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Inhibition of Pseudomonas bacteria by microwave plasma jet (mipj)

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ABSTRACT

Non-thermal atmospheric pressure plasma has recently garnered a lot of attention in the industrial and biological industries because to its numerous benefits, including its high efficiency, straightforward systems, simple operations, non-toxic byproducts, and low cost. In this experiment, argon gas was used to create non-thermal (cold) plasma using a voltage source with a specific frequency (microwave up to 2.4GHz).the discharges of argon gas plasma jet at exposure time (5min) flow rate (5 L/min) and with voltages (170 V) have been researched to kill pseudomonas bacteria that causes skin diseases.

Keywords: Microwave plasma jet, bacteria, plasma parameters, Skin Diseases.

1. Introduction

In the middle of the 20th century, plasma was first created through the interaction of electromagnetic fields with gases like helium or argon. This new generation of electrochemical sources includes microwave plasma (MWP), which operates at a GHz frequency and is particularly useful as an emission source for optical emission spectrometry (OES) and as an ionization source for mass spectrometry (MS). An external cavity or antenna is used to connect the microwave radiation to the gas stream that is going through the torch . According to the mode of power transfer to the plasma gas, the plasma form, and its position relative to the plasma torch, two categories of MWP are often stated. A capacitive linked microwave plasma, initially created by Combine and Wilbur in 1951, is a plasma that resembles a flame at the electrode's tip (CMP). The inner conductor of a CMP torch creates a capacitance against the ground and transmits microwave energy via its tip into the plasma gas. The plasma in the second form is sustained in a quartz or ceramic tube that is housed inside a resonant cavity, where it is created by the inductive transfer of energy from standing waves in a suitable resonator. The term "microwave generated plasma" is frequently used to describe this system (MIP). It is the most effective and widely applied kind of microwave discharge. Either a magnetic field (H pairing) or an electrical field (E pairing) is used to link the microwave energy to the working gas. The usual frequency of a MIP is (2.45 GHz) . Seed electrons are introduced into the plasma gas to ignite it, typically, this is done by inserting an electrically conductive and heat-resistant substance while power is being delivered. A correctly tuned system

encourages the ionization of the plasma gas following the injection of these seed electrons, and plasma develops. The originally tuned resonant cavity creates a standing electromagnetic wave that is axially oriented to the plasma discharge tube and has a maximum electric field at its center. The cavity is set to have a minimum amount of reflected power after plasma ignition. Exceptionally, under appropriate experimental conditions, heating of the discharge tube and extraction of the seed electrons from the discharge tube material might cause the plasma to ignite "Spontaneously." Flexible working conditions are ensured by a self-ignition of the discharge, which is advantageous, especially when low- In certain MWP sources, nitrogen or air plasmas are created by igniting the plasma with argon while the plasma is being matched to the impedance that is most appropriate for the nitrogen or air discharge. The originally tuned resonant cavity creates a standing electromagnetic wave that is axially oriented to the plasma discharge tube and has a maximum electric field at its center. The cavity is set to have a minimum amount of reflected power after plasma ignition. Rarely, under particular experimental circumstances immediately following the creation of the argon plasma, the argon flow is progressively replaced by nitrogen or air, allowing for the maintenance of stable plasma in a molecular gas. Different gases, including noble gases, nitrogen, air, oxygen, or carbon dioxide, under both normal and decreased pressure, can produce MWP. The plasma gas's composition and pressure affect the discharge's characteristics. Due to several fundamental differences in the technological design and

functioning of these two microwave techniques, the development of CMP and MIP occurred concurrently.

