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Corrosion of Orthodontic Metallic Brackets Immersed in Solutions of Salt and Spices in Artificial Saliva

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Abstract

Background: Orthodontic treatment is commonly use to treat dental malalignment, especially orthodontic braces as it help to realigned teeth to the normal position as well as for aesthetic purpose. As orthodontic braces is a choice of orthodontic treatment various kind of orthodontic braces had been invented based on the material used, adhesives systems as well as their strengths to bring about tooth movement. As it is placed in the oral cavity, the aggressive environments of the oral cavity, will lead to corrosion of the orthodontic brackets. This may affect it physical properties and clinical performance.

Aim: To study the corrosion of orthodontic brackets that immersed in the solution of artificial saliva and spices.

Materials and Method: Stainless steel orthodontic brackets were used for this studies. Each bracket was placed in the container contain artificial saliva and other agents. Several types of aqueous solutions were prepared for this study by using different agents (spices). They were pure artificial saliva, salt (sodium chloride), black pepper, turmeric and mixture of all of the spices along with salt. After 24 hours, surface changes was seen under the optical microscope.

Results: Based on the study, orthodontic brackets surface immersed in the controlled medium, revealed that more corrosion was seen in the salt medium when compared to pure artificial saliva. More pitting also was seen in the salt medium of the controlled group. Based on the surface analysis of the orthodontic brackets in the studied groups, demonstrate that more corrosion and pitting was seen in the aqueous solution of mixture of artificial saliva with salt and spices and less pitting and corrosion was seen in the turmeric solution.

Conclusion: Based on the study, the finding suggest that the corrosion behaviour of the orthodontic brackets is influenced by the presence of a salt (NaCl) and other spices. Salt and black pepper are responsible for the corrosion of the orthodontic brackets, while turmeric capable in reduction or slowing the process of corrosion.

Keywords: *Corrosion of brackets, spices, orthodontic treatment*

Introduction

Orthodontic treatment is commonly use to treat dental malalignment, especially orthodontic braces as it help to realigned teeth to the normal position as well as for aesthetic purpose. Early approach for orthodontic treatment will help to provide a better outcome. As orthodontic braces is a choice of orthodontic treatment various kind of orthodontic braces had been invented based on the material used, adhesives systems as well as their strengths to bring about tooth movement. This will help to provide a good results and also patient comfort and aesthetic through the dental treatment. Example of dental brackets include metal brackets, titanium brackets, ceramic bracket and plastic brackets (aesthetic) [1].

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Among these brackets, metal brackets is commonly used for orthodontic treatments due to their strong shear strength and also its successful results in clinical orthodontic study. However, when orthodontic brackets are placed inside the oral cavity, pitting and corrosion may occur as they are exposed to the components of the saliva as well as the food that accumulate in the oral cavity. Generally, saliva composed of inorganic salts which mainly chlorides and phosphates, along with other components like organic acids, enzymes, bacterial and also gastric secretions [2]. These mixture of saliva along with the food intake (especially spices), will create an aggressive environment for the orthodontic braces, which in return may results to degradation. Even though, they are manufacture to become resistant against the mechanical stress and also degradation cause by the active forces and corrosive environment [3].

This aggressive environments of the oral cavity, will lead to corrosion of the orthodontic brackets. Variety of dietary sources like spices, common salt; sodium chloride (NaCl), fruit juices and carbonated drinks also could be one of the factors which promote the corrosion of the brackets [4]. therefore, diet plays an important role in causing the corrosion of the metal appliances that placed in the oral cavity [5]. Corrosion of this dental materials in oral cavity tend to cause tooth discolouration, local pains or allergic reactions due to released of the metals ions into the organisms present in oral cavity [3,6]. Apart from that, corrosion of the metal parts can also affect their biomechanical properties along with the appliance efficacy [7].

