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The Investigation On How Applying An Electric Field For 60 Minutes Affects The Growth Of Specific Bacterial Species

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Abstract. We discovered that some of them suffered damage to their walls or membranes as a result of the electric field lines flowing through them. Depending on the variation in intensity, bacteria are affected by the field, whether it is positive at most or negative to a small extent, as this laboratory experiment demonstrated. Despite the strength of their walls, we discovered that pathogenic bacteria are affected by an electric current of 60 amps, which caused a modest change in their growth or, more precisely, made them growth-inhibiting in contrast to their pure state.

Highlights:

1. Electric fields damage bacterial walls/membranes based on intensity variation.
2. Pathogenic bacteria affected by 60-amp current, inhibiting growth.
3. Growth differs from pure state due to electric exposure.

Keywords: electric field, bacterial growth, nutrient agar, Staphylococcus aureus

Introduction

The innate tendency of microbial biofilms to exchange electrons with their support when they develop on a conductive surface has become increasingly apparent [1]. So-called electrochemical techniques have been derived [2]

Our knowledge of extracellular electron transfer within biofilms and between biofilms and electrodes has advanced considerably as a result of extensive foundational research [2]. However, our understanding of the early development of electrically active biofilms is still very limited. In particular, it is still not known how microbial cells move towards a solid surface when an electric field is present. It seems to be implicitly understood that microbial cells approach the surface of polarized electrodes randomly and that the electrode only influences biofilm formation while the cells are growing on the surface. It is rarely suggested that the electric field may have an effect on the approach phase, which occurs before the cells reach the electrode surface [3].

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According to some research, bacterial cells may behave as dipoles [4] or move in the electric field as equally charged colloids [5]. It was thought that in these situations, bacterial cells migrate passively without using a specific sensing mechanism. In contrast, some investigations have postulated that bacteria may sense the concentration gradient of oxidizing chemicals [6] and use chemo taxis to detect local electric fields [7]. Without mentioning possible mechanisms, some papers have shown how an applied current can inhibit cell movement [8]. Others have observed that Shewanella species swim faster when close to a polarized electrode. Clearly, this finding is not the same as passive migration, as swimming speeds increase in On the other hand, eukaryotic cells have been shown to have complex mechanisms to sense and use electric fields to direct their movement [9-11]. This property, known as electro taxis, is essential for vital physiological functions such as organogenesis, wound healing, and tissue development [12-15]

Methods

Experimental procedure

To achieve the objectives of this study, a descriptive design was chosen, as examinations were conducted to measure the left ventricular mass in the period from June 6, 2021, to August 2, 2021

Experimental procedure

1- Preparation of the culture medium: The nutrient agar medium was prepared in an amount of 250 ml by weighing 7 grams of the medium, which was dissolved in sterile distilled water, then the medium was heated using a magnetic hot plate for 15 minutes to achieve homogeneity between the medium and water and complete dissolution, then the medium was sterilized using an autoclave at a temperature of 121 degrees Celsius for 15 minutes. The medium was poured into the dishes to solidify in the flow chamber to avoid contamination of the culture medium.

2- Planting the sample using the brush method:

A pure and single colony of bacteria was taken and spread over the entire medium using a cotton swab, then the planting process was carried out on 8 dishes. These dishes were left for a full hour to solidify.

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3- An electric field was generated using a car battery with a generating capacity of 60 amperes.

4- dishes containing positive bacteria were exposed to the electric field for a full hour as shown in figure 1

5- The dishes not exposed to the field were placed in the incubator, which had a number of 4, as well as the dishes exposed to the field, which had a number of 4, in the incubator as well, and we waited for 24 hours to discover the results as shown in figure 2.

Figure 1 The application of an electric field on bacteria for 60 minutes using 60 A battery