2. Effects of Plasma in the Medical Field

In the ten years from 1995 to 2004, pioneering research, on plasma at a low temperature and pressure for biological purposes was carried out. The initial investigations used pulsed plasma generated in salty resolutions for medical purposes as well as dielectric wall absorption to deactivate microbes on exteriors and in liquids. Soon after, research was conducted on the use of cold plasma for cell dissociation, fibroblast growth stimulation, and wound cleaning. These foundational studies eventually caught the attention of the low temperature plasma exploration community, and the field experienced significant growth in the years after 2005 and up to the current. Presentations in dentistry, cancer therapy, and other fields. Have since been investigated in several labs and research facilities throughout the globe, resulting in a notable rise in the number of paper publications on the subject and the production of multiple volumes. The capacity of cold atmospheric plasma to incapacitate germs has lately become increasingly relevant as a result of the significant healthcare issues that modern civilization is currently experiencing. Some of these include: (1) Hospital acquired infections (HAIs), which can be deadly to patients with weakened immune systems, are begun by antibiotic-resistant forms of germs such as Methicillin Resistant *Staphylococcus aureus* (MRSA) and *Clostridium difficile* (C-diff); (2) One of the issues with protracted sores, such as diabetic abscesses, is the in height amount of impurity brought on by a variety of bacteria. Because square systems were unable to adequately address these issues, new methodologies based on cutting-edge technology were required. Cold atmospheric plasma is highly appealing techniques that may be utilized to assist overcome the difficulties described above. It has existed demonstrated to successfully incapacitate bacteria like MRSA, to considerably decrease the bacterial load in diseased prolonged wounds. The first clinical trials using cold special plasma to heal enduring wounds were conducted voguish 2010, and the outcomes were promising. There are multiple plasma devices available today that are licensed as medical devices, may be used in medicine, and can even be used to treat a variety of dermatological conditions. LTP may be used in one of two ways. The first type involves exposure that is considered "direct." All plasma-produced drugs operate on the cubicles and muscles because, this manner of administration, the plasma is in direct connection with the biological objective. The second exposure method is mentioned to as "indirect." this instance, only the plasma's exhilaration is utilized, unless the plasma is first used to stimulate a liquid average before the liquid is put on maximum of chambers or materials. One benefit of the latter is the ability to store and use the plasma activated liquid (PAL) later,

providing suppleness that straight exposure organizes not.

2.1. Experimental Procedure

Microwave-induced plasma jet system was used . It includes five main parts ; Microwave source (magnetron), Rectangular waveguide, Plasma discharge tube, Explosion system and Gas supply .& flow control device. Microwave source (magnetron) In order to generate microwave radiation with a frequency of (2.45 GHz), a local oven magnetron (Panasonic-2M210) was used and connected to a suitable high voltage circuit (transformer, capacitor and diode). In this experiment, an ionized gas flask is typically an industrial chemical been used in a microwave plasma system. The connection tube between the plasma needle and the gas bottle is installed, and the flowmeter unit that controls the gas passage is 1/min. We employ a magnetron attached to the top to produce microwave radiation at a frequency of 2.4GHz. a voltage circuit that transforms the applied voltage When traveling through a microwave, a component known as a waveguide catches the rays and guides them into a quartz glass tube.[Fig2] By altering the plasma's inherent characteristics, Voltage at the input and gas flow rate. For each In this instance, we investigate how cold plasma affects the inhibition of *Pseudomonas* bacteria.

3. Results and Discussion

The conditions selected are; Voltage (170 volt), frequency (2.45 GHz), distance (2.5cm), time (15, 30, 60, 180, 300) sec. and gas flow.rates (1, 2, 3, 4, 5) l/min The best inhibition rate was in flow (5 l/min), using Microwave plasma jet particularly for this in testing of biomaterials that have undergone plasma processing and for thorough understanding of the effects of plasma. A plan of attack must be communicated, and medication must be began. research on destroying bacteria. The percentage of inhibiting and killing bacteria procedure was using a microwave jet plasma and argon gas. We note - through work - how to increase the percentage of inhibition or killing with the increasing of the time used. When exposing a Gram-negative bacteria (*pseudomonas*), it was found that the bacteria are inhibited with time. At time (15 seconds) the percentage of bacterial inhibition was (5%), at time (30 seconds) the percentage of inhibition was (10%), at time (60 seconds) the percentage of inhibition is (20%), at time (180 seconds) the percentage of inhibition is (60 %) and at time (300seconds) the percentage of inhibition is (100%) as shown in the table [1] above and the flowing figure 3. shows that when the exposure time to cold plasma increases the percentage of bacterial inhibition increases with it.