On the orthodontic brackets surfaces, pitting corrosion are commonly seen. It is the most destructive type of corrosion which seen in the orthodontic appliances placed in the oral cavity [8]. It caused localised type of corrosion which can be scattered, isolated or closed togethers in forms of holes or pits within the metal. It will result to rough like appearance on the surface of the appliance. This pitting usually occur primarily within the crevices or other protected areas on metal surfaces that exposed to ward the corrosive agents or environment [4]. Therefore, this study was done to evaluate the relationship between the corrosion of the orthodontic brackets in artificial saliva with salts and spices.

Materials and Method

Artificial Saliva

Materials that bring used in the study were mainly orthodontic brackets, artificial saliva and also spices. Orthodontic brackets used for the study are stainless steel (Libral Traders). The artificial saliva used was Wet mouth ICPA, which is manufactured artificial saliva for wetting purposed. It commonly indicated for the xerostamia patient or patient on oral therapy. It composed of water, glycerine, cellulose gum, sodium saccharin, parabens and also flavouring agents.

Salt and Spices

Several types of aqueous solutions were prepared for this study by using different agents (spices). They were pure artificial saliva, salt (sodium chloride), black pepper, turmeric and mixture of all of the spices along with salt. Salt which is sodium chloride (NaCl) was used as the promoter of corrosive agent in this study, while numeric act as inhibitor of the corrosion. The chemical compositions of the spices used in this study were showed in Table 1.

Table 1: Chemical compositions of spices used in present investigation

Spices	Scientific Name	Chemical Compositions
Black pepper	Piper nigrum	Crystalline alkaloids, piperine, piperettine, terpenes, β-caryophllene, limonene, sabinene, β-pinene, myrcene, p-cymene and oxidated constituents [5]
Tumeric	*Curcuma longa*	Diaryl heptanoid (curcuminoid, curcumin), sesquiterpenes (zingiberene), ketones and monoterpenes [5]

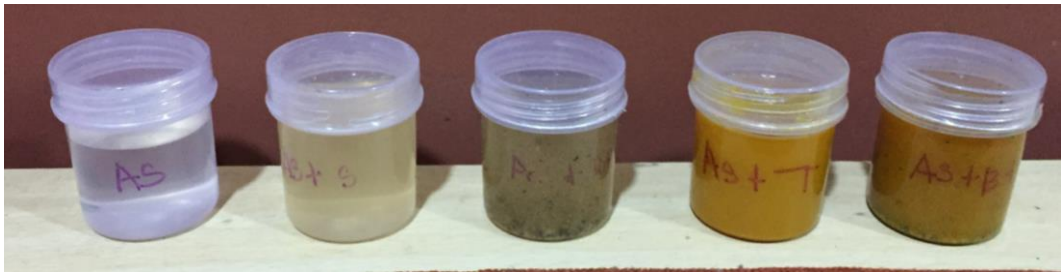

FIGURE 1: IMMERSION OF THE ORTHODONTIC BRACKETS IN VARIOUS AQUEOUS MEDIUM. (AS-ARTIFICIAL SALIVA, S-SALT, BP-BLACK PEPPER, T-TUMERIC)

Surface analysis study

Initially, this study was conducted by preparing the aqueous medium, followed by immersing the orthodontic brackets in the prepared aqueous solutions as shown in Figure 1. The orthodontic brackets was placed in the closed container for about 24 hours. After 24 hours, surface analysis was done in order to identify the rate of corrosion of the orthodontic brackets immersed in the artificial saliva with salt and other spices solutions. Surface analysis was done by using the optical microscope.

Results

Artificial saliva and artificial saliva with sodium chloride medium were controlled variables of the study, which used as reference mediums. Whereas, turmeric, black pepper and mixture of the spices were used as the studied solutions. Based on the visual observation of the orthodontic brackets surface immersed in the controlled medium, it revealed that more corrosion was seen in the salt medium when compared to pure artificial saliva. More pitting also was seen in the salt medium of the controlled group.

