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E. Coli Bactria Deactivation by Plasma Jet with Replica Plate Technique

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Abstract

In this research, non-thermal plasma system (plasma jet) of argon gas is designed to work at normal atmospheric pressure and suitable for work as well as use in medical and biotechnological applications, also applied this technique in the treatment of The *E. Coli* bacteria and show the role of the applied voltage on the killing rate of bacteria, and we obtained a 100% killing rate during the time of 5 minutes .

Keywords: *Plasma jet, applied voltage, E.Coli bacteria.*

Introduction

Plasma, the fourth instance of the issue . Different instances of the substance are strong, fluid and gas., plasma, is ionized gas. The greater part of these substances known to mankind is plasma. For instance, enormous items, for example, stars are plasma. Be that as it may, there is likewise man-made plasma, utilized every day on our planet. Plasma is utilized in modern and in medicinal applications, in the plasma business are utilized in numerous advancements: plasma TV screens, lighting frameworks, and power frameworks. A moderately new zone is plasma use in biomedical applications and dentistry [1].

There are a few different ways to create non-warm plasma. Vitality is expected to deliver and support plasma. This should be possible in a few different ways: through warm, electrical, or photovoltaic vitality. Generally, a gas release happens electrically. For this situation, just [2].

(Electrons and particles) can get vitality from the electric field. At the point when these particles are in the minority, the warming of unbiased particles will be constrained. In this way, diffuse plasma where the division of ionizing species is under 0.1%, for the most part, non-warm. This mode is effectively accomplished under low weight, inside 10 to 1000 P. The impact of low weight is twofold: in uncommon gas ionization occasions uncommon, which keeps up a low charge thickness. In addition, the recurrence of impacts is adaptable among electrons and low particles, so electrons don't have an extraordinary shot of transmission[3,4].

The temperature of the electron is usually greater 10^4 K°, while the temperature of both particles and neutral ions depends heavily on the type of plasma produced Temperature can vary from approximately room temperature to 10^7 K°. It is usually for each class of plasma components of its own degree the temperature of the T_e electrons and the positive ions of T_i and T_n neutral molecules. So it can be said that plasma is the only substance that contains several temperatures at the same time[5].

In this type of plasma ions and the temperature of neutral particles surrounding the same, the electron temperature rises much higher that any $T_e >> T_i >> T_n$ in the cold plasma, most of the processing energy in the electrons in the plasma, this produces effective electrons instead of gas heating as a whole, because Ions and neutral components remain relatively cool This feature will enable us to use (plasma) to process sensitive materials, including biological tissue [6].

Escherichia coli (E. coli) bacteria contribute to many infections in hospitals such as surgery and burns. At present, bacterial resistance has increased for many drugs[7, 8]. The colonies may appear in blood agar (3-4 cm), Mac Conkey agar, in the colonies appeared red and these bacteria appeared in the form of fermentation of lactose [7, 8, 9].

Experimental Procedure: To generate the discharge of the air gap between two poles covered with insulation, use a high frequency digital oscillator to measure current and voltage as well as high voltage power source. Applied voltage, discharge current measured and analyzed.

Plasma jet system is based on a conventional plasma discharge which is basically a system driven by alternating current .High voltage is applied between two conductors where one or both are covered with a dielectric to limit the current and to prevent transition to an arc.

Cold plasma is produced by alternating voltage applied (1- 30 kV) between an insulated high-voltage electrode and the grounded base holding the sample.

A variable voltage and current power supply was used for treating samples. The power supply was connected to stainless steel tube .

The dielectric prevented current flow between electrodes, creating plasma with high reactive species concentrations but minimal gas heating, the discharge distance between the dielectric and the sample was (1-3-cm).

In (13 kHz), to limit the current and to prevent transition to an arc. Fig. 2, shows the schematic diagram of the experimental set-up used in study. System is equipped with a high voltage (1-30 kV) connected to a stainless steel wire, the other part connected to the mica to prevent the discharge of the catcher.

