



CORROSION PERFORMANCE OF ORTHODONTIC BRACKET MADE OF SS18/8 ALLOY INCIDENCE OF SOME TABLETS WITH ARTIFICIAL SALIVA

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ABSTRACT

The goal of this research was to investigate the corrosion performance of Orthodontic Bracket based on SS18/8 alloy with artificial saliva (AS test solution) in three different tablets (Shelcal, Cefixime, Biogenetics) using Polarisation, AC impedance techniques. The incidence of Shelcal and Biogenetics tablets, Corrosion measurements such as R_{pol}, R_{ct} value increases and I_{corr}, C_{dl} value decreases. These data indicate high corrosion resistance of SS18/8 alloy incidence of Shelcal and Biogenetic tablets with AS test solution. But incidence of Cefixime tablet R_{pol}, R_{ct} value decreases and I_{corr}, C_{dl} value increases. Polarisation curve (E_{corr}) showed that the Shelcal, Biogenetic tablets cathodic reaction controlled and the stable defending film formed on the SS18/8 alloy surface. Subsequently it is suggested to those implanted with orthodontic bracket made of SS18/8 alloy should not hesitation to take Shelcal, Biogenetic tablets but Cefixime tablet should avoid. The increase in corrosion rate or decrease in corrosion rate is due to incidence of active component of tablets.

KEYWORDS: SS18/8 alloy, Corrosion resistance, Tablets, AC Impedance and polarisation method.

1. INTRODUCTION

A variety of metal, alloy used in dentistry as orthodontic bracket. Corrosion of metallic implants is of vital importance, because it can adversely affect the mechanical integrity and bio-compatibility of implants. The corrosion resistance of 22carat gold with artificial saliva in presence of aceclofenac, from the results LPR value increased and I_{corr} value decreased. Electrochemical studies indicate higher corrosion resistance of 22carat gold alloy.^[1] Influence of eugenol.^[2] Corrosion resistance of Stainless Steel, Nickel Alloy in Aq.NaOH^[3] iodine glycerine, copper ion and aroma compound in the artificial saliva has been evaluated.^[4,5] The corrosion resistance of SS316L, Mild steel, Ms-Zn alloys in artificial saliva in spirulina powder, D-glucose.^[6,7] The titanium alloy^[8] stainless steel alloys in the vicco paste^[9] 18 carat gold in synthetic saliva in the presence of alloxan^[10] tablet.^[10] Two type of orthodontic wires namely NiTi, stainless steel wires in artificial saliva with protein. Protein concentration increases the corrosion resistance increases of Ni-Ti alloys.^[11] The comparative study of corrosion resistance of three orthodontic wires with fluoride mouthwashes^[12] stainless steel and Nickel titanium wires.^[13] C-glucose on 22carat gold alloy and SS 316L alloy in artificial

saliva^[14] corrosion resistance of stainless steel 316L alloy better than 22carat alloys.^[15] This present study is to evaluate the corrosion performance of SS18/8 alloy with artificial saliva (AS test solution) in three different tablets (Shelcal, Cefixime, Biogenetics) using polarisation curves and AC impedance techniques.

2. METHODS AND MATERIALS

2.1. Polarization method

Polarization curves were carried out in a CHI-electrochemical work station with impedance 660A. It was provided with iR compensation facility. A three types of electrode cell assembly was used. The WE (working electrode) was SS18/8 alloy. A SCE was the reference electrode. Platinum electrode (Pt) was the counter electrode (CE). From polarisation studies, corrosion parameters such as corrosion current (I_{corr}), corrosion potential (E_{corr}), Tafel slopes (b_a and b_c) were calculated and polarization studies was done. Polarization studies have been used to prove the defending film formed on metal alloy surface for the period of corrosion process.^[16,17] Stipulation a defending film is formed on metal alloy surface, the I_{corr} (corrosion current) value decreases and R_{pol} (linear polarization resistance) value increases.

