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People Clipped with Orthodontic Wire made of Ni-Cr Alloy should Avoid Taking Copper Barrel Hard Drink Orally

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Abstract

Copper barrel brandy can be taken orally with dilution using bisleri water or soda water and without dilution. People clipped with orthodontic wires may take copper barrel brandy orally, with dilution of without dilution. How far the orthodontic wires will be affected by these items? To find an answer the present research work is undertaken. Ni-Cr alloys have good corrosion resistance. This is attained by arrangement of protective oxide film in oral environment. Corrosion resistance of orthodontic wires prepared from Ni-Cr alloy in artificial saliva in existence & nonexistence of copper barrel, water and soda water has been estimated by polarization technique. It is generally noted that corrosion resistance of Ni-Cr alloy in synthetic saliva in existence of copper barrel, water and soda water decreases. When orthodontic wire made of Ni-Cr is engrossed in simulated saliva, the linear polarization resistance (LPR) value is 792355 Ohmcm.^{2} When it is submerged in copper barrel + artificial saliva (AS) system, linear polarization resistance (LPR) value decreases to 334516 Ohmcm.^{2} Corrosion current increases from 5.448 x 10^{-8} A/cm^2 to 14.47 x 10^{-8} When it is engrossed in soda water + artificial saliva (AS) system, LPR value decreases to 245052

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Polarization Study.

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Ohmcm^2. Corrosion current increases from 5.448 x 10^{-8} A/cm^2 to 18.68 x 10^{-8}. When it is immersed in copper barrel + soda water + artificial saliva (AS) system, LPR value decreases to 205729 Ohmcm.^{2} Corrosion current (I_{corr}) increases from 5.448x10^{-8} A/cm^2 to 23.65 x 10^{-8} When it is immersed in copper barrel + water + artificial saliva (AS) system, LPR value decreases to 407219 Ohmcm.^{2} Corrosion current (I_{corr}) increases from 5.448 x 10^{-8} A/cm^2 to 10.90 x 10^{-8}. It is concluded that people who have been clipped with orthodontic wire made of Ni-Cr alloy should shun taking copper barrel in any form, namely, with dilution or without dilution.

Introduction

Beautiful objects are symmetrical in nature. Symmetry leads to beauty. Symmetry is a result of regular arrangement. Regular arrangement of teeth leads to attractive and beautiful smiles which attract everyone. Unfortunately by God's grace, some people do not have regularly arranged teeth.

To regularize the development of teeth, people need the assist of Dentists. They utilize of orthodontic wires prepared of a variety of alloys such as SS 316 L, SS 18/9, NiTi, NiCr etc., After clipping these wires, people take a lot of tablets, food recipes and juices orally. Because of these activities the orthodontic wires undergo corrosion.

A Study of Tribocorrosion occurring at implant & implant alloy Interface: Dental implant materials" has been undertaken by Mehkri *et al*[1] Electrochemical corrosion resistance of LDX 2101® duplex stainless steel in fluoride-containing environment has been reported by Rosalbino *et al.*[2] Corrosion of Dental Alloys Used for Mini Implants in Simulated Oral Environment has been examined by Curkovic *et al.*[3] Mindivan *et al.* have studied Microstructure % tribocorrosion properties of pulsed plasma nitrided cast CoCr alloy for dental implant applications.[4] Electrochemical corrosion behavior of LDX 2101® duplex stainless steel in fluoride-containing environment has been considered by Rosalbino *et al.*[5] Feng *et al.* have investigated Corrosion Resistance of SLM Denture Scaffold in Simulated Oral Environment.[6] Fretting & fretting corrosion processes of Ti6Al4V implant alloy in simulated oral cavity environment have been investigated by Klekotka *et al.*[7] Corrosion Resistance of SLM Denture Scaffold in Simulated Oral Environment has been investigated by Feng *et al.*[8] Musa Trolic *et al.* have studied influence of probiotic supplements suggested for use in orthodontic patients on corrosion steadiness of stainless steel and three types of NiTi orthodontic wires.[9] Corrosion resistance was calculated by polarization study & AC impedance spectra. It was noted that probiotic bacteria L. Reuteri & probiotic supplement influence on general corrosion rate as well as on likelihood of pitting corrosion occurrence.[9] Effect of Cu-doping on corrosion resistance of NiTi alloy arch wires under simulated clinical conditions has been reported by Wang *et al.*[10]

