

Sterilization Effect on Oral Germs Using Microwave

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Abstract

This research was conducted to prevent oral disease by preventing the recurrence and re-adhesion of germs present in toothbrushes by promoting sterilization of toothbrushes easily and conveniently at home using microwave ovens. Microwave treatment time was treated with a toothbrush contaminated with *S.mutans* for 0, 30, 60, and 90 seconds, respectively. To check the sterilization effect in the toothbrush, 1 ml of D.W was treated and 900 µl was added to the agar plate. The processed agar plate was cultured at an incubator of 37°C for 24 hours and the number of microorganisms was measured using CFU method. A total of three repetitions were performed in the same way to reduce the margin of error of the test results. *S.mutans* bacteria, which are highly resistant to sterilization, are mostly extinct in 90 seconds, it is believed that the household can kill microorganisms that reside in the Old River economically and effectively in a short time. Through this study, microwave sterilization effect is known, and the toothbrush sterilization is performed easily and conveniently at home to prevent the inflow of bacteria present in the toothbrush into the oral cavity, which is believed to be a suitable method to prevent oral diseases.

Keywords: Microwave; sterilization; bacterial; oral germ; effect

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Date of Submission : 10.04.2020

Introduction

Brushing is the most basic means of removing tooth surface bacteria or food debris attached to the teeth. A toothbrush is a tool that massages the gingiva and cleans the tooth surface. After use, it is recommended to wash well with running water and store in a dry place out of contact with each other to prevent the growth of bacteria (Ji YJ., 2012). However, most people are not aware of the importance of proper toothbrush storage, and they neglect toothbrush management and leave it in

an environment that can be contaminated with bacteria. In other words, bacteria that have been propagated by the wrong management method come back into the oral cavity through a contaminated toothbrush and multiply secondarily, causing periodontal disease and dental caries. According to Yang et al.'s report (Yang EJ et al., 1998), $1 \times 10^1 \times 10^6 - 9 \times 10^9$ bacteria are always attached to toothbrushes used in general households. Recently, as a problem due to bacterial propagation of toothbrushes has emerged, various toothbrush sterilizers have been introduced, and representative examples include ultraviolet sterilizers, ozone sterilizers, and microwave sterilizers. The portable toothbrush sterilizer released by supplementing the difficulty of carrying due to the large volume and weight of the ultraviolet sterilizer is mostly sterilizing using ozone. Ozone is a colorless gas that always exists in the atmosphere, and it is easy to combine with other substances and has an oxidizing power. For this reason, it is also used for disinfection and cleaning, and quickly sterilizes various bacteria, fungi and pathogenic viruses. However, if ozone is excessive, there is a disadvantage that it may be harmful to the human body due to strong oxidizing power. Gaudry and Klitorinos (Gaudry SD et al., 1995) showed an average of 4×10^3 CFU/ml when bacteria were isolated from healthy adult toothbrushes, and Verran and Leahy-Glimartin (Verran J et al., 1996) reported that the total number of bacteria isolated from toothbrushes varied up to 4×10^8 CFU/ml. Ahn et al (Sang Hee An et al., 1996) reported that as a result of examining the bacterial contamination of the toothbrush according to the period of use and washing period, as the washing time increased, the bacteria in the toothbrush decreased. Microwaves represent radio waves in the range of hundreds of MHz to tens of GHz of wavelength, and because of their short wavelength, they have almost similar properties to light, and are characterized by strong sterilization power. Microwave (oven) is the application of these characteristics. If the semi-permeable action is damaged by ions affecting the charge distribution near the cell membrane by the force of the electric field under the action of microwaves, it affects the function of the Na-K pump and causes cell membrane dysfunction, thereby disrupting or destroying the normal metabolic function of the cells. Eventually, it results in inhibition, arrest and sterilization of bacterial growth. In addition, the sterilizing effect of microwaves against microorganisms has been reported not only by heating, but also by non-heating effects, that is, by the physiological action of microwaves themselves (Guan D et al., 2003). This study aims to easily and conveniently sterilize toothbrushes at home using microwaves generated from microwave ovens, and also to prevent oral disease by preventing the recurrence and re-adhesion of germs present in toothbrushes.

