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Metal Ion Release From Ni-Cr Alloy with Different Artificial Saliva Acidities

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الخلاصة

الأهداف: تهدف الدراسه الى تقيم تأثير تغير درجة حامضية اللعاب على تحرير الايونات المعدنية من سبيكة نيكل–كروم بازمنة مختلفة وكذلك حساب كمية ايونات نيكل والكروم المتحررة من هذه السبيكة. **المواد وطرائق العمل** : تم استخدام ثمانيه واربعون عينه من سبيكة النيكل–كروم، قسمت هذه العينات الى اربع مجاميع، غمرت العينات بعد التقسيم في اللعاب الصناعي ذو درجات حامضية مختلفة (2.5,5,6,7).تم حساب النسب للايوناتالمتحرره عند درجة (37º) عندما كان زمن الغمر(36,24,12) يوما وذلك باستخدام مطياف الامتصاص الذري. **النتائج** : بينت نتائج تحرر ايونات النيكل والكروم احصائيا ان هناك فرق معنوي عند ($P\leq0.05$) للمحاليل الثلاثهبازمنة (36,24,12) يوما.وكذالك بينت نتائج تحرر ايونات النيكل والكروم بوجود العاب الصناعي ذو درجة الحامضيه (2.5) ان معدل تحررها اكبر من بقية المحاليل الاخرى ذات (5,6,7) phبأزمنة الغمر المختلفه. **الاستنتاجات**: هنالك دليل من خلال النتائج ان هناك تحرر لايونات النيكل والكروم اللعاب الصناعي ذات درجات حامضيه مختلفه . وكذلك بينت النتائج بأن معدل تحرر ايونات النيكل والكروم بنسب عاليه في العاب الصناعي ذو درجة حامضة (2.5). ولاكن معدل تحرر ايونات النيكل اكبر من تحرر ايونات الكروم عند غمرها بللعاب الصناعي ذو درجات حامضيه مختلفه.

ABSTRACT

AIMS: evaluate the effects of changes in salivary pH on ion release from the Ni – Cr alloy at different time and calculate the amount of nickel, chromium ions released from these alloyes.**MATERIALS AND METHODS**: Fourty eight specimens of Ni-Cr alloy were divided, four specimens immersed in each of four types of artificial saliva at different pH (7 as control,6,5 and 2.5), in three storage periods (12, 24 and 36days). All test tubes were incubated at 37°C. After the immersion time was finished the quantities of metallic ions released for Ni and Cr were measured for each test solutions after 12, 24and 36days of immersion by atomic absorption spectroscopy. **REULTS**: The results of Nickel and Chromium ion release showed a statistically significant difference at $p\leq0.05$ between three immersion solutions after (12, 24, 36) days, artificial saliva (pH2.5) showed higher rate of Ni and Cr release than artificial saliva (pH 7as control ,6,5) after various immersion times. It should mention the nickel ion release has been found to be more than chromium ion release. **CONCLUSIONS**: There is an evidence that the Ni and Cr ions release from Ni-Cr alloy at the presence of different acidity of artificial saliva. Chromium and nickel ion release in small amount in artificial saliva with pH(6,5), while in pH 2.5 release in large amount after (12, 24, 36) days of immersion. Nickel exhibited the highest level of ion release than Cr.

Key words: Corrosion, ion crelease, Ni-Cr alloy.

