

The effect of different mouth washes on the metallic ion release from cobalt-chromium alloy denture base material

(Mouth washes and ion release from Co-Cr alloy denture base)

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ABSTRACT

Aim: To evaluate the effect of different mouth washes on the metallic ion release (Co and Cr) from Cobalt-Chromium alloy denture base material after two immersion periods

Materials and Methods: Thirty-two samples of Co-Cr alloy and three mouth washes, (Kin, Zac and Siwak extract 1%) and distilled water as a control were used. Co-Cr alloy samples were distributed to mouth washes in which half of them were immersed into their groups for two weeks at 37 °C and the other half were immersed for one month. Then they were undergone metallic ion release test by the use of atomic absorption spectrophotometry four times for each study group.

Results: There was a significant difference in Chrome and Cobalt ions release after 2-weeks among mouth wash groups, also a significant difference in Chrome ion but insignificance in Cobalt ion release after one-month. The least release of total ion was in persica group (siwak) in both immersion periods, while the highest amounts were in zac and kin groups.

Conclusions: Cobalt and Chromium ions release in one-month was more than two-weeks immersion. Persica mouth wash group had the least amount of total ions release.

Keywords: Mouth washes, ion release, Co-Cr denture base.

INTRODUCTION

Chrome containing alloys are the principle materials from which removable partial denture frameworks, major connectors and denture bases are constructed. The popularity of Cr-Co alloy materials is increased as they are rigid, strong in the thin sections, having good thermal conductivity and low density⁽¹⁻³⁾.

Dental alloys are exposed daily to different conditions in the oral cavity which offer ideal condition for corrosion and chemical degradation of dental material. The material employed in the mouth must be tarnish-resistant and must not be affected by mouth fluids⁽⁴⁾. The release of metal ions from dental alloys may be distributed throughout the body and cause adverse biological effects, depending on the ion species and its concentration^(5,6).

Many different mouthwashes are commercially available, the selection needs to take into consideration factors such as oral conditions, the efficacy and safety of the mouthwash^(7,8). Fluoride mouthwashes reduce dental caries and they are recommended for patients who have difficulty with oral hygiene procedures and those undergoing fixed orthodontic treatment⁽⁹⁾.

Salvadora Persica (Miswak-Siwak) is a medical plant whose roots, twigs or stems have been used for centuries as oral hygiene tool in many parts of the world and was advised by Prophet Mohammed (PBUH) to be used before every praying. Several studies have shown that extract of Salvadora Persica possess many biological properties including antibacterial, antifungal, anticaries, anti-inflammatory and reduces gingivitis⁽¹⁰⁻¹⁴⁾.

The aim of this study was to measure the quantity of Co and Cr ions released from C-Cr alloy denture base in different mouthwashes as a function of two immersion periods.

MATERIALS and METHODS

1- Preparation of Co-Cr alloy denture base:

Wax pattern was prepared using base plate wax to construct thirty two samples of (10x10x1) mm dimension of Co-Cr alloy denture base (Biosil, Germany). The wax patterns were sprued and invested in phosphate bonded investment material (Biosint –Supra, Degussa, Germany) in accordance with manufacturers' instructions. Investment molds were placed in a casting furnace and heated at a constant rate to 1050 °C with the total heating time about 150 minutes according to manufacturers' instructions. The investment mold and refractory crucible containing the metal were placed in the casting machine (Motor-cast, Degussa, Germany). When the metal was completely molten, the heat source was removed and the casting arm of the machine was rotated to thrust the molten metal into the mold⁽¹⁵⁾. The samples were removed from the mold and sandblasted to remove investment material. Finishing and polishing were performed using carborandum wheels, special stone burs, brushes and rubber wheels.

2- Types of mouth washes in the study:

Four study groups were used in this study according to the type and concentration of mouth washes as following:

First group: *Salvadora Persica* (Siwak) extract:- *Salvadora Persica* chewing sticks (Saudi Arabia) were removed from their package and left to dry, they were cut to small pieces and ground to powder using a food blender. 120 ml of 60% ethanol were added to 40 gm of powder in a sterile well capped container, left for 3 days at room temperature and then filtered using No.1 filter paper. The extract was autoclaved at 37°C until it became dry and it was stored in a sterile screw capped vials in the refrigerator until needed for use and then freshly prepared in distilled water immediately before use at a concentration of 1% (10mg/ml)^(13,16,17). Siwak mouth wash had (NaF=32.5 ppm) and (PH=7).