Use of Ni Cr alloy in dentistry

Assortment of metallic alloys is at present obtainable for prosthodontic restorations, among which, nickel-chromium (Ni-Cr) casting alloys are utilized in dental crown & bridge fabrication. It is corrosion resistant, castable, and has a similar coefficient of thermal expansion as that of porcelain. The alloy can be cast centrifugally and has a hardness which lies slightly above that of gold. Used for dentures, bridges and crowns which are coated with porcelain or a synthetic material. In the present study, corrosion behavior of orthodontic wires made of Ni-Cr alloy in artificial saliva in nonexistence & existence of copper barrel, water and soda water has been evaluated by polarization study. Linear polarization resistance & corrosion current values are obtained from polarization study by immersing Ni-Cr alloy in artificial saliva in nonexistence & existence of copper barrel, water and soda water.

Experimental

Nickel–Chromium (Ni–Cr) Alloy

Nickel–chromium (Ni–Cr) alloys have been utilized for dental prostheses. (M/s Intellodent - offering orthodontic wire, for dental orthodontics, Roorkee, Uttarakhand). This is due to the low prices & outstanding properties in veneered restorations.

Most Ni-Cr restorations execute well clinically, corrosion products & constituents of alloys are known to have potential to initiate & other tissue reactions. Nickel content of nickel-chromium alloys c is as high as 73.5%.[11]

Preparation of Artificial Saliva

Fusayama Meyer artificial saliva was used in extant study. Composition of artificial saliva is given in Table 1 .

Table 1: Composition of Artificial saliva

Name	Weight , g/lit
KCl	0.4
urea	1
$Na_2S.9H_2O$	0.005
$NaH_2PO_4.2H_2O$	0.690
$CaCl_2.2H_2O$	0.906
NaCl	0.4

Copper Barrel Brandy

It is an Indian brandy, made from molasses/Grain spirit, in Kals Distilleries Pvt. Ltd., Kallakottai village, Pudukottai District, Tamilnadu. It cntains demineralised water, neutral spirit, permitted natural colour INS 150a (A dark brown food color produced by heat treatment of sucrose. It is a food additive approved by the European Union and is denoted by INS150a under International Numbering System.) & permitted flavours.

Potentiodynamic Polarization Study

CHI Electrochemical work station (model 660A) was used to record polarization studies.

It has been provided with *iR* compensation facility. The three electrode cell assembly used is shown in Figure1.