Between the upper surface of the model and the bottom surface of the tube, the discharge occurs. The distance between discharge (1-3 cm) and the diameter of the glass tube (2.5 cm)

All the treatments are at room temperature and atmospheric pressure and were carried out according to the same procedure.

Method

Midstream Urine samples (MSU) and burns swabs were obtained from patients with urinary tract infections (UTI_s) and burns respectively, these samples were cultured on culture media to isolate bacterial colonies. After that, bacteria were identified by means of highly specific tests. *Escherichia coli* (*E.coli*).

Results and Discussion:

According to replica plating technique, the effects of the plasma jet treatment on *E. coli* bacteria were studied. The bacteria were killed in different percentages depending on the experiments conditions. Killing percentage as a function of the plasma treatment time for different conditions was presented in figures The results, show that the killing percentage increases with the increasing of treatment time for all applied voltages and gap distances. Also, it was clear, killing rate for bacteria increases with increased voltages while it was decreases with the increasing of the gap distance. That is the general behavior of the killing percentage according to the results.

In figure (2), the applied voltage is 13 kV and when the gap distance is 3 mm,the killing percentage for *E. coli* is 20% in 180 sec,then killing rates for bacteria increase with increased plasma processing time (exposure time). It was increased up to 70% in 270 sec.

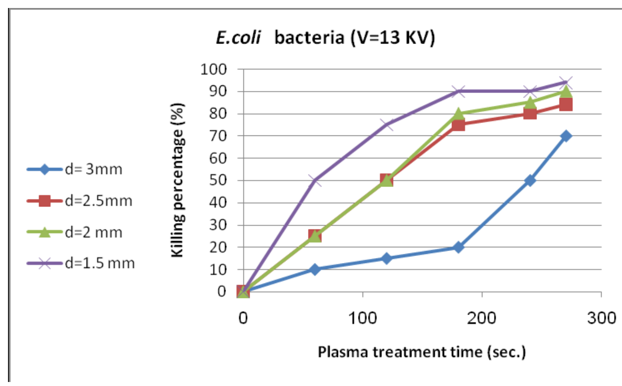

Figure 1: shows killing rate of E. coli with treatment time and at different distances of the gap in the frequency and voltage (17 kHz, 13 kV)

When the gap distance is 2.5 mm, the killing percentage for E.coli bacteria increases up to 84% at 270 sec, while when the distance between electrodes 2mm,the killing percentage up to 90% at same period . Finally, when the distance between electrodes becomes 1.5 mm, the killing percentage was 90% with increase for plasma treatment time, then increases to 94% at plasma treatment time 270 sec.

However, the best result of killing percentage resulted from gap distance shorter and plasma treatment time longer,when gap distance 1.5 mm,killing percentage arrives to 94% in 270 sec, as long time effects with little on bettering killing percentage in 270 sec because interaction between *E.coli* are almost completed through this time. These curves indicated that killing percentage became high with an increasing treatment time within 270 sec. However, a longer time had little effect on improving the killing percentage after 270sec.This was because the interaction between bacteria and reaction species was almost complete within 270 sec **.**

In figure (3), when applied voltage 17 kV, killing percentage for *E.coli* bacteria differs with different gap distances between electrodes,when distance 3 mm,it increases with increasing plasma treatment time and rest in 120 and 180 sec respectively,where it 50%, may be because less period, beyond this period,it increases more to 80% and rest with increasing plasma treatment time,where no effect on killing percentage with increasing plasma treatment time .

When the distances 2 mm and 2.5 mm the killing percentage increases with increasing plasma treatment time .While distance 1.5mm, the killing percentage increasing in 60 sec, and it rest on 50% to time 120 sec, then increases to 96%,this favorite expectant value when plasma treatment time 270 sec, at 17kV,the electric field dense in little gap distance, cold plasma generated by (plasma jet) which is active consequently,the plasma (jet) produced is more abundant for reaction species and connected with bacteria and led to efficiency for large killing percentage for bacteria with converted high energy [10].