Second group: Kinmouth wash (0.12g CHX digluconate with 0.05 g NaF and 0.06 g sodium saccharine, PH= 5.8).

Third group: Zac mouth wash (0.12% CHX digluconate with 0.05% NaF, PH= 6).

Fourth group: Sterile distilled water (control group).

In this study, thirty two samples of Co-Cr alloy denture base were distributed to the four study groups in which each of these groups has eight samples which were incubated at 37 °C and subdivided into two immersion periods (two weeks and one month), so each subgroup had four samples. Each sample was placed separately in a well capped glass container containing 5 ml of its corresponding mouth wash. The containers were stored and incubated at 37°C. At the end of each immersion period, metallic ion release was measured.

3- Measurement of Corrosion:

The quantity of metal ions released into mouth washes (measure of a corrosion) in each container was determined using a flame atomic absorption spectrophotometer (Analytikjena, NOVAA 350, Germany). These measurements were taken four times for each group of study and the mean concentration of element released from the samples were presented in ppm.

4- Statistical Analysis:

One-way analysis of variance followed by Duncan's multiple range test was used to analyze the mean (standard deviation) of the ions released from the Co-Cr alloy denture base and t-test was used to compare between immersion periods. Statistical differences were defined at $P < 0.05$ level of significance.

RESULTS

Table(1) revealed that there was a significant difference in chrome ion release and Cobalt ion release kept in different mouth wash groups after 2-weeks immersion. Duncan's multiple range test, Figure(1) showed that control group (Distill water) had the least Chrome ion release, while Figure(2) showed that *Salvadora Persica* (siwak) group expressed the least Cobalt ion release after 2-weeks immersion.

Table(2) demonstrated a significant difference in Chrome ion release but insignificance in Cobalt ion release $P > 0.05$ among mouth wash groups after one-month immersion. Duncan's multiple range test, Figure(3) showed that Chrome ion release registered the least amount in control group and highest amount in Zac mouth wash group, while Figure(4) expressed the highest Cobalt ion release in Kin mouth wash group and the least one in siwak extract group after one-month immersion.

Table(3) showed a significant difference in total ion release (Co+Cr) after 2-weeks immersion and insignificant difference in total ion release after one-month. Duncan's multiple range test, Figure(5) demonstrated that siwak group recorded the least total ion release after 2-weeks and zac mouth wash recorded the highest one, while Figure(6) showed that the least total ion release after one-month was recorded in siwak group and the highest amount in

kin mouth wash group. Table (4) demonstrated insignificant increase in total ion release after one month when compared to 2-weeks immersion in all mouth washes.

DISCUSSION

The oral environments particularly ideal for the biodegradation of metals, because of its thermal microbiological and enzymatic properties. A metal in aqueous solution will be thermodynamically unstable and there is a tendency to pass from solid state to anionic form which is associated with decrease in energy. The direction of energy changes influenced by factors such as surface morphology, salivary composition, PH and temperature. An unstable metal may corrode, releasing metal ions into a solution and may have adverse biological, aesthetic and functional effects^(18,19).

Usually mouthwashes must be used twice a week for about 1 minute. But, it is recommended that after mouthwash a patient must not eat, drink and rinse so the components of mouthwash are present for a long time and it is difficult to determine the exact duration of contact between the mouthwash and the dental appliance⁽²⁰⁾. Several studies have demonstrated that the level of metal release from fixed orthodontic appliances peak at day 7 and that all release is completed within 4 weeks⁽²¹⁾.

The focus of this study was a comparison between three mouthwashes and distilled water by measuring cobalt and chrome ions release concentration using atomic absorption spectroscopy.

Table (1,2,3) demonstrated that release of cobalt ion and chrome ion separately and totally after both immersion periods (2 weeks and one month) registered highest levels in Kin and Zac mouthwashes and the least levels in Siwak extract (Salvadora Persica) and distilled water. As the acidity of mouthwashes is (5.8, 6.2, 7, 7.5) for Kin, Zac, Persica and water respectively, so when PH conditions became more acidic, the amount of ion released from metallic alloys became higher⁽²²⁾. Salvadora Persica extract at 10 mg/ml concentration is well tolerated and safe. As a mouthwash is less effective than Chlorhexidine in preventing plaque accumulation⁽²³⁾. But it released metal ions less than Zac and Kin washes, this could be attributed also to the presence of chlorhexidine in the composition of Zac and Kin washes which is responsible for their corrosiveness, in addition the Fluoride concentration and acidic PH impair the corrosion resistance of a metal⁽²⁴⁾.