Based on the surface analysis of the orthodontic brackets in the studied groups, demonstrate that more corrosion and pitting was seen in the aqueous solution of mixture of artificial saliva with salt and spices as shown in Figure 6. Figure 3 reveals less pitting and corrosion was seen in the turmeric solution. The corrosion and pitting of the orthodontic brackets were arranged in the ascending order as mention below.

1. Turmeric
2. Artificial saliva
3. Salt
4. Artificial saliva and black pepper
5. Mixture of artificial saliva, salt, turmeric and black pepper

Table 2: pH of solution medium immediately after preparation and after 24 hours.

MEDIUM	pH of solution immediate after preparation	pH of solution after 24 hours
Artificial saliva	7.5	7.7
Salt	7.2	7.4
Turmeric	6.2	6.5
Black pepper	6.7	7.0
Mixed of spices and salt	6.5	6.9

Discussion

Variety of spices used in food have lots of benefits and medical used. In general, both tumeric and black pepper are having anti oxidants property, which allowed them to scavenge the free radicals produced inside the body [9]. However, when they are consumed in a large amount it may cause corrosion to the orthodontic appliances which placed inside the oral cavity due to their aggressive nature especially the black pepper. Salt is also one of the ingredients which commonly used in food, as flavour enhancer. However, high intake of salty food should be avoided especially during the orthodontic treatment, as it can promote the corrosion of the orthodontic brackets, due to formation of acid. This acid is formed due to release of chloride ions from the salt with all available hydrogen ions in the oral cavity [10].

Released of the chloride ions from the salt also cause negative effect on the formation of the passive layer on the metal surface. Passive film is a protective film that formed on the orthodontic alloy which can be spontaneously forms or reformed in air or under the wet conditions, in the presence of oxygen. Oxygen allow this film to form and maintain it consistency [11]. However, in the presents of acidic or chloride ions, it may cause alterations on the passive film, which can promote corrosion of the orthodontic brackets. This chloride ion will combine with a metal ion to form metal chloride, which lead to dissolution and propagation of the latter in autocatalytic manner [5]. As the release of this metal ions increased, this will result to increase in the pH of the saliva, which in turn increase the rate of corrosion of the orthodontic brackets.

Other spices like black pepper and chilly powder also may cause corrosion of the orthodontic brackets, due to their aggressive nature. Adding of the black pepper to the artificial saliva enhance the aggressive property of the artificial saliva also through chloride ions, which promote corrosion of orthodontic brackets. Pitting is one of the common localised corrosion which seen on the surface of the metallic orthodontic brackets. It usually form due to the chloride ions, which break down the protective thin oxide film and cause rapid dissolution of the underlying metal and result to localise pitting formation [12]. Thus, it may cause formation of holes, if the solution are too aggressive. Therefore, mixture of artificial saliva with salt and black pepper show the most corrosion in compare to other aqueous solutions.

Although, some spices can cause corrosion of the orthodontic brackets, some spices may inhibit or slowing the process of corrosion of orthodontic brackets like turmeric and coriander. The components of turmeric may have favoured in delayed of the corrosion of the orthodontic brackets. They will allow for prevention of adsorption of chloride ion, which is the responsible agent to cause pitting and corrosion of the orthodontic brackets. Therefore, aqueous solution of turmeric show the least corrosion on surface analysis min compare to other mixtures.

Thus, a proper diet should be educate to patient undergone the orthodontic treatments, as corrosion of the orthodontic appliances may affect the physical properties and its mechanical performance for a success orthodontic treatments.

Conclusion

Based on the study, the finding suggest that the corrosion behaviour of the orthodontic brackets is influenced by the presence of a salt (NaCl) and other spices. Corrosion can cause weakening of the orthodontic brackets and leading to mechanical failure of the orthodontic treatment, as it may affect the physical and chemical properties of the materials. Salt and black pepper are responsible for the corrosion of the orthodontic brackets, while turmeric capable in reduction or slowing the process of corrosion. Therefore, a proper diet should be instructed to patient undergone orthodontic treatment, in order to prevent failure of the treatment and also promote the success of the treatment.

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Source of Funding- Self

Conflict of Interest - Nil

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