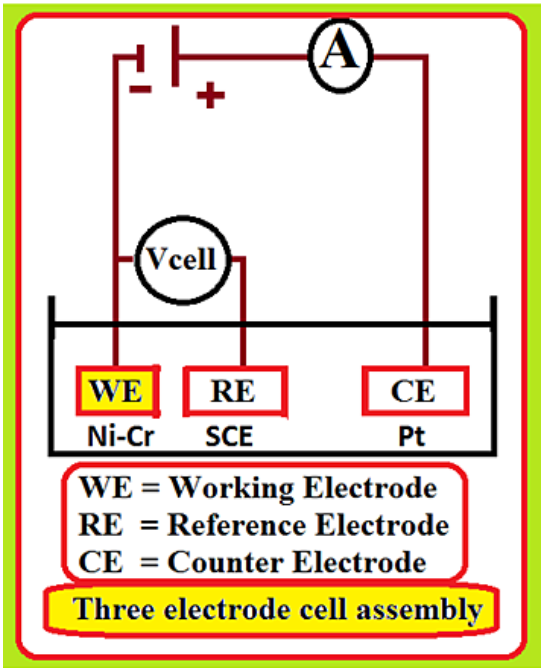

Fig. 1: Three electrode cell assembly

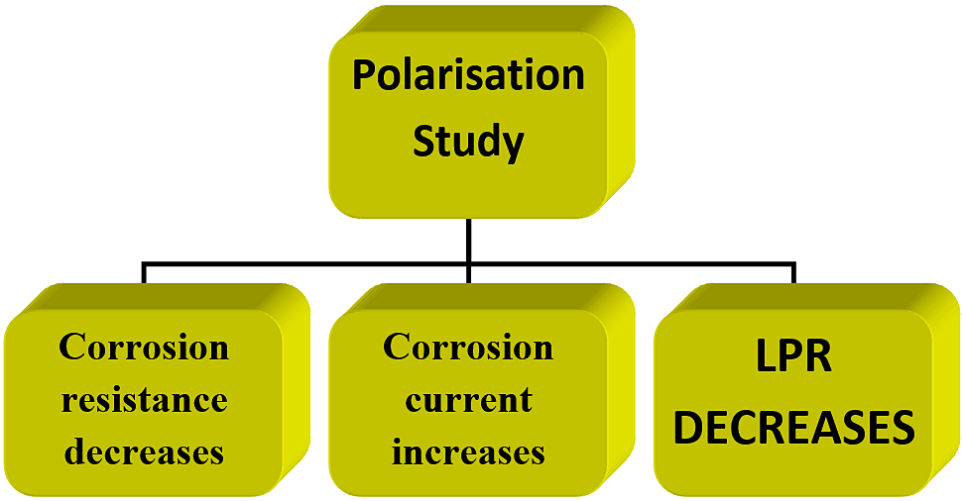

Fig. 2: Correlation among corrosion parameters in polarization study.

Platinum foil was used as counter electrode. Saturated calomel electrode (SCE) was used as reference electrode. Working electrode was Ni-Cr alloy. Corrosion parameters such as corrosion potential (E_{corr}), corrosion current (I_{corr}) and Tafel slopes (anodic = b_a & cathodic = b_c) & linear polarization resistance (LPR) were obtained from polarization study.

Results and Discussion

Ni-Cr Alloy System

Polarization technique has been employed to measure corrosion resistance of orthodontic wire made of Ni-Cr alloy in artificial (simulated) saliva in existence & nonexistence of Copper barrel, water and soda water. The results are shown in Table 2 and Figures 2 to14. When corrosion resistance upsurges, linear polarization resistance (LPR) value upsurges & corrosion current (I_{corr}) decreases. On other hand, when corrosion resistance decreases linear polarization resistance (LPR) value decreases & corrosion current (I_{corr}) value increases. These are the principles of polarization study.[12-23]

One component system

When Ni-Cr alloy is immersed in one component system, namely, copper barrel or water or soda water (in the absence of artificial saliva) the corrosion resistances are as follows (Table 1)

Copper barrel > water > artificial saliva > soda water

This order is due to the ingredients present in various systems. Copper barrel is grape-based distilled from wine, but made with a heap of other fruits as well. So it offers more corrosion protection. So corrosion resistance of Ni-Cr in soda water decreases.

Soda water is basically a carbonated water which holds water and into this Carbon dioxide gas has been dissolved under the pressure. Basically Carbon dioxide and the water just reacts chemically to yield the Carbonic acid which is actually a weak acid.

Three Component System

When Ni-Cr alloy is immersed in three component system, namely, copper barrel , water and soda water the corrosion resistances are as follows (Table1): This order is due to the ingredients present in various systems.

AS > CB + W + AS > CB + Soda + AS

Implication

When copper barrel is mixed with soda water, corrosion resistance of Ni-Cr alloy in artificial (synthetic) saliva, is observed to be less than that of the system consisting of copper barrel and water in existence of artificial (simulated) saliva. Corrosion resistance of the two systems are lower than that of the AS system. It is exciting to note that, in above two systems, corrosion resistance (conflict) of Ni-Cr alloy in (artificial) synthetic saliva, is found to decrease. Hence it is accomplished that people having clipped with orthodontic wire made of Ni-Cr alloy should keep away from taking CB + W or CB + Soda orally.

Table 2: Corrosion Parameters of Ni-Cr alloy engrossed in various test solutions containing Copper Barrel attained by Polarisation Technique

System	$-E_{corr}$ mV vs SCE	b_c mV/decade	b_a mV/decade	LPR Ohmcm^2	icorr A/cm^2
Artificial saliva(AS)	619	171	237	792355	5.448×10^{-8}
CB	266	164	287	3138462	1.447×10^{-8}
Water	328	158	277	1230397	3.558×10^{-8}
Soda	499	156	404	153774	31.80×10^{-8}
CB + W + AS	691	167	262	407219	10.90×10^{-8}
CB + Soda + AS	499	188	277	205729	23.65×10^{-8}
CB + AS	616	183	284	334516	14.47×10^{-8}
Soda + AS	598	180	255	245052	18.68×10^{-8}
W + AS	582	174	262	218217	20.86×10^{-8}