Materials and Methods

Materials

Toothbrush

Double-fine bristle toothbrushes [Ozone, Busan, Korea] sold on the market were used as experimental materials.

Microwave oven

To reproduce microwave, the sterilization effect process was carried out using a microwave oven (RE-C210A, Samsung Electronics) of 700W.

Strains and bacterial culture methods

The strains used in this experiment were used by the Korea Research Institute of Biotechnology (KCCT) with *Streptococcus Mutans* bacteria and were added to the Brain Heart Infusion (BHI) brown (FlukaSwitzerland) with 24 hours of culture.

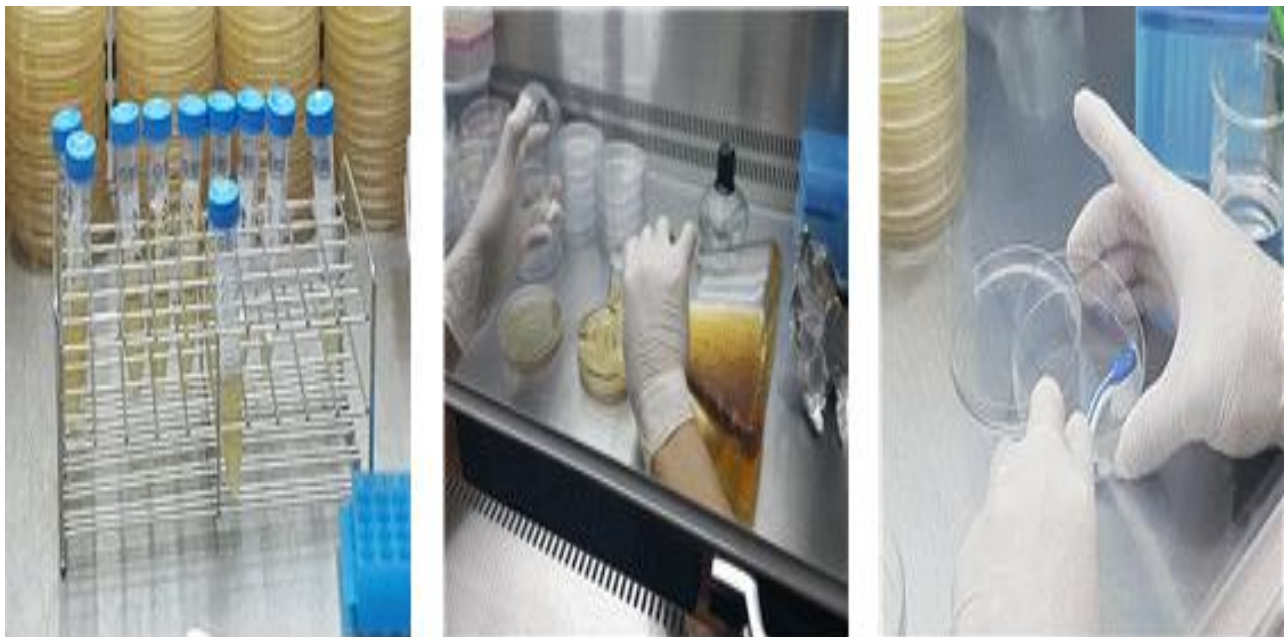


Figure 1: *S. mutans* cultivation

Methods

Sterilization Effect Measurement

Microwave treatment time was treated with a toothbrush contaminated with *S. mutans* for 0, 30, 60, and 90 seconds, respectively. To check the sterilization effect in the toothbrush, 1 ml of D.W was treated and 900 μ l was added to the agar plate.

The processed agar plate was cultured at an incubator of 37°C for 24 hours and the number of microorganisms was measured using CFU method. A total of three repetitions were performed in

the same way to reduce the margin of error of the test results.

Results and Discussion

Genus of resident bacteria in the mouth

The results of the experiment using gram dye to determine the type of bacteria that reside in the mouth are as shown in Figure 2. Among the large amounts of bacteria, both gram-positive bacteria and gram-negative bacteria were detected, and the ratio of gram-negative bacteria was significantly higher than that of gram-positive bacteria.