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INTRODUCTIONS

Dental casting alloys with high and low noble metal contents are widely used in dentistry, nickel-chromium dental casting alloys were developed as an alternative to gold based alloys for partial dentures and crowns, in part because of their superior properties in porcelain fused to metal applications. [1,2]

Corrosion may be described as the deterioration of materials by aggressive action of the environment and the oral environment is conducive to corrosion. Factors that may initiate corrosion include the quantity, quality and pH value of secreted saliva (which are affected by the diet and intake of medicines or-drugs),intake of organic acids commonly-found in foods and beverages (such as lactic, acetic, malic, oxalic,tartaric, and carbonic acids), and accumulation of dentalplaque.[3]

Several studies have reported on the release of metallic ions from base dental casting alloys under differing pH conditions which simulated the oral cavity. A low pH environment acidic conditions increases the release of metallic ions from

dental alloys, this effect is especially pronounced for nickel based alloys. Dental plaque often adheres to dental alloys and creates a low pH environment locally. This condition promotes the corrosion of dental alloys. [4,5,6]

Atomic absorption spectrophotometer was used to measure the amount of ion release; atomic absorption is a technique based on the unique spectrum of each element.[7] We aimed to evaluate the effects of changes in salivary pH on ion release from the Ni – Cr base alloy at different time intervals, and calculate the the amount of nickel and chromium ions released from this alloy.

MATERIALS AND METHODS

The dental casting alloy used in this study is nickel chromium alloy (Bremen, Germany). The chemical composition of this alloy is given in Table(1). The samples were designed according to ADA specification No. 14 (ADA, 1995) (20×10×0.6) mm ±0.1, fourty eight rectangular casting alloy specimens were fabricated. The wax pattern was constructed using base plate wax (Plastodentse, Degussa,Germany).The wax was sprued, invested and cast in phosphate bonded investment material (Accufit,Cleveland,OH) using a conventional lost wax technique. All processes of wax pattern, investment, burn out and casting were carried out according to the manufacturer's instructions.

Table (1): Composition of dental alloy for ceramics on nickel base .

Ni %	Cr%	Mo%	Si%
62	26	11	1,5

Finishing of the casting:

The major portion of the investment was gently removed. The all casted specimens were carefully cleaned using 50-µm aluminum oxide air borne particle abrasion for 15 second to remove investment debris. The specimen were machined with carborandum wheels , special stone burs rubber wheels and then the specimens were ground wet with 180, 400, 600, 800,1000 and 2000 grit silicon carbide papers. After this steps a high speed polishing grinder machine (Denta rapid, Germany) with rouge material were used to obtain smoother and mirror surface. This is done according to the manufacture instructions, then ultrasonically cleaned in ethanol for 15 min and washed with distilled water. [8]

Immersion solutions:

The conditioning media used in this test was artificial saliva with different pH(7as control,6,5 and 2.5) made in the laboratory, the composition artificial saliva was 7.69 g of K2HPO4, 2.46 g of KH2PO4, 5.3 g of NaCl, and 9.3 g of KCl added to 1,000 mL of distilled water. To prepare artificial saliva with different PH(6,5 and 2.5), by adding lactic acid ,and by adding NaOH was obtain pH 7 (control). After the pH values were adjusted to their desired levels using lactic acid and NaOH, they were measured using a pH meter (Philips PW 9422). The PH 2.5 solution was used to test the extreme conditions of short term pH variances, examples of causes of short term pH variances include the intake of acidic beverages. The pH (5,6) was used to test pH variances arising from long term exposure, such as that of daily saliva.[6,10]

Immersion times:

Application time correspond to the accumulated periods of regular usage of the partial denture, so when the patient wear the denture ten hours (as average amount) in the day,12 day time correspond to the acumulated effect of regular usage of the partial denture for one months and 24 day,36 day time correspond to the acumulated effect of regular usage of the partial denture for two and three months respectively. These immersion periods seems to be too shorter cumulative periods. [11]

Immersion test:

Fourty eight specimens of Ni-Cr alloy were divided, four specimens immersed in each of four types of artificial saliva (PH 7,6,5 and 2.5),in three storage period (12, 24and 36days). Metal specimens were coded, washed in distilled water and