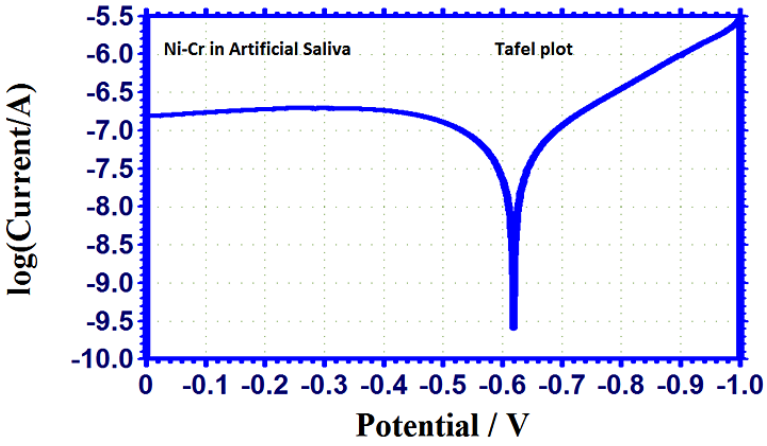

Fig. 3: Tafel plot of Ni-Cr alloy engrossed in (simulated) Artificial Saliva (AS).

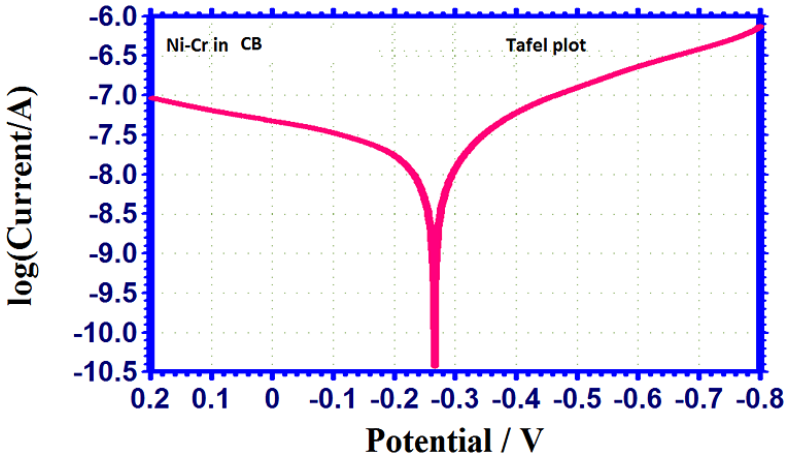

Fig. 4: Tafel plot of Ni-Cr alloy engrossed in copper barrel

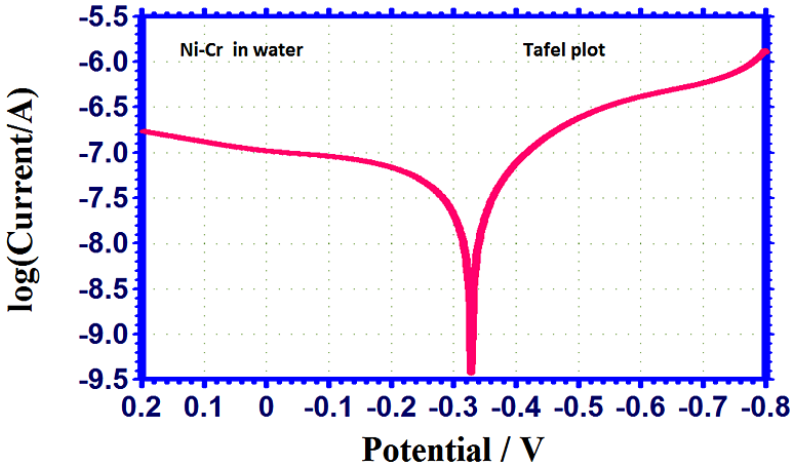

Fig. 5: Tafel plot of Ni-Cr alloy engrossed in bislery water

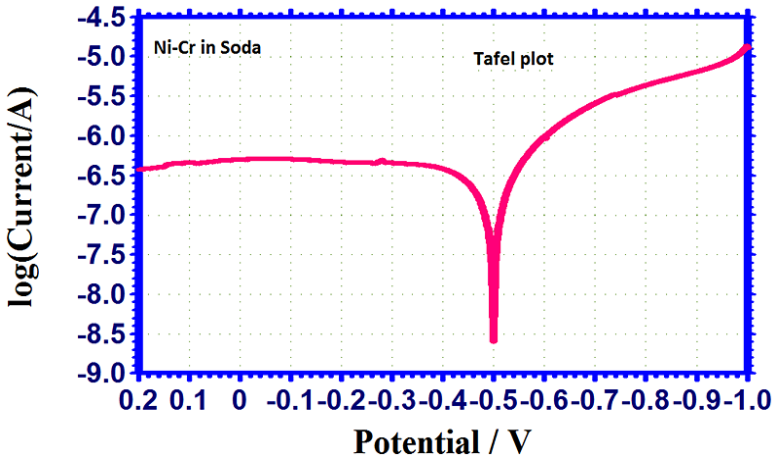