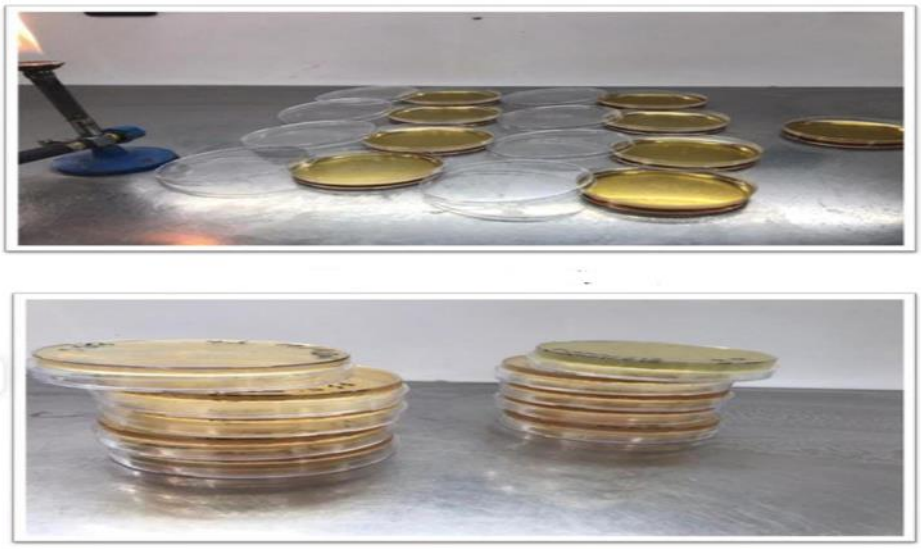

Figure 2 The preparation of culture media without the effect of the electric field

Result and Discussion

It is important to note that the growth media was exposed to the electric field for one hour. The development of bacteria was exposed to an electric field over the course

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of a day. The results were contrasted with those obtained without the influence of an electric field.

We discovered that the growth of the negative bacteria Pseudomonas anginas was unaffected by the electric field. The applied electric field did not significantly alter the bacterial growth of the aforementioned negative bacteria.

For the positive bacteria Staphylococcus aurous we noticed a slight effect on the growth of bacteria, especially in the middle area of the dish, where we found that the growth was less and lighter. This is due to the concentration of the electric field in this area.

By comparing it with its identical type (control bacteria) not exposed to the electric field, its growth was dense, which is naturally denser growth than the growth of negative bacteria.

This study included Klebssila as a new target of the electric field where contrary to the growth of (Pseudomonas anginas), it was found that there was a slight effect on the Klebssila especially at the boundary of the nutrient agar in the Petri dish hence the growth was less than in the middle of the agar.

This was a surprising result since it is well known that Klebsiella is an aggressive bacteria and more defensive against the antibacterial, yet we found that the electric field has a slight effect on this bacteria. The smooth effect led to less growth at the boundary of nutrient agar which by the way means that the strong electric field has affected Klebssila more than Pseudomonas anginas, It is necessary here to mention that the boundary of both the used agar and the petty dishes were closer to the metallic plates of the used capacity.

The results obtained in this research for the three bacterial cases are shown in Figures 3 to 5.

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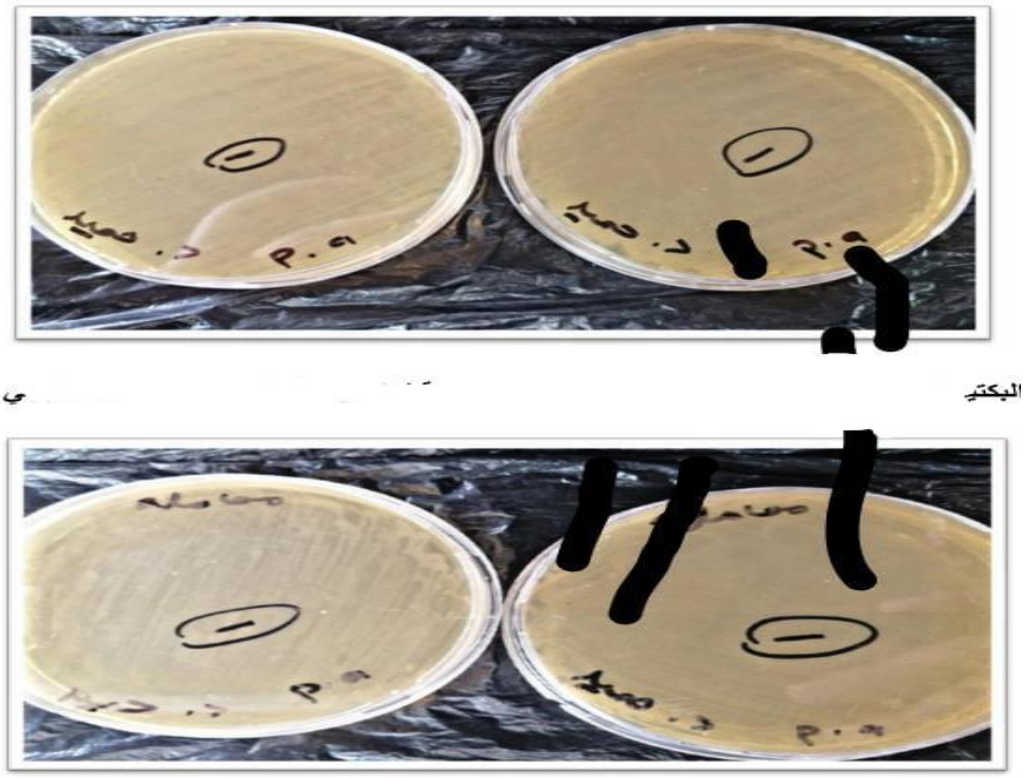