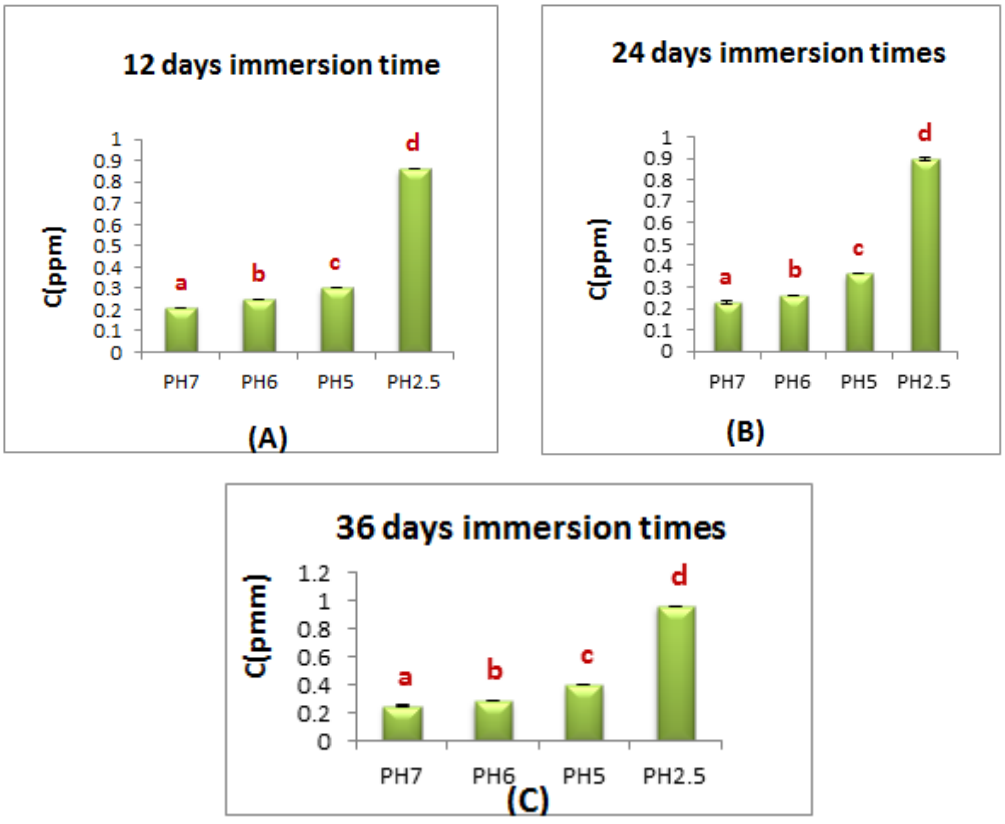
alcohol, and then immersed in polypropylene tubes containing 15mL of artificial saliva of each test solution. To monitor the release of metallic ions into the immersion solutions in polypropylene tubes, control test tubes containing immersion solutions only were also prepared. All test tubes were incubated at 37°C, after the immersion time was finished the quantities of metallic ions released for Ni and Cr were measured for each test solutions after 12, 24and 36days of immersion. Atomic absorption spectroscopy absorbance readings per element were made for each sample. Each reading was used to determine the mean concentration of the different elements in part per million (ppm) released from the alloys.

By SPSS statistical program we obtained: 1) Descriptive statistics includes, mean and standard deviation values.2) ANOVA, Duncan and Dunnett'smultiple range test were used. The statistical results were considered significant at $p \leq 0.05$.

RESULTS

A -Chromium ion release :

The value of mean of Cr ion release (pmm),±standard deviation, Dennett's test and Duncan Multiple analysis rang test of control, and three immersion solutions of artificial saliva with different pH(7as control, 6, 5 and 2.5) after various immersion times are shown in Figure (1). After 12, 24 and 36 days of immersion, Cr ion release in small amount in solution with pH(6,5) respectively, while in pH 2.5 release in large amount (0.860, 0.896,0.962 ppm) respectively when compare with control pH7 as shown in Figure(1) Cr ion release showed a statistically significant difference at $p \leq 0.05$ between three immersion solutions after various immersion times as shown in Table (2).