Fig. 6: Tafel plot of Ni-Cr alloy engrossed in soda water

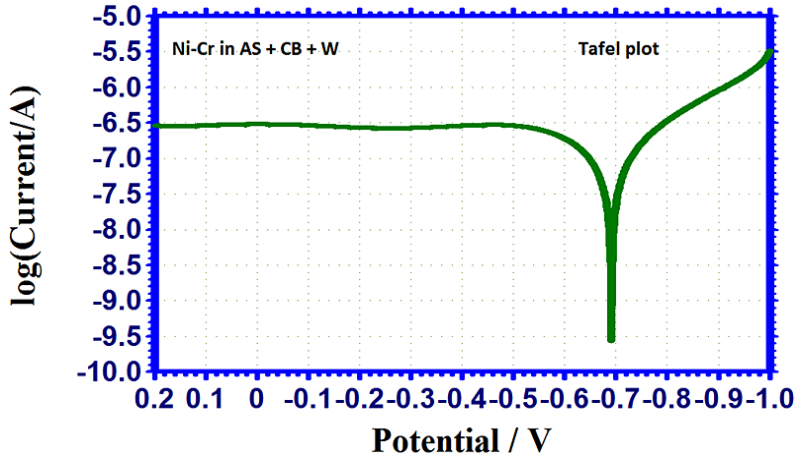

Fig. 7: Tafel plot of Ni-Cr alloy engrossed in the artificial saliva + copper barrel + bislery water system

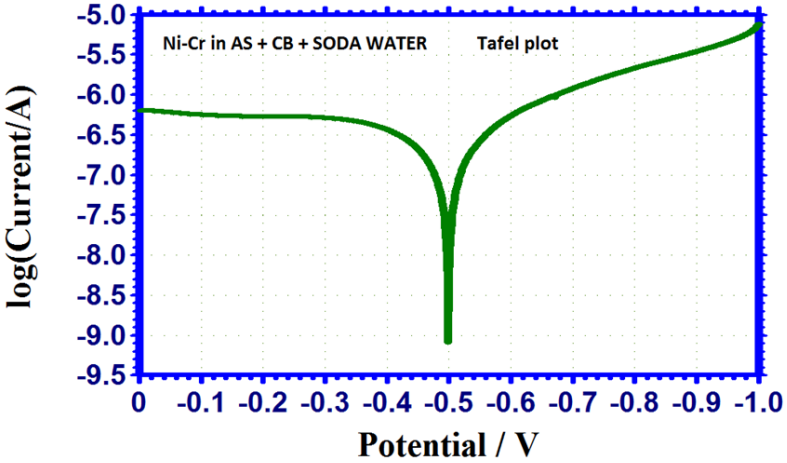

Fig. 8: Tafel plot of Ni-Cr alloy submerged in artificial saliva + copper barrel + soda water

