The Roles of the Various Plasma Agents in the Deactivation of Streptococcusmutans Bacteria on Teeth

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Abstract

In this work; Cold plasma jets were utilize to determine the role of the charged molecules in the process of blocking the bacteria. These charged molecules played a key role in this disruption and using argon gas. These particles were found to play an important role in disabling *Streptococcus mutans* bacteria .UV and heating showed no secondary role in inhibiting bacteria while metastable stateandO3as well as O played a key role in this disruption.

Keywords: *Noble gas, cold plasma, S. mutans, metastable state.*

Introduction

Plasma Ionized gas represents a fourth state of matter consisting of electrons and charge carriers in addition to ions[1]. The killing of bacteria using non-thermal plasma has made this plasma an effective and useful role in various medical and biologic applications such as the removal of bacterial contamination and the sterilization of medical instruments in hospitals[2]. This type of plasma works at or near room temperature and this feature made Plasma does not produce heat damage to associated models or materials. This feature has opened the possibility of treating heat sensitive materials when developing a plasma jet that uses noble gases such as argon or helium, as well as killing bacteria in this way[3,4]. In the respiratory tract and mouth there *Streptococcus mutans* bacteria, gram positive bacteria and one member of mutant groups. *S.mutans* bacteria are responsible for the formation of bacteria in the mouth and therefore affect the teeth as well as immunodeficient patients who undergo bone marrow transplantation and chemotherapy. The most of these organisms have the ability to analyze sucrose and the formation of a layer on the teeth, which in turn provide the environment for fermentation and acid resulting from this fermentation leads to necrosis The tooth enamel layer is therefore tooth decay, figure (1) shows, a *S.mutans* bacteria and stock culture[5,6].

Figure 1: The Ovoid cells of streptococcus mutans bacteria and diameter (0.5–0.75 µm)[5]

Installation and operation of the experiment: A high voltage power source (12 KHz) used to generate discharge between two electrodes covered with an electric insulator. The voltage and current are measured by a high frequency digital oscillator (Tektronix TDS 2000). The high voltage applied is between two connectors, one or both, insulated with insulation to prevent turning

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to the arc and limiting current. The plasma system is a conventional jet and discharge system.

Through the alternating voltage between the isolated high voltage electrode and the base of the model, a cold plasma is created to process the samples, the power source is connected to a stainless steel tube, the insulation is prevented. The current flows between the electrodes. The plasma is produced with a high concentration and with minimal gas heating and a vacuum between the needle The model (1-4 cm).

Figure 2 illustrates the experimental diagram of our work. A part connected to the isolated mica block which prevents heat transfer to the catcher, the other side is a stainless steel dielectric tube connected to the high voltage source, the system provides a high voltage (0-15 kV).

Between the upper surface of the model and the bottom of the probe the discharge is generated,distance is controlled during discharge at a fixed diameter (2.6 cm) and for all samples at room temperature and air pressure when conducting the experiment.

