of passive flim on the metal surface.

It is well known to everyone that mild steel should not be implanted in inside 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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