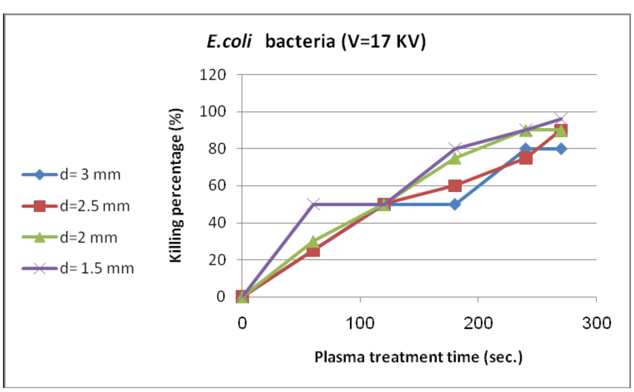

Figure 2: shows killing rate of E. coli with treatment time and at different distances of the gap in the frequency and voltage (17 kHz, 17 kV)

In figure (4),at 22 kV, killing percentage for *E.coli* bacteria increases with increasing plasma treatment time,when the distance between the electrodes is 3mm,the killing percentage increases to 76% in 120 sec,then it increases little until the resting in 90% with plasma treatment time 270 sec,when the distance is 2.5 mm, the killing percentage arrived to 97% in plasma treatment time 270 sec,when the distance between electrodes 2 and 1.5 mm, the killing percentage arrives to 94% at 2mm and 97% at 1.5 mm, respectively.

These results indicate that the applied voltage increases with a high ionization rate of gas and this indicates the increased intensity of the different reaction to kill the bacterial cells [10,11]**.**

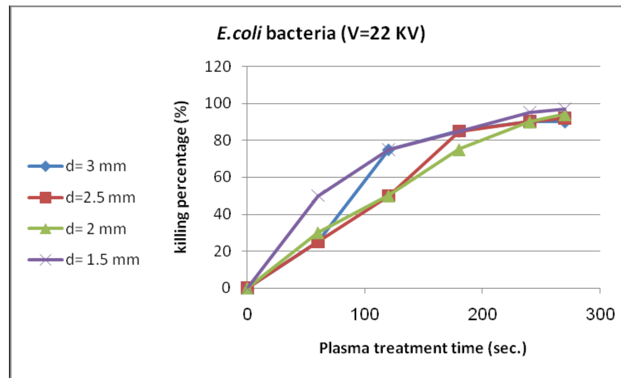

Figure 3: Shows killing rate of E. coli with treatment time and at different distances of the gap in the frequency and voltage (17 kHz, 22 kV)

Figure (5) shows the typical sample for the killing of *E.coli* bacteria 84% at 4.30 sec when applied voltage 13 kV and gap ditance is 2.5 mm at room temperature .

Bacteria killing is attributable for active various species produced by plasma. The plasma efficiency killing percentage was dependent on the treatment time, air-gap distance, and the applied voltage. Within less than 5 min of plasma exposure, 97% killing efficiency must be completed for *E.coli*. bacteria

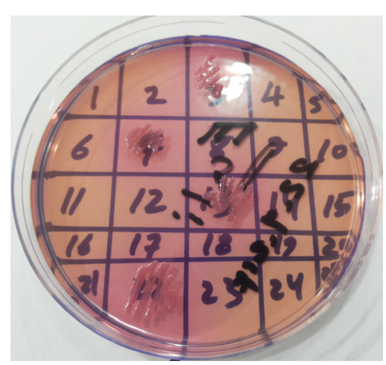

Figure 4 : Typical sample for the killing percentage of E.coli bacteria 84% at 4.30 sec on MacConkey agar.

Conclusion

Non-thermal plasma (cold) was manufactured using air pressure and used as an application for sterilization of

E. coli. At different volts (13, 17 and 22 kV), the bacteria are disrupted in 5 minutes. The sterilization efficiency improves with increased voltage applied. Through active species such as oxygen OH, N_2 which appeared in the plasma jet, which oxidation and bombardment of the bacterial cell and inhibition.

Conflict of Interest: Nil

Source of Funding: Self

Ethical Clearance: Not required

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