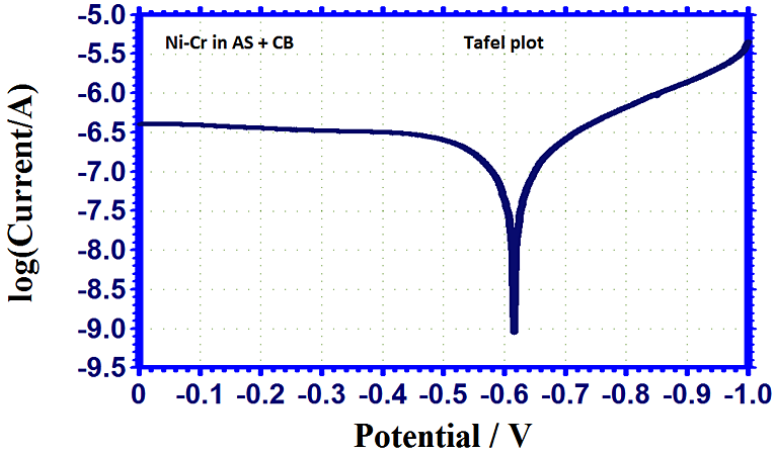

Fig. 9: Tafel plot of Ni-Cr alloy engrossed in artificial saliva + copper barrel

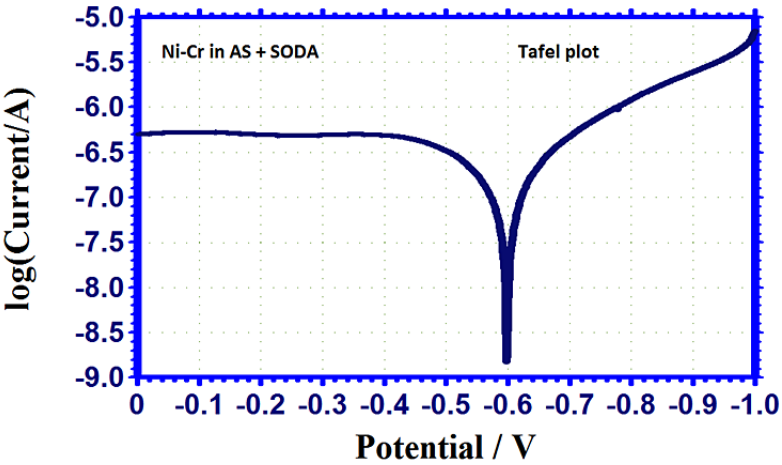

Fig. 10: Tafel plot of Ni-Cr alloy engrossed in artificial saliva + soda water

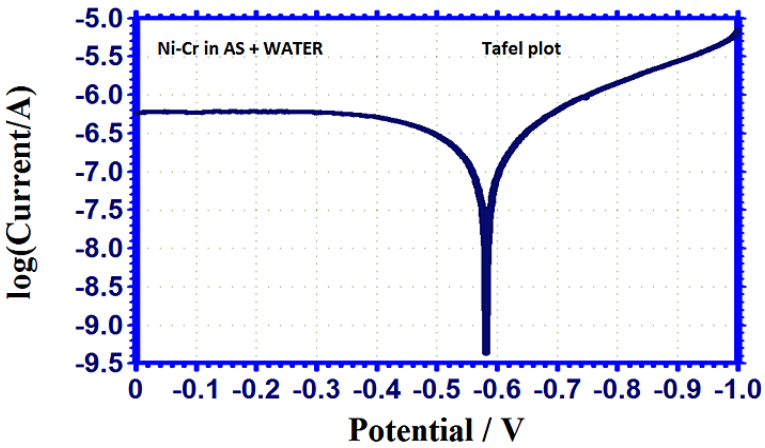

Fig. 11: Tafel plot of Ni-Cr alloy engrossed in artificial saliva + bislery water