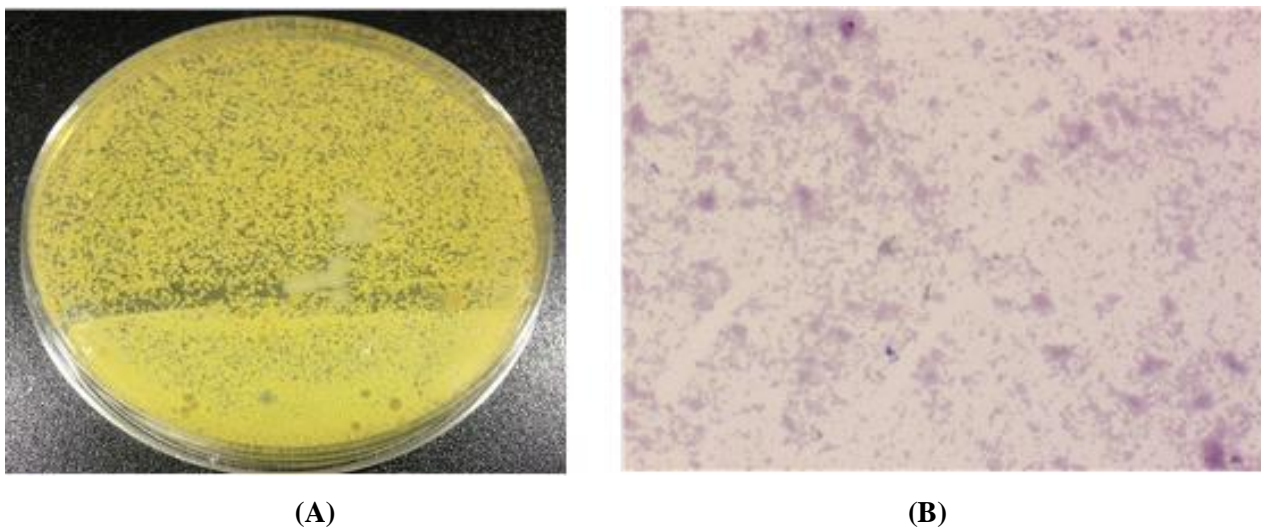


Figure2: Gram-negative bacteria residing in the oral cavity

Changes in the number of microorganisms according to sterilization time

The sterilization effect of *S.mutans* strains is analyzed by analyzing the sterilization effect attached to the toothbrush by the time of sterilization. After processing in the microwave for 0, 30, 60, and 90 seconds, most of the results were dead-end at 30 seconds to 4-log, at 60 seconds to 5-log, and 90 seconds to the death effect. According to this study, it is confirmed that sterilization results are higher as the microwave treatment time increases in *S.mutans* when handling toothbrushes contaminated with microwave ovens