In this study, two ions release were measured (chrome and cobalt), chrome ion release was very low when compared with the release of cobalt ion, the result is due to the compositions of cobalt-chromium alloy used in the study which contains about 64% cobalt and 29% chromium⁽⁴⁾.

Table (4) showed that the amount of ion release kept in mouthwashes was increased with increasing conditioning time. This result was in accordance with Huang et al⁽²⁵⁾ and Nejatidanesh et al⁽²⁶⁾ who reported that corrosion of a metal surface increases overtime and this result was independent of the PH of immersion solution.

Mouthwashes used in this study in a static condition, but more metal ion release could occur in real life because of fluidity of Saliva in the mouth and also because oxide layers are removed by tooth brushing^(20,21).

From results of this study, it can be concluded that the corrosion activity of mouthwashes depends on its acidity, chemical composition and immersion time in releasing ions from metallic denture base.

CONCLUSIONS

Relying on the quantity of Cobalt and Chromium ion released from Co-Cr alloy denture base into mouth wash groups, Salvadorapersica extract (siwak) is better option than zac and kin mouth wash groups. In all groups Chrome ion release was less than Cobalt ion and long immersion period (one-month) released more ions than short immersion (2-weeks).

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Table(1): (ANOVA) of the mean Chrome ion and mean Cobalt ion released from Co-Cr alloy denture base in different mouth washes after two weeks immersion

Type of ion release		Sum of Square	df	Mean Square	F-value	p-value
Chrome ion	Between groups	0.002	3	8.235	4.704	0.021
	Within groups	0.002	12	1.750		
	Total	0.005	15			
Cobalt ion	Between groups	1.772	3	0.591	4.713	0.021
	Within groups	1.504	12	0.125		
	Total	3.276	15			

df: degree of freedom

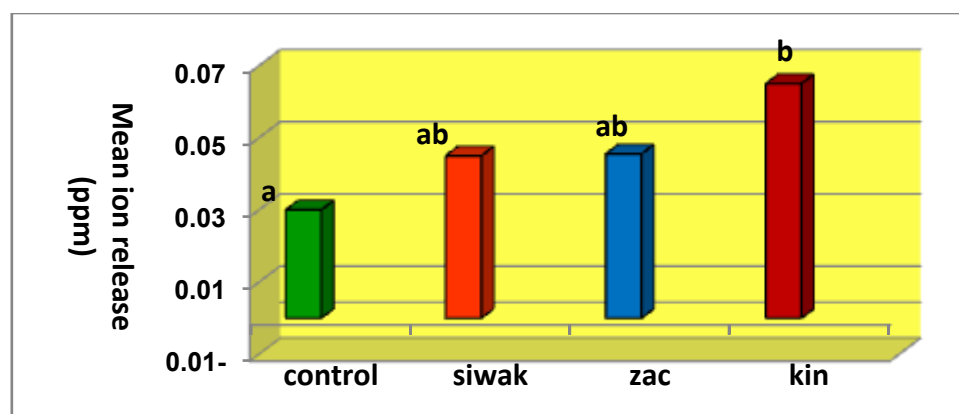


Fig. (1): (DMRT) of the mean Chrome ion release from Co-Cr denture base in different mouth washes after two-weeks immersion

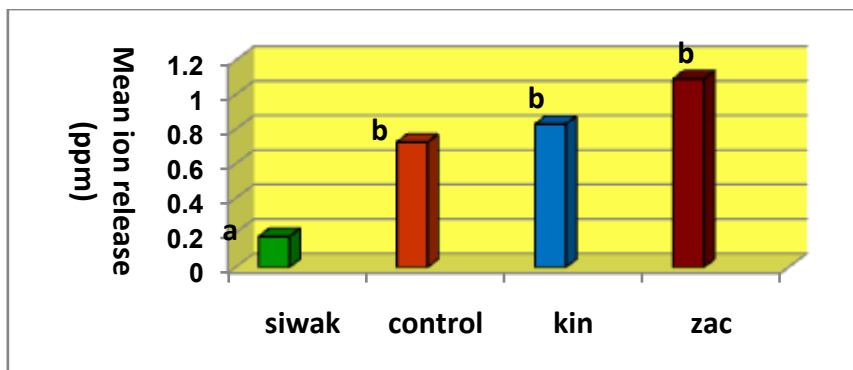


Fig (2): (DMRT) of the mean Cobalt ion release from Co-Cr denture base in different mouth washes after two-weeks immersion