4. Conclusions

The use of low temperature and high pressure plasma in healthcare has created new scientific and technical possibilities. As a result, significant progress has been made in the search for new plasma-based therapies

for treatment. A sign that hypothermic plasma may soon be considered an innovative and practical therapeutic in biomedicine and many healthcare related issues. To learn more about upcoming developments in this sector. In this case, plasma apheresis offers a viable alternative to perishable therapies in the form of technology. Undoubtedly, there is still potential for progress in the strategic field of human health regarding the application of plasma processes. Especially for this in the testing of biomaterials that have undergone plasma treatment and a comprehensive understanding of the effects of plasma. The action plan must be reported and treatment initiated. To decide when plasma therapy should be given, he should follow vital clinical signs

before and after exposure. The results indicate that as the duration of exposure to cold plasma increases, so does the rate of bacterial inhibition, which is important for the development of plasma-based therapies for wound healing, cancer treatment and other clinical specialties. We anticipate significant developments in bio-oriented knowledge in plasma science and technology in the near future, and firmly believe that relevant plasma-based therapeutic approaches will be developed at that time, and will have a significant impact on human health care from fundamental, clinical and economic.

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Table 1: The differentiate of number of bacteria with (170 V) and different time

Voltage (v)	170	170	170	170	170
Time (sec)	15	30	60	180	300
Number of bacteria	90	60	35	30	0
Flow rates (l/min)	5	5	5	5	5

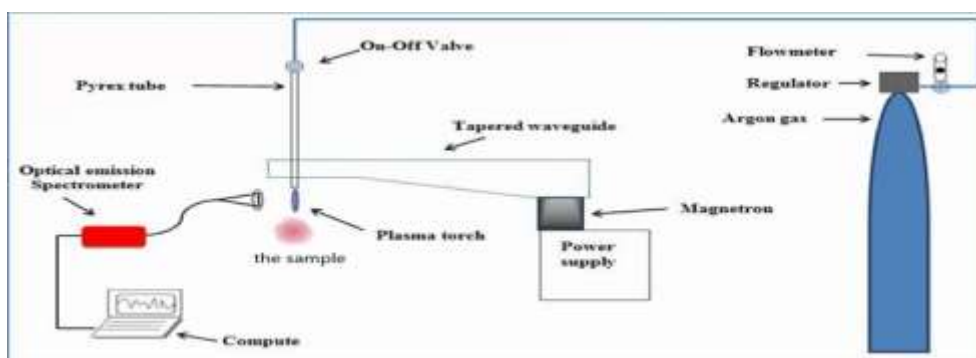


Fig. 1: Diagrammatic drawing of the MIPJ system



Fig 2; MIPJ system



**Fig 3: pseudomonas growth after exposure to MIPJ plasma system
(A: control, B: 15 sec, C: 30 sec, D: 60 sec, E: 180 sec, F: 300 sec)**

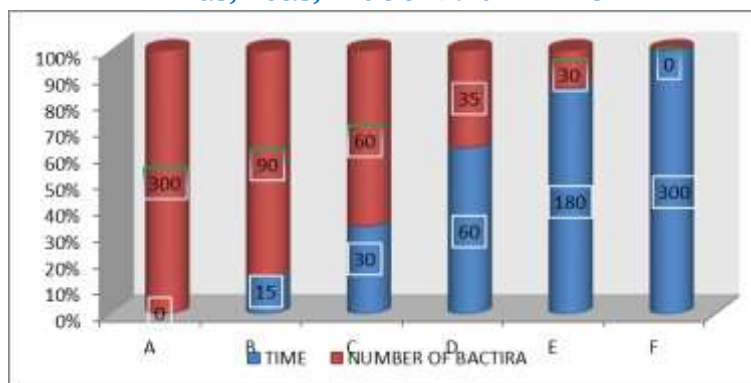


Fig 4: shows the ratio between exposure time and bacterial inhibition

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تطبيقات البلازما الباردة في الأمراض الجلدية

الملخص

حظيت بلازما الضغط الجوي غير الحراري مؤخرًا بالكثير من الاهتمام في الصناعات الصناعية والبيولوجية نظرًا لفوائدها العديدة ، بما في ذلك كفاءتها العالية وأنظمتها المباشرة والعمليات البسيطة والمنتجات الثانوية الغير ضارة والتكلفة المنخفضة. في هذه التجربة ، تم استخدام غاز الأرجون لتكوين بلازما غير حرارية (باردة) باستخدام مصدر جهد بتردد محدد (ميكروويف يصل إلى 2.4 جيجا هرتز). وبجهد كهربائي (170 فولت) . و بمعدلات التدفق (1 ، 2 ، 3 ، 4 ، 5) لتر / دقيقة) لقتل بعض أنواع البكتيريا المسببة للأمراض الجلدية