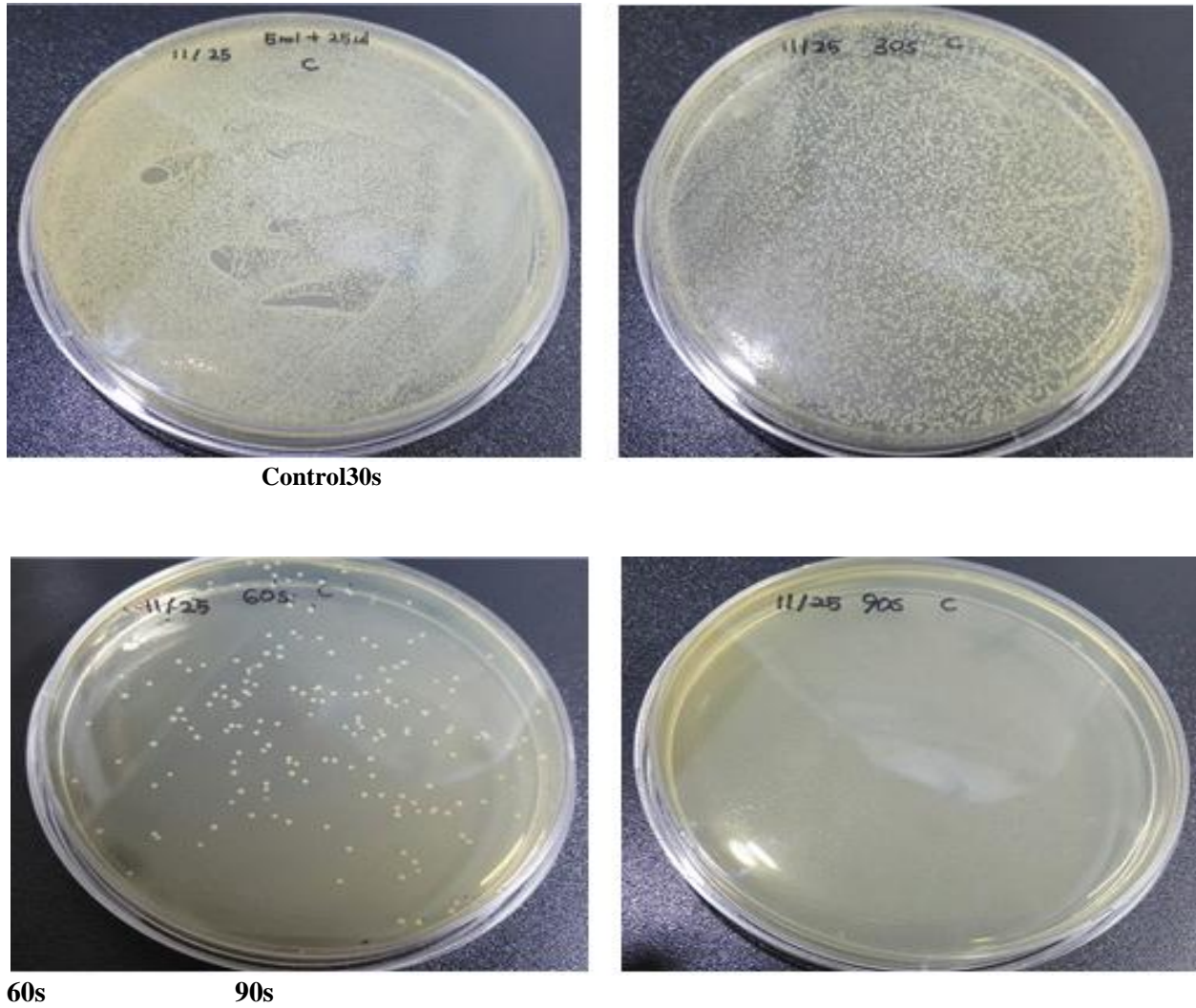


Figure 3: Changes in the number of microorganisms according to sterilization time