Table(2):(ANOVA) of the mean Chrome ion and mean Cobalt ion released from Co-Cr alloy denture base in different mouth washes after one month immersion

Type of ion release		Sum of Square	df	Mean Square	F-value	p-value
Chrome ion	Between groups	0.038	3	0.013	9.700	0.002
	Within groups	0.016	12	0.001		
	Total	0.054	15			
Cobalt ion	Between groups	5.546	3	1.849	2.101	0.154
	Within groups	10.558	12	0.880		
	Total	16.103	15			

df: degree of freedom

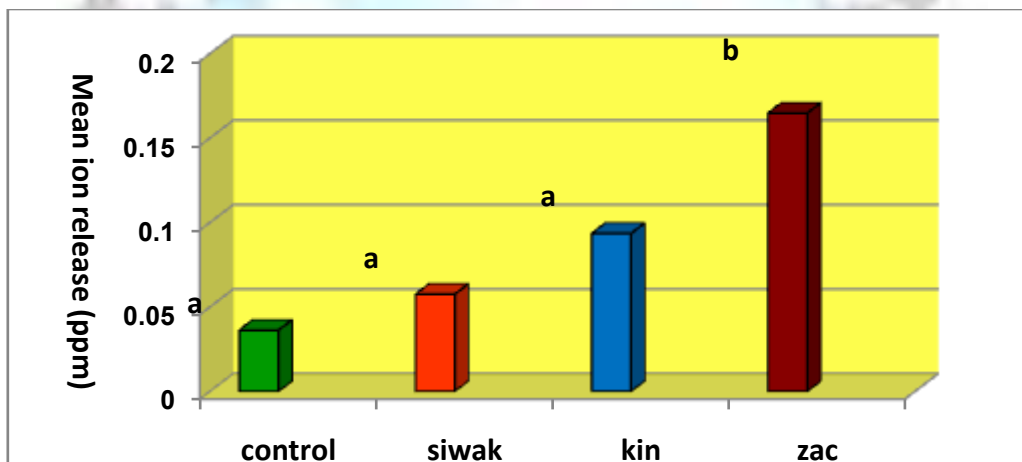


Fig (3): (DMRT) of the mean Chrome ion release from Co-Cr denture base in different mouth washes after one-month immersion

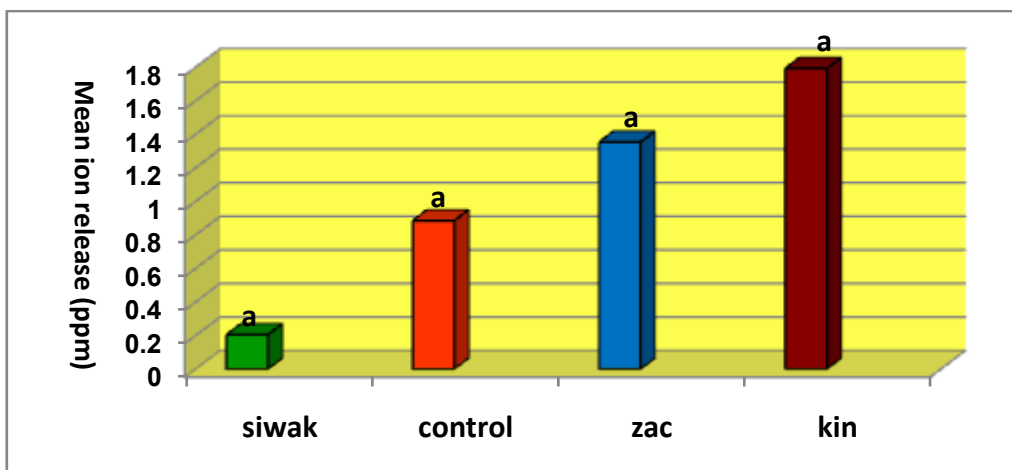


Fig (4): (DMRT) of the mean Cobalt ion release from Co-Cr denture base in different mouth washes after one-month immersion

Table(3):(ANOVA) of the mean total ions released(Chrome ion and Cobalt ion) from Co-Cr alloy denture base in different mouth washes after two weeks and after one month immersion