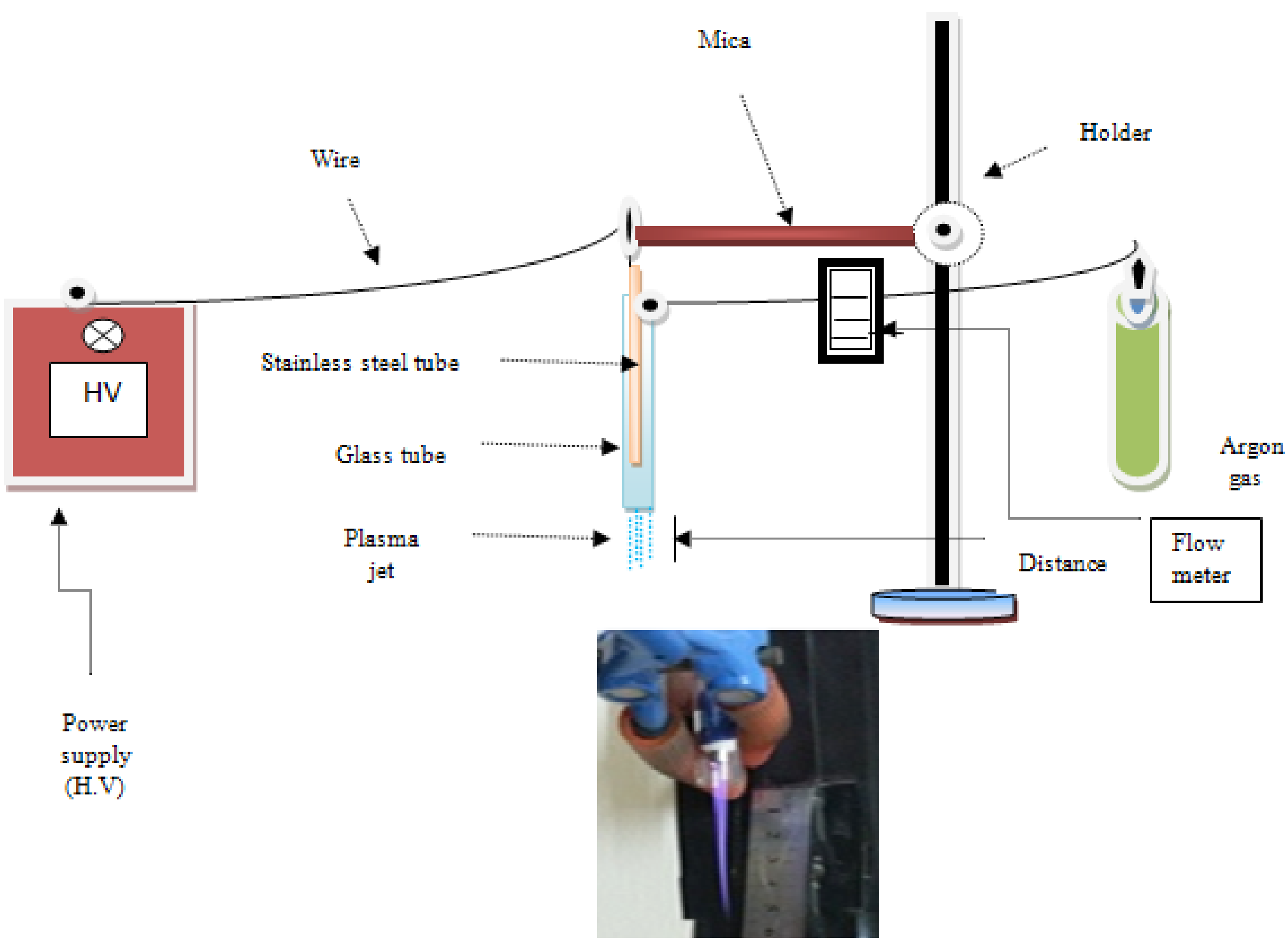

Figure 2: A schematic form to generate plasma jet

Materials and Method

In this work, the applied voltage (2 kV) and flow rate (1-3 l/min) as well as frequency (12 kHz) are optimal conditions to create non-thermal plasma to inhibit the bacteria in the mouth, teeth and tongue surface.

When a colony was taken from a solid medium after incubating it at 37°C and incubating overnight, a suspension of 1.5×10^8 (CFU/ml) was suspended using 0.5Mcfarland standard. 1: 100000 (*Streptococcusmutans* bacteria) and the effect of non-thermal plasma on this type of bacteria.

Below the plasma needle, place a 1 mL petri dish of suspended bacteria and variable distances (3,4 cm) at operational conditions (1, 2,3, 4 l/min) for exposure to this plasma.

Isolated isolates are not exposed to plasma. The isolated bacteria exposed to non-thermal plasma contain special media for all bacteria and cultured in petri dishesand then placed for 24 hours in the incubator at 37°C. After incubation, to demonstrate the efficacy and activity of non-thermal plasma in bacterial inhibition.