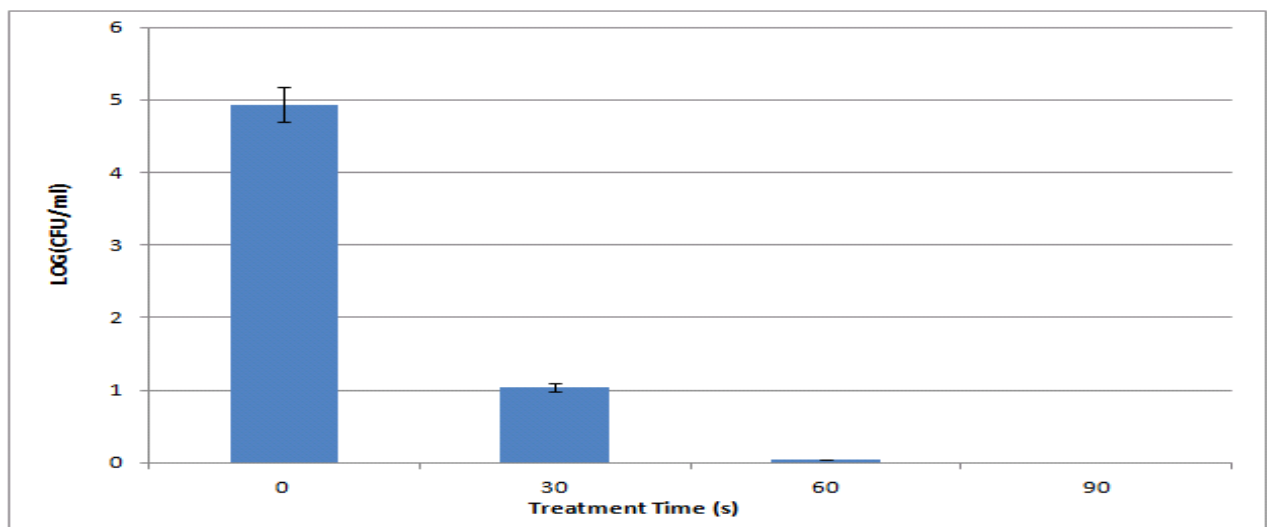


Figure 4: *S. mutans* Survival Rate at Agar Plate

Among the studies published using microwaves, Banik et al.(Banik S et al. 2003) said that microwaves improve the positive biological system in cells of animals as well as human, and Latimer and Matsen(Litimer JM et al. 1977)sterilized laboratory tools using microwaves and exposed them to microwaves for more than 5 minutes reported that sufficient sterilization was achieved. Andrea et al.(Sherbondy AL et al. 2002) reported that patients' catheter tube can be sterilized using a microwave oven capable of reproducing microwaves at home. Microwave's sterilization effect was investigated using *S. mutans* bacteria, which has the most effect on dental caries. *S. mutans* bacteria, known as the biggest cause of dental caries, is a type of bacterial bacteria. It lives in hard tissues rather than soft tissues in the oral cavity such as the mouth, mucous membranes, and tongue. Due to the habit of not brushing properly after eating food, it occurs mainly in an environment where various bacteria are inhabited. The most common way to sterilize toothbrush bacteria is the UV toothbrush sterilizer. When the sterilization time was more than 10 minutes, all of the UV toothbrush sterilizers tested were more than 96%, and the sterilization power was satisfactory, but there is a disadvantage that the treatment time takes more than 6 hours⁶⁾. Kozai et al.(Kozai K et al. 1989) reported that the toothbrush drying time was related to the bacterial contamination of the toothbrush, and it was reported that if the toothbrush is stored in a well-ventilated place, the number of bacteria present in the toothbrush can be reduced. In this study, as a result of processing in a microwave apparatus using *S. mutans* strains, it was confirmed that 99.99% in 30 seconds, 99.999% in 60 seconds, and 99.9999% in 90 seconds were killed. *S. mutans* bacterium belongs to gram-positive bacterium as a tragic anaerobic bacteria. In the case of gram-positive bacteria, there is a problem that it is difficult to kill due to the thick cell wall, but these results are thought to have been effective in both gram-negative bacteria and gram-positive bacteria residing in the oral cavity, and it is thought that the heat generated from microwaves acted effectively to destroy the cell wall. However, since the microwave oven may affect the physical and mechanical properties of the bristles due to environmental hormones on the plastic material, which is the handle of the toothbrush. It is believed that research and efforts to develop a toothbrush with increased durability or made of a brush head or toothbrush handle made of a material resistant to microwave ovens are required⁶⁾.The limitation of this study is that although the sterilization effect of the microwave oven has been proven, environmental hormones may be released from the plastic part of the toothbrush during sterilization, and deformation may occur after a certain period of time in the microwave depending on the type of bristles and head. And since the experiment was limited to *S. mutans* bacteria, the sterilizing effect on oral microorganisms other than *S. mutans* bacteria cannot be accurately known. However, as most of the *S. mutans* bacteria, which are highly resistant to sterilization, died in 90 seconds, it is considered that it can economically and

effectively kill the microorganisms residing in the oral cavity within a short time at home.

Conclusion

In this study, using the strain of *S. mutans*, which is the most existing gram-negative bacteria in the oral cavity, the sterilization effect of a microwave toothbrush that can be easily and conveniently used at home was compared with an ultraviolet sterilizer, analyzed and reviewed, and the following results were obtained.

1. As a result of Gram staining by collecting bacteria from a toothbrush used for 3 months, various types of Gram-positive and Gram-negative bacteria were detected in the oral cavity.
2. When the toothbrush was sterilized, the number of *S. mutans* bacteria decreased mostly in 30 seconds to 4-log, 60 seconds to 5-log, and 90 seconds.
3. In the bacterial culture medium of the 90 second group, which showed the most effective bactericidal power, there was no colony or an average of less than 1, showing 99.99% of the sterilization effect.

Through this study, microwave sterilization effect is known, and the toothbrush sterilization is performed easily and conveniently at home to prevent the inflow of bacteria present in the toothbrush into the oral cavity, which is believed to be a suitable method to prevent oral diseases.

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