2.2. AC impedance measurements

A CHI-660A impedance analyzer model was used to record AC impedance measurements. The cell set up was the same as that used for polarization methods. The real part (Z' -ohm) and imaginary part (Z'' -ohm) of the cell impedance were measured for different frequencies. The

R_{ct} (charge transfer resistance), impedance (Bode plots), and C_{dl} (double layer capacitance) values were calculated. Stipulation a defending film is formed on metal surface, charge transfer resistance (R_{ct}) increases and Impedance value increases; double layer capacitance value (C_{dl}) decreases.^[16,17]

Table 1: Composition AS test solution.

Compounds	CaCl ₂ . 2H ₂ O	KCl	NaCl	NaH ₂ PO ₄	Na ₂ S.9H ₂ O	Urea
g/L	0.906	0.4	0.4	0.690	0.005	1.0

Table 2: Components of Tablet.

Tablets name	Components	Represent
Shelcal-500mg	1.Calcium Carbonate From An Organic Source (Power Oyster Shell)-1250mg 2.Vitamin D3 -259Iu	Tablet-B
Cefixime -200mg	Cefixime as unhydrate-200mg	Tablet-C
Biogenetic	1.Peppermint oil -0.003ml 2.Dired aluminium hydroxide gel-120mg 3. Magnesium trisilicate-250mg	Tablet-D

3. RESULTS AND DISCUSSION

3.1. Polarization study

The polarization curves (E_{corr}) of SS18/8 alloy in AS test solution with three tablets and without tablets in Fig. 1. The corrosion potential (E_{corr} mV vs SCE), Tafel slopes (bc, ba mV/decade), linear polarization resistance (R_{pol} ohm cm²), and corrosion current (I_{corr} A/cm²) values in Table 3. When Shelcal tablet are added to artificial saliva the E_{corr} of SS18/8 alloy shift to cathodic side (-373 to -514 mV vs SCE). These

parameters indicate that a defending film is formed on cathodic sites of the SS18/8 alloy surface Fig. 1(a). That is cathodic domain of metal dissolution is controlled by defending film on cathodic sites of metal alloy surface. The active components of the Table-B have been adsorbed on metal alloy surface forming metal complexes on the cathodic sites. Similarly both Tablet-C and Tablet-D (-496, -505) that the cathodic reaction is controlled predominant Fig. 1(b,c).

Table 3: Corrosion parameter of SS18/8 alloy in AS test solution with and without Tablets (300ppm).

Systems (300ppm)	E_{corr} [mV vs SCE]	R_{pol} [ohm cm ²]	I_{corr} [A/cm ²]	bc [mV/ Decade]	Ba [mV/ Decade]
AS test solution	-373	3352584	1.561×10^{-8}	197	309
AS + Tablet-B	-514	3562980	1.257×10^{-8}	189	225
AS + Tablet-C	-496	3086027	1.601×10^{-8}	166	253
AS + Tablet-D	-505	4266224	1.032×10^{-8}	184	224