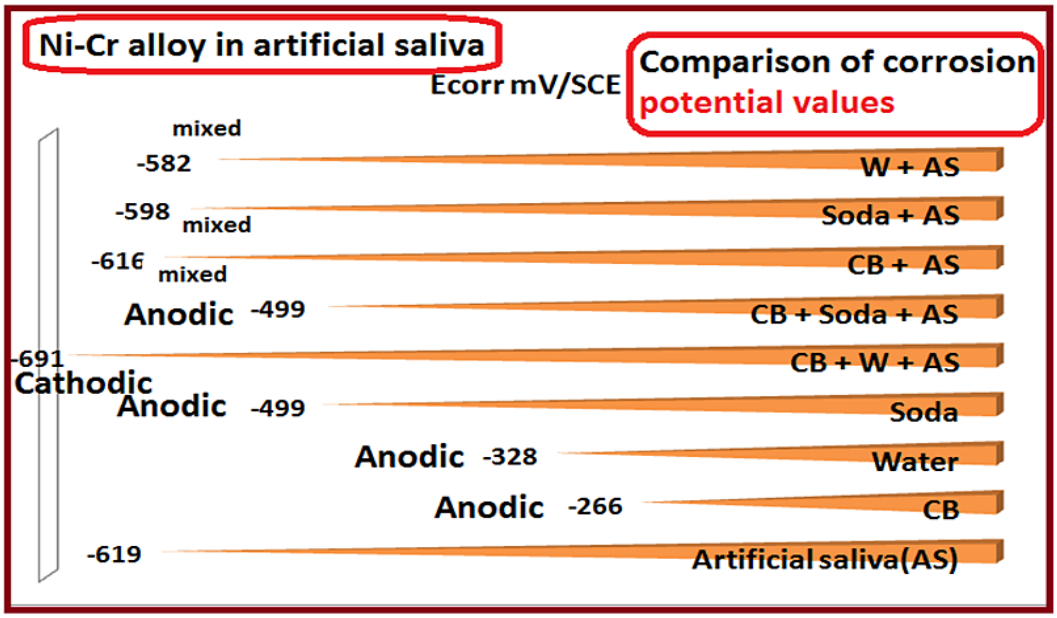

Fig. 12: Comparison (evaluation) of corrosion potential values of Ni-Cr alloy engrossed in innumerable systems

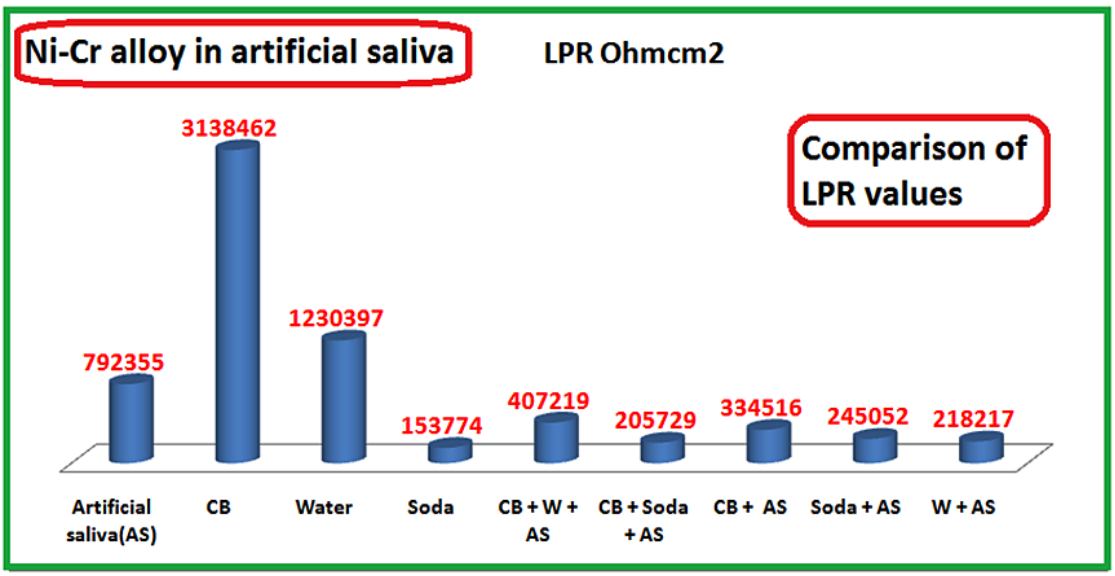

Fig. 13: Evaluation (Comparison) of LPR values of Ni-Cr alloy engrossed in different systems