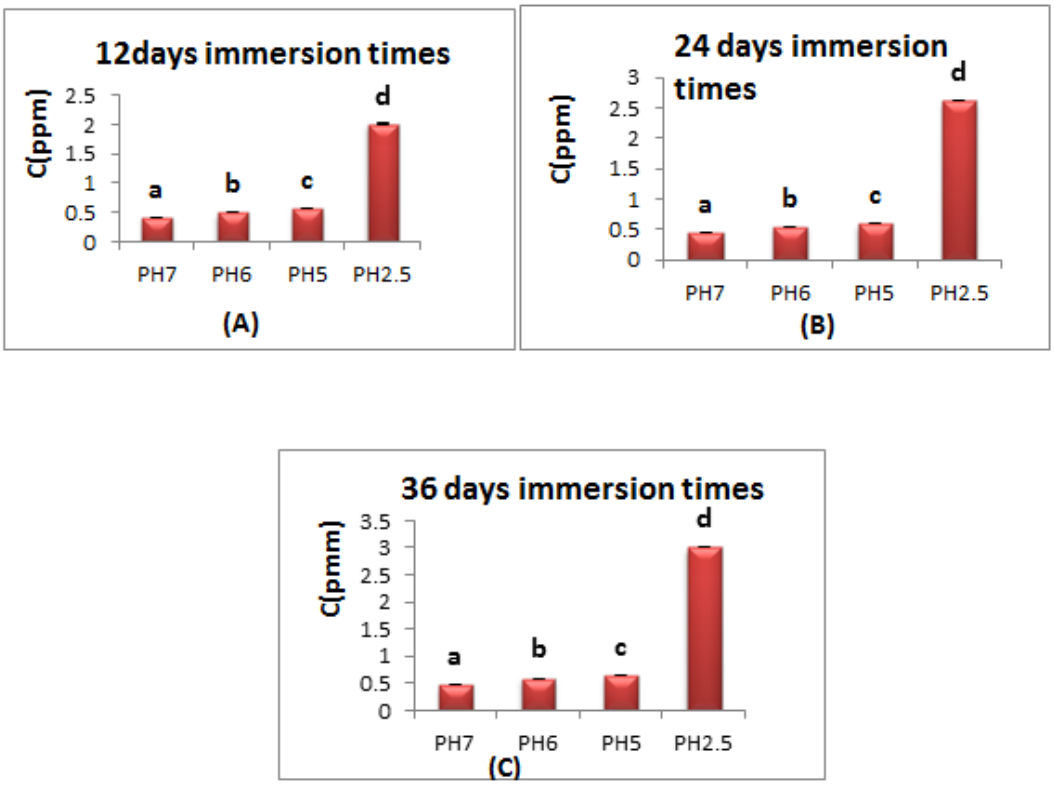
Figure(1):mean,±standerd deviation and Multiple Comparisons of Cr release s in solution dependent on the pH after various immersion times, (A:12 days immersion time, B: 24days immersion time,C: 36 days immersiontime).

Table (2): Anova of Cr ion release after different immersion times.

	Sum of Squares	df	Mean Square	F	Sig
Cr-12 Between Groups	1.056	3	.352	20539.435	.000
With Groups	.000	12	.000		
Total	1.056	15			
Cr-24Between Groups	1.180	3	393	227507.99	.000
With Groups	.000	12	.000		
Total	1.180	15			
Cr-36 Between Groups	1.360	3	.453	324692.10	.000
With Groups	.000	12	.000		
Total	1.360	15			

B -Nickel ion releases:

The value of mean of Ni ion release (pmm),± standard deviation, Dennett's test and Duncan Multiple analysis rang test of control, and three immersion solutions artificial saliva with different pH(7as control,6,5 and 2.5) after various immersion times are shown in Figure (2). After 12, 24 and 36 days of immersion, Ni ion release in small amount in solution with pH (6,5) respectively, while in pH 2.5 release in large amount (2.01,2.61, 3.012 ppm) respectively when compare with control pH7 as shown in Figure(2). Ni ion release showed a statistically significant difference at $p \leq 0.05$ between three immersion solutions after various immersion times as shown in Table (3). It should be mentioned that nickel ion release has been found more release than chromium as shown in Figure (1,2).