Figure 3 The Effect of Electric Field on the growth of Pseudomonas anginas (The above ones were not exposed to an electric field, unlike the under ones, which were exposed to the electric field

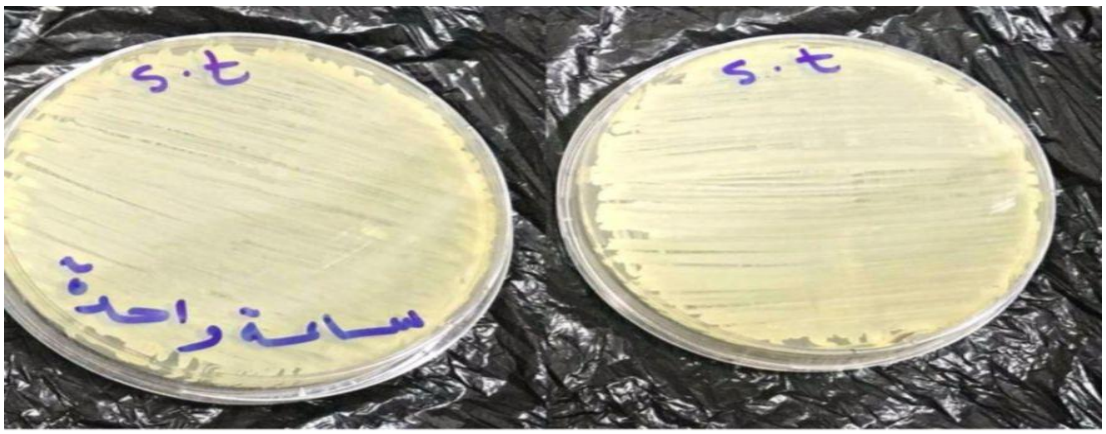

Figure 4 The Effect of Electric Field on the growth of Staphylococcus aurous (The one on the left was exposed to an electric field, unlike the one on the right, which was not exposed to any field)

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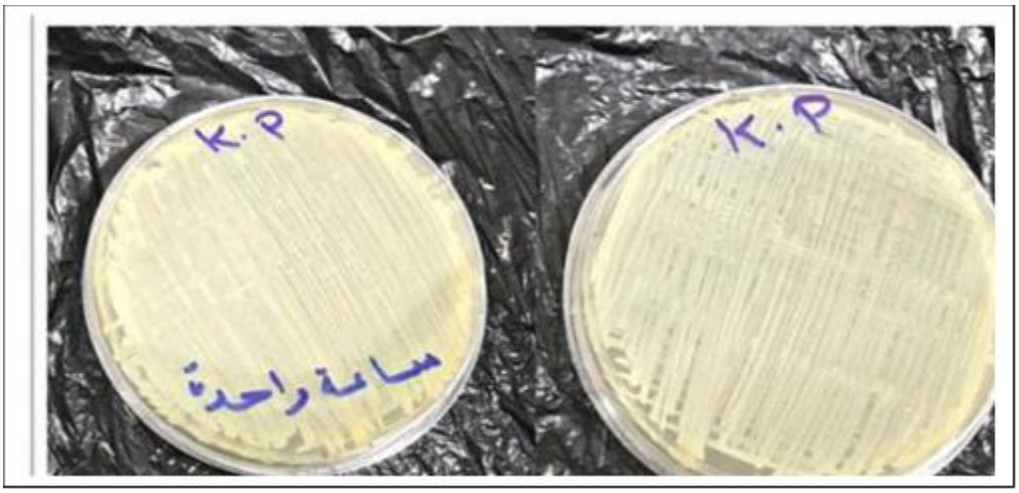

Figure 5 The Effect of Electric Field on the growth of Klebssila (The above ones were not exposed to an electric field, unlike the under ones, which were exposed to the electric field

Conlusion

After one day, we observed the growth of positive and negative bacteria in both cases - those exposed to the field and those not exposed. However, by comparing the negative bacteria to the control bacteria, we discovered that the electromagnetic field did not affect the former. In both cases, we observed the same growth. The positive bacteria showed a noticeable effect of the electromagnetic field on their wall, especially in the central section because the field was concentrated there, and grew slightly more than the control bacteria

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