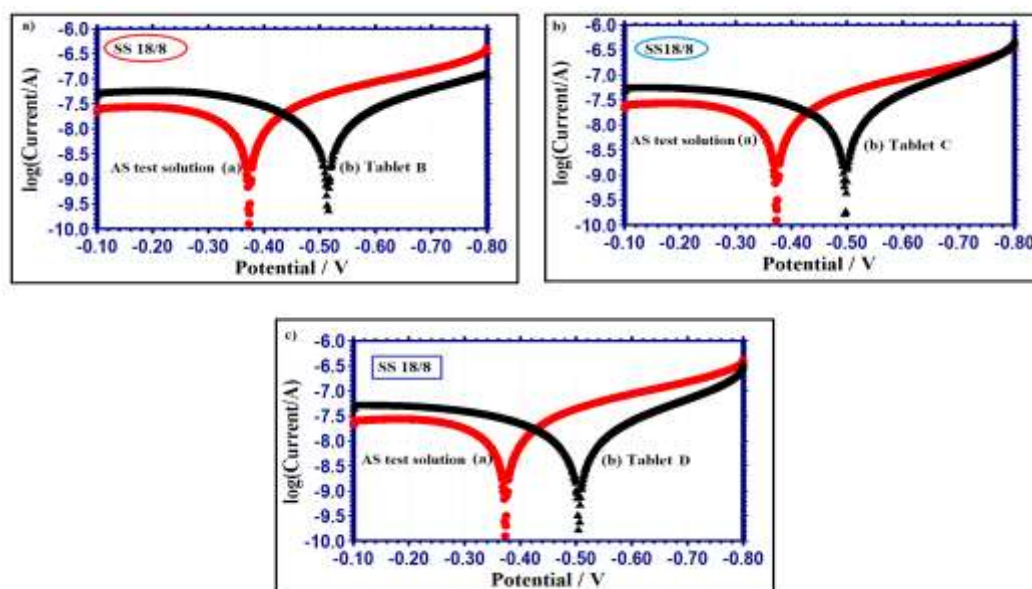


Fig 1: Polarisation curves of SS18/8 alloy in AS test solution with tablets and without Tablet (300ppm).

Further, the increases in R_{pol} value from 3352584 to 3562980 ohm cm^2 , the decreases I_{corr} from 1.561×10^{-8} to 1.257×10^{-8} A/cm^2 . Subsequently polarization data confirms the defending film on the metal alloy surface. It conclusion that incidence of Tablet-B the high corrosion resistance of SS18/8 alloy. Similarly incidence of Tablet-D high corrosion resistance of SS18/8 alloy (3352584 to 4266224 ohm cm^2). The active components of the tablet have not corroded the orthodontic bracket made of SS18/8 alloy. But incidence of Tablet-C that the corrosion resistance of SS18/8 alloy decreases (Table.3). Hence polarization study suggested that those having orthodontic bracket made of SS18/8 alloy should not hesitation to take Tablet-B, Tablet-D but Tablet-C should avoid.

3.2. AC Impedance study

Impedance parameters namely charge transfer resistance (R_{ct}) and double layer capacitance (C_{dl}) derived from Nyquist plots Fig.3. The impedance values derived from Bode plots Figs.4 and Table.4. Incidence of Tablet-B in AS test solution, the charge transfer resistance (R_{ct}) from 44851 to 48764 ohm cm^2 increases. The C_{dl} value decreases from 1.137×10^{-10} to 1.045×10^{-10} F/cm^2 . The impedance value increases from 4.634 to 4.708; Nyquist plot Fig.3 (a) and bode plots Fig.4 (b) indicates that a defending film is formed on SS18/8 alloy surface. All these observations that incidence of Tablet-B the corrosion resistance of SS18/8 alloy in AS test solution increases.

Table 4: Impedance data of SS18/8 alloy in AS test solution with tablets and without tablets.

Systems (300ppm)	R_{ct} ohm cm^2	C_{dl} F/cm^2	Impedance Log (z/ohm)
AS test solution	44851	1.137×10^{-10}	4.634
AS + Tablet-B	48764	1.045×10^{-10}	4.708
AS + Tablet-C	21512	2.370×10^{-10}	4.432
AS + Tablet-D	63030	0.8091×10^{-10}	4.962

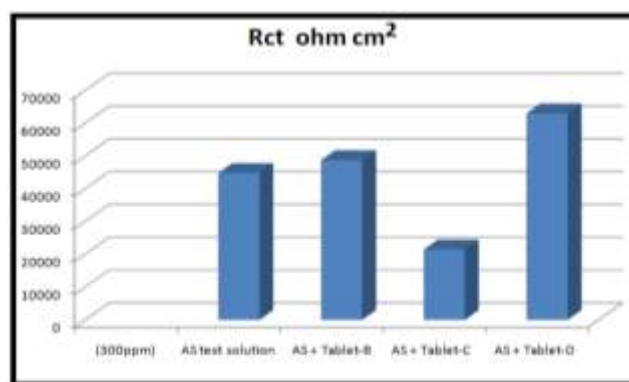


Fig 2: Corrosion resistance of orthodontic bracket SS18/8 alloy in AS test solution with and without three tablets (300ppm).