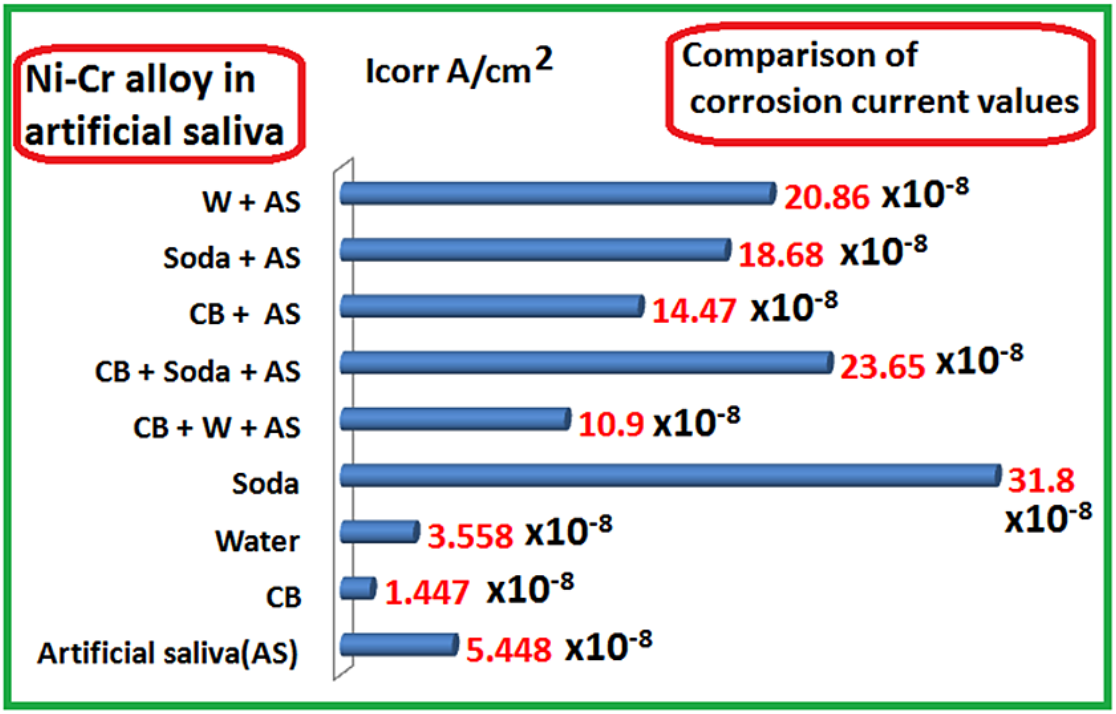

Fig. 14: Comparison (evaluation) of corrosion Current values of Ni-Cr alloy immersed in different systems

Two Component System

When copper barrel alone or soda water alone or water alone, is orally in taken, corrosion resistance of Ni-Cr alloy in (simulated) artificial saliva is as follows (Table 1)

Artificial saliva > copper barrel alone > soda water alone> water alone

This order is due to the ingredients present in various systems

Implication

Copper barrel alone or water alone or soda water alone should not be taken orally (orally implies in presence of saliva), by the people who have been (clipped) attached with orthodontic wire completed of Ni-Cr alloy.

Comparison of Corrosion Parameters Derived from Polarization Study

The corrosion parameters obtained from polarization study are compared in Figures 12-14.

Figure 12 compares corrosion potentials of Ni-Cr alloy engrossed in innumerable test solutions. In some systems anodic reaction is controlled mainly. In a few systems both cathodic reaction & anodic reaction are controlled to an equivalent extent.

Figure 13 compares the LPR values of Ni-Cr alloy engrossed in innumerable test solutions. It is noted that when corrosion resistance decreases, LPR values decrease.

Figure 14 compares the corrosion current (I_{corr}), values of Ni-Cr alloy submerged in numerous test solutions. It is noted that when corrosion resistance decreases, corrosion current values increase.

Conclusions

- In the present study, corrosion resistance of orthodontic wires made of Ni-Cr alloy in artificial saliva in presence & nonexistence of copper barrel, water and soda water has been inspected by polarization study.
- Linear polarization resistance & corrosion current values are obtained from polarization

study by immersing Ni-Cr alloy in (artificial) simulated saliva in nonexistence & existence of copper barrel, water & soda water.

- For one component system the order of corrosion resistances is as follows:

Copper barrel > water > artificial saliva > soda water

- For three component system the order of corrosion resistances is as follows:

AS > CB + W + AS > CB + Soda + AS

- For two component system the order of corrosion resistances in presence of artificial saliva is as follows:

Artificial saliva > copper barrel alone + AS > soda water alone + AS > water alone +AS

- The people who have been clipped with orthodontic wire consisting of Ni-Cr alloy may avoid taking copper barrel orally (in the presence of saliva) in any form that is, with dilution or without dilution.

Future Perspective

- Experiments can be carried out using other hard drinks and soft drinks
- Other types of orthodontic wires may be used
- Surface analysis of protective films can be made

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Conflict of Interest

There is no conflict of interest.

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