Immersion period		Sum of Square	df	Mean Square	F-value	p-value
Two-weeks	Between groups	1.793	3	0.598	4.753	0.021
	Within groups	1.509	12	0.126		
	Total	3.302	15			
One-month	Between groups	6.077	3	2.026	2.164	0.145
	Within groups	11.234	12	0.936		
	Total	17.312	15			

df: degree of freedom

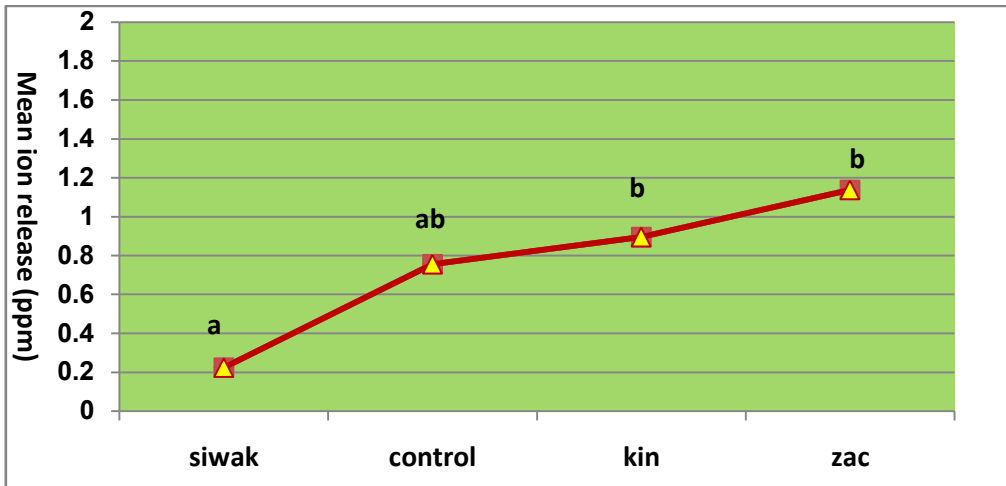


Fig (5): (DMRT) of the total ion release (Co + Cr) from Co-Cr denture base in different mouth washes after two-weeks immersion

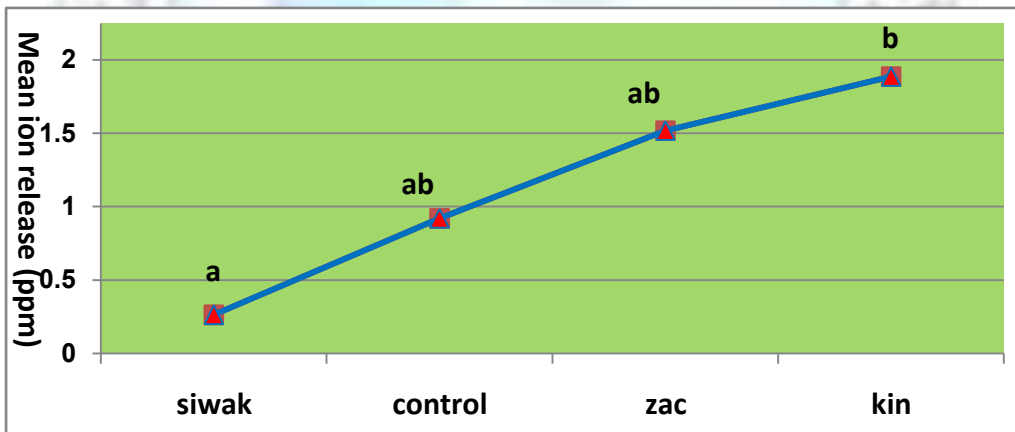


Fig (6): (DMRT) of the total ion release (Co +Cr) from Co-Cr denture base in different mouth washes after one-month immersion

Table(4): t-test of the total ion release (Cr+Co) between 2-weeks and one month immersion in mouth washes.

Paired Samples Test					
Groups		Mean	t	df	p-value
Kin	Release after 2-weeks - Release after 1-month	0.89450 1.88775	-0.941	3	0.416
Zac	Release after 2-weeks - Release after 1-month	1.13725 1.151850	-2.314	3	0.104
Siwak	Release after 2-weeks - Release after 1-month	0.22325 0.26275	-0.276	3	0.800
Control	Release after 2-weeks - Release after 1-month	0.75500 0.92175	-1.359	3	0.267