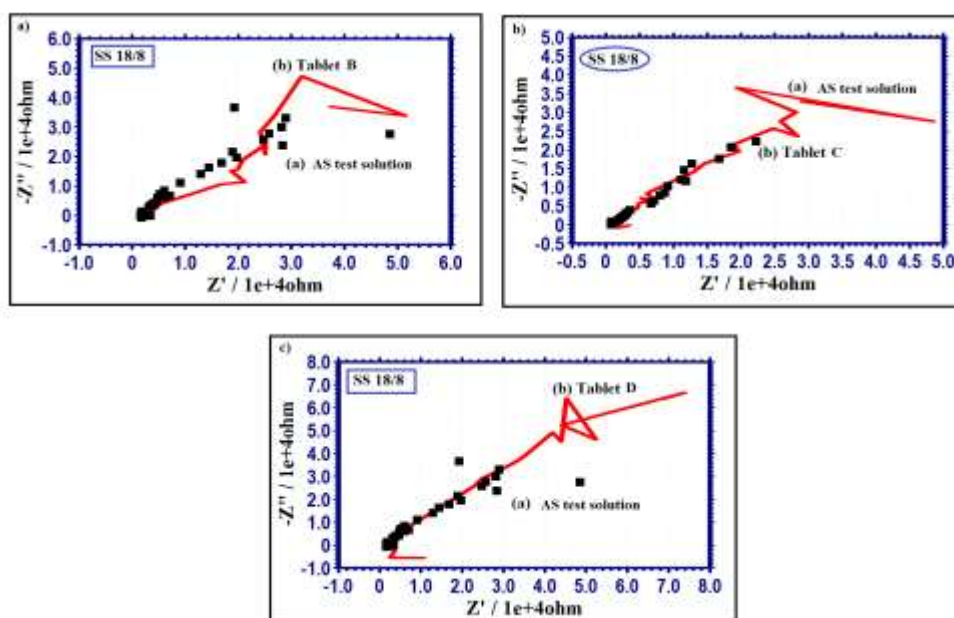


Fig 3: Nyquist Plots of SS18/8 alloy in AS test solution with and without tablets (300ppm).

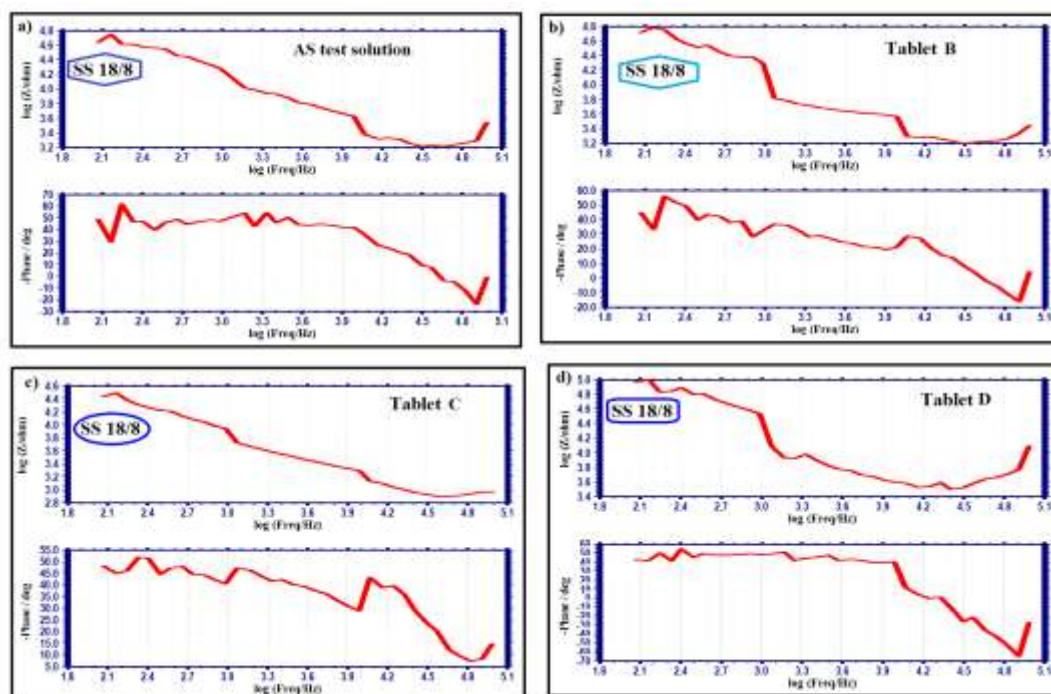


Fig 4: Bode Plots of SS18/8 alloy in AS test solution with and without tablets (300ppm).