Figure(2): mean,±standerd deviation and Multiple Comparisons of Ni ion release in solution dependent on the pH after various immersion time, (A:12 daysimmersion time, B: 24 days immersion time,C: 36 day simmersion time).

Table (3): Anova of Ni ion releaseafter different immersion times.

	Sum of Squares	df	Mean Square	F	Sig
Cr-12 Between Groups	9.490	3	3.163	186534.95	.000
With Groups	.000	12	.000		
Total	9.490	15			
Cr-24Between Groups	12.876	3	4.292	2395572.5	.000
With Groups	.000	12	.000		
Total	12.876	15			
Cr-36 Between Groups	21.057	3	7.019	10528552	.000
With Groups	.000	12	.000		
Total	21.057	15			

DISCUSIONS

Dental casting alloy should not be toxic, which means that they should not chemically react with either acids or alkaline solutions when a prosthetic appliance is inserted into the oral cavity dental alloy, is in contact with saliva. Saliva is a hypotonic solution and good conductor of electricity, Metal ions which are released from dental alloys in the humid oral cavity medium can lead to allergic responses. Furthermore, there by causing different changes base metals.[12,13,14,15]

Results showed that the artificial saliva (pH2.5) showed a significantly and higher rate of Ni and Cr release at $p \leq 0.05$ than artificial saliva with (pH 7as contro,6,5) after various immersion times as show in Figures (1,2).

All three observed parameters, chemical composition of the alloy, pH value of the artificial saliva, and time of exposure to the solution influenced ion release. Statistically significant stimulation of ion release at lower pH ($P < .05$), which is in line with the hypothesis that organic acids in dento bacterial plaque affect the release of ions, emphasizes the major role of oral hygiene in minimizing corrosion. [13,16,17]The finding of (Majak, et al, Elshahawy,et al) was concluded that levels of released ions were gradually increased with decreasing solution pH. This occurred because the acidic condition provide a reducing environment in which the oxide film required for corrosion resistance is less stable. The pH and period interactions were statistically significant, highest amount of ion release occurred after 60 days of immersion for every alloy in artificial saliva of pH 2.3 and lowest in 0.9% saline solution. It was concluded that ion release from alloys was pH dependent. [6,18] Our study determined that, the greater amount of element release of Ni from Ni-Cr alloy as compared to Cr, Cr release from the Ni-Cr alloy were much lower in comparison to the release of Ni in artificial saliva, could be related to the lower content of Cr in its composition of alloy,the amount of element release increased with increasing conditioning, times, this finding agreement with other reseaeches. [1,19,20,21] While our finding disagree with the result of (Duffo, et al,Menek, et al) who showed that nickel ion release was decreased with increasing pH of the different liquids is independent on the pH of the solution in all time periods. Finaly in the present study, quantities of Ni eleased from Ni based alloy in the four different immersion media were markedly below the average dietary intake of (200–300 μg/day), and average dietary intake of Cr is 280 μg/day,this agreement with the results of (Bhaska and Reddy).

CONCLUSIONS

There is an evidence that there is Ni and Cr ions release from Ni-Cr alloy at the presence of different acidity of artificial saliva, Cr and Ni ion release in small amount in solution with pH(6,5), while in pH 2.5 release in large amount after (12, 24, 36) days of immersion. Amount of metals released from Ni-Cr alloy in artificial saliva, was significantly below the average dietary intake and did not reach toxic concentrations. Nickel exhibited the highest level of ion release and Cr the lowest level. Alloy type, pH and alloy pH interaction each affected the degree of release of the ions.

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