Results and Discussion

The activity of the gas flow rate on inhibition bacteria: The high flow rate of argon gas and high-speed particle discharge make it penetrate the outer wall of the *Streptococcus mutans* bacteria and inhibit bacteria through non-thermal plasma.

Increasing the rate of gas flow leads to the destruction of the cell membrane and the penetration of high-speed particles plays an important role in destroying the external structure of bacteria and the disappearance of cytoplasm; thus the death of bacteria. Figure 3 shows the increase in the kill rate by increasing the non-thermal plasma treating time at (3 cm) with the flow rate of the argon gas.

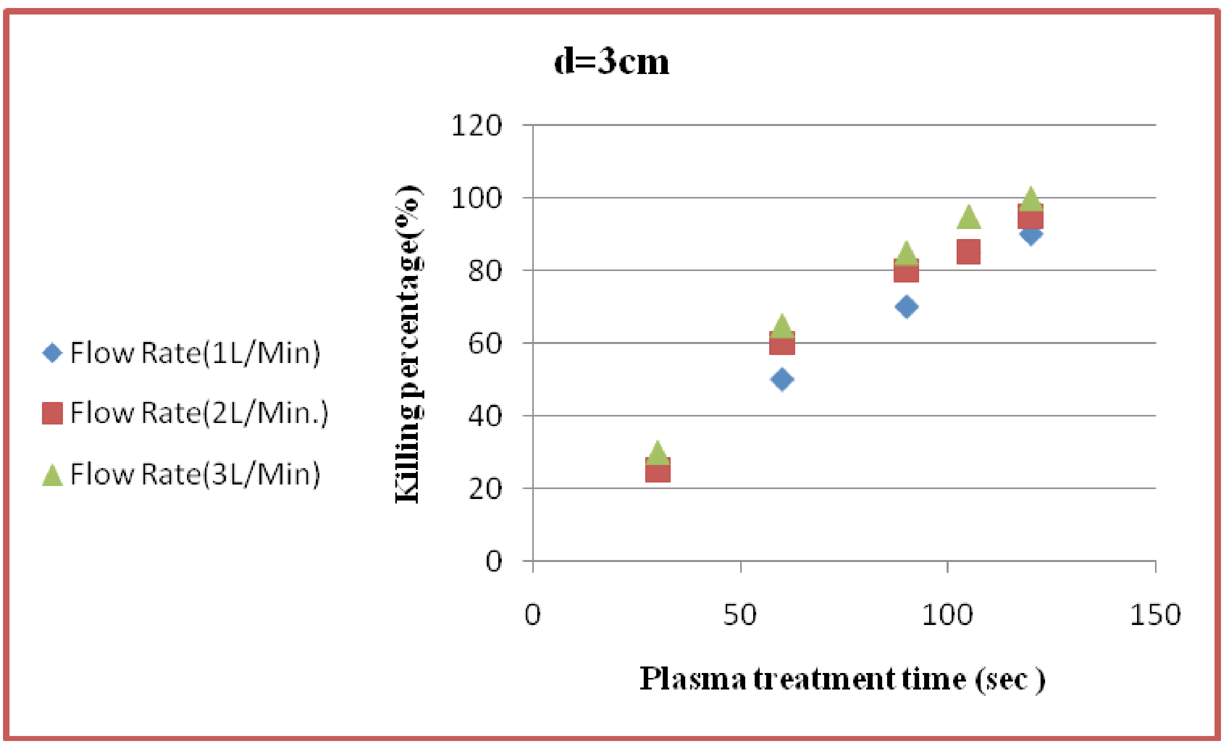

Figure 3: Killing percentage of Streptococcus mutans bacteria
The relationship between & plasma treatment time at distance 3 cm

The effect of distanceon inhibition of S. mutans bacteria: Under certain conditions, the plasma treatment and its role on S. mutans bacteria were examined with different distances and times. The number of bacteria was estimated at different rates through the experimental conditions. The bacterial killing rate was defined as a function of plasma treating time as in Fig. 4. The results showed that the rate of killing of these bacteria increased with increased treatment time and decreased distance.