Also incidence of Tablet-D the Rct and impedance value increases and Cdl value decreases Table 4. It indicates high corrosion resistance of metal alloy. The active components of the tablet have not corroded the orthodontic bracket made of SS18/8 alloy. But the incidence of Tablet-C Rct value 44851 to 21512 ohm cm^2 decreases and Cdl value 1.137×10^{-10} to 2.370×10^{-10} increases Fig.3(c), 4(c). Hence AC impedance study showed that those having orthodontic bracket made of SS18/8 alloy should not hesitation to take Tablet-B, Tablet-D but Tablet-C should avoid.

4. CONCLUSION

Polarisation studies reveal that the three tablets Shelcal, Cefixime, Biogenetic act as cathodic type of corrosion inhibitor. It observed from impedance results the linear polarisation resistance and charge transfer resistance values show the defending film formed on SS18/8 alloy surface in AS test solution. Hence it concluded that in the incidence of Shelcal, Biogenetic tablets the corrosion resistance of SS18/8 alloy increases. The electrochemical study suggests that those having orthodontic bracket made of SS18/8 alloy need not any hesitation to take Shelcal, Biogenetic but Cefixime tablet should avoid.

5. REFERENCE

1. H. Mohamed Kasim sheit, M. Seeni Mubarak, S. S. Syed Abuthahir and Susai Rajendran *Int. J.Sci. Eng.Appl. Sci.*, 2017; 3: 4.
2. L. Kinani and A. Chtaini., *Leonardo J.Sci.*, 2007; 11: 3340.
3. M. Abdallah, M. M. Salem, I. A. Zaafarany, A. Fawzy And A. A. Abdel Fattah, *Oriental Journal Of Chemistry*, 2017; 33(5): 2875-2883
4. Fumiyo Kusu, Keiji Ohe, and Kiyoko Takamura, *Electrochimica Acta*, 1998; 43: 1873–1879.
5. J. H. Hong, S. E. Duncan, A. M. Dietrich, and S. F. O’Keefe, *J. Agri. Food Chem.*, 2006; 54: 9168–9175.
6. S. Rajendran, J. Paulraj, P. Rengan, J. Jeyasundari, and M. Manivannan, *J.Dent.Oral Hyg*, 2009; 1: 1–8.
7. S. Rajendran,V. Uma, A. Krishnaveni, J. Jeyasundari, B. Shyamaladevi and M. Manivannan, *Arab.J.Sci.Eng*, 2009; 34(2c): 47-158.
8. J. Loch, H. Krawiec, A. Łukaszczyk, J. Augustyn-Pieniążek, *J. Achiev. Mater. Manuf. Eng*, 2016; 74: 1.
9. Renita D Souza, Amit Chattree, Susai Rajendran, *Der Pharm. Chem.*, 2017; 9, 8: 25–31.
10. A.Krishnaveni, S.Rahendran, M.Pandiarajan, *Eur. Chem. Bull*, 2013; 2,8: 558-561.
11. Chao Zhang, Xinhua Sun, Xu Hou, Hongmei Li and Daqian Sun, *Int. J. Med. Sci*, 2013; 10,8: 1068-1072.
12. N.Schiff, F.Dalard, M.Lissac, L.Morgon, B.Grosogeat, *Eur. J. Orthod*, 2005; 27: 541-549.
13. Wassana Wichai, Niwat Anuwongnukroh, Surachai Dechkunakorn, *Adv. Mat. Res*, 2014; 884-885: 560-565.
14. Saranya R, Susai Rajendran, *Der Pharma Chemica*, 2017; 9,8: 128-132.
15. Barham Hamah-Ali Majeed, *Inte. J. Eng. Develop.Res*, 2015; 3,2: 1098-1106.
16. R. Nagalakshmi, L. Nagarajan, R. Joseph Rathish, S. Santhana Prabha, N. Vijaya, J. Jeyasundari and S. Rajendran, *Int. J. Nano. Corr. Sci. Engg*, 2014; 1,1: 39-49.
17. T.Gowrani, P.Manjula, Nirmala Baby, K.N.Manonmani, R.Sudha, T.Vennila, *Int. J. Nano. Corr. Sci. Engg*, 2015; 2,1: 12-21.