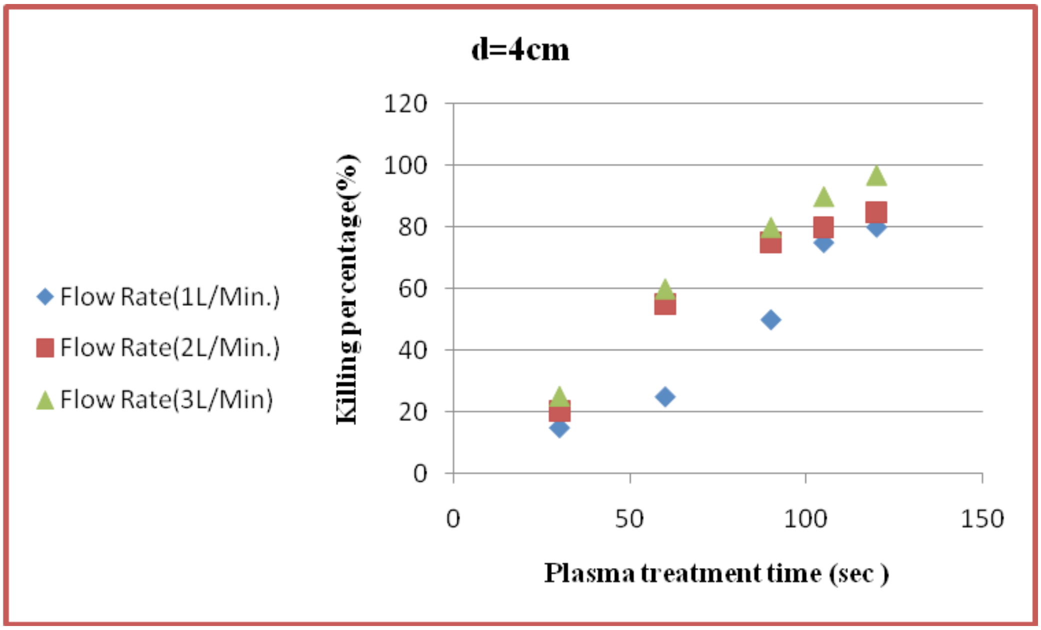

Figure 4: Killing percentage of Streptococcus mutans bacteria

The relationship between plasma treatment time at distance 4 cm: Within two minutes, interaction between reaction species and bacteria types is completed. This shows the role of the high voltage produced to a high degree to ionize the gas, this increases the intensity of the reaction which plays an important role to reduce bacterial cells. The charged particles also have the effect of deactivation of bacteria, UV and heating, it has been shown that active species such as ozone have a key role in inhibition of *streptococcus mutans* bacteria[7,8].

The increase in plasma treatingtime increases the inhibition of *streptococcus mutans* bacteria and these bacteria can be eliminated by exposure to cold plasma, this disruption Represented by working conditions of the plasma, such as processing time, flow of gasas well asapplied voltage [9].

Conclusions

The operating conditions of non-thermal plasma, such as treatingtime and distance, as well as gas flow, have a role in inhibition of *streptococcus mutans* bacteria. The use of plasma jet with atmospheric pressure, the use of plasma jet plasma generates a cold plasma that investigation the role of charged particles by inhibiting the bacteria.

The charged molecules, active species such as ozone and stable state, were found to be able to deactivate and inhibit the activation of *streptococcusmutans* bacteria**..**

Ethical Clearance: The Research Ethical Committee at scientific research by ethical approval of both environmental and health and higher education and scientific research ministries in Iraq

Conflict of Interest: The authors declare that they have no conflict of interest.

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