

EFFECT OF ULTRA-VIOLET AND MAGNETIC FIELD EXPOSURES ON

Pseudomonas aeruginosa

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Abstract:

In our research study, we have been exposing *Pseudomonas aeruginosa* to ultraviolet radiation under different experimental conditions. Furthermore, we use an intense electromagnetic fields (10^3 Gause) to expose some other samples of *Pseudomonas* to investigate the influence and lethal-dose of *Pseudomonas* irradiation. We expect that results will give us indication and a picture on the influence of both UV and electromagnetic fields on living tissues in general including human being.

Experiments have revealed that, the increase in dilution and exposure times cause decrease in number of colonies . for example at the dilutions 10^{-5} and 10^{-6} the number of colonies were reduced from 300 cfu to 0 in 60 seconds, and from 280 cfu to 0 at 8 seconds, respectively.

On the contrary, the effect of electromagnetic field is seen sometimes increasing and other times decreasing. The increase in growth is noticeable especially at times 10 and 15 minutes.

I - Introduction

UV radiation has wavelengths below 400 nm till 10 nm and a quantum energy of $3.10 \text{ eV} \leq h\nu \leq 124 \text{ eV}$. The quanta contain energy sufficient to excite electrons in molecules from their ground state into higher energy orbitals making the molecules more reactive. Chemical reactions thus induced in microorganisms can cause the failure of critical metabolic processes leading to injury or death.

The greatest lethality is shown by wavelengths around 260 nm which correspond to a strong absorption by nucleic acid bases. The pyrimidine bases appear particularly sensitive, and UV light at this wavelength will, among other things, induce the formation of covalently linked dimmers between adjacent thymine bases in DNA . If left intact these will prevent transcription and DNA replication in affected cells (Albert, *et al.* 2002).

On the other hand, one of the mostly discussed contemporary problem in the biophysics is whether magnetic fields can affect living systems. A lot of publications concerning this topic have been published in the last 20 years, but the results are very controversial. A big number of attempts to explain magnetic field effects on the molecular level have been given . It was shown that magnetic fields can affect biological functions of organisms by changes of the concentration of hormones, by changes of the activity of enzymes or of the transport by cell membranes, by changes in the synthesis or transcription of DNA, etc.

In this work, we continue in the investigation of the UV light and magnetic field effects on gram negative bacteria *Pseudomonas aeruginosa* to find whether their effects are bactericidal or bacteriostatic.

II - Materials and Methods

a- materials

- Ultra Violet source (Bassaire , British).
- Alternating magnetic field source 10^3 Gauss.
- The bacteria *Pseudomonas aeruginosa* from the Department of Medical Microbiology, Faculty of Science, Ibb University, Ibb, Yemene were used.
- Nutrient agar(Bridson,1978) was used for cultivation of the bacteria

b- Methods :

The number of colony forming was used to quantify our results. Fresh bacterial cultures were used throughout the experiments. Control cultures were kept in the same conditions as the exposed ones except the sole exposition to the magnetic fields or UV light.

In our experiments diluted bacterial cultures were exposed appropriately to ultra violet light and to magnetic fields for several times at certain distance from irradiating sources.

Four replicates were applied for each treatment. SPSS 13.0 was used to proceed one way ANOVA in order to detect the significant of Ultra-Violet and Magnetic Field effect on *P. aeruginosa* .

III - Results and Discussion:-

a- Effect of ultra-violet :-

During this research investigation we have been exposing *Pseudomonas aeruginosa* to the uv radiation . the duration of exposures varied in the rang of 0 – 60 sec. We observed a decrease in the number of colonies for all dilutions with the increase of dilution and duration of the exposure. Results are shown in Tables 1& 2 and in Figs 1& 2.

From these results, probably the most interesting aspect of this series is the results with dilutions 10^{-5} and 10^{-6} (table 2 & Fig 2) where there is a very definite decrease in the number of colonies and recorded lethal dose 60 and 8 sec. respectively.

The results showed that, *Pseudomonas aeruginosa* exhibit high percent of inhibition. This is may be due to the inefficiency of their DNA repair system and can not forming spores.

Table 1 : Effect of UV on *P. aeruginosa* for different dilutions in different times.

| Time(s ec.) | No. of Colonies 10 ⁻¹ | No. of Colonies 10 ⁻² | No. of Colonies 10 ⁻³ | No. of Colonies 10 ⁻⁴ | No. of Colonies 10 ⁻⁵ | No. of Colonies 10 ⁻⁶ | f-test | p-value |
|-------------|----------------------------------|----------------------------------|----------------------------------|----------------------------------|----------------------------------|----------------------------------|--------|---------|
| 0 | ∞ | ∞ | ∞ | ∞ | 300±11.2 | 280 ±3.56 | 482.3 | 0.0 |
| 10 | 90 ± 7.07 | 56 ± 2.83 | 22 ± 1.41 | 20 ± 2.01 | 12 ± 2.94 | 0 ± 0.0 | 368.0 | 0.0 |
| 20 | 50 ± 2.94 | 34 ± 2.16 | 15 ± 0.82 | 10 ± 0.82 | 8 ± 2.16 | 0 ± 0.0 | 437.8 | 0.0 |
| 30 | 40 ± 2.94 | 30 ± 2.16 | 8 ± 1.41 | 7 ± 1.41 | 5 ± 0.82 | 0 ± 0.0 | 343.5 | 0.0 |
| 40 | 30 ± 2.94 | 26 ± 0.82 | 5 ± 0.82 | 3 ± 0.0 | 2 ± 0.0 | 0 ± 0.0 | 426.2 | 0.0 |
| 50 | 28 ± 0.82 | 18 ± 1.63 | 4 ± 2.16 | 2 ± 0.82 | 1 ± 0.0 | 0 ± 0.0 | 366.0 | 0.0 |
| 60 | 21 ± 1.41 | 11 ± 2.16 | 3 ± 0.82 | 1 ± 0.0 | 0 ± 0.0 | 0 ± 0.0 | 233.0 | 0.0 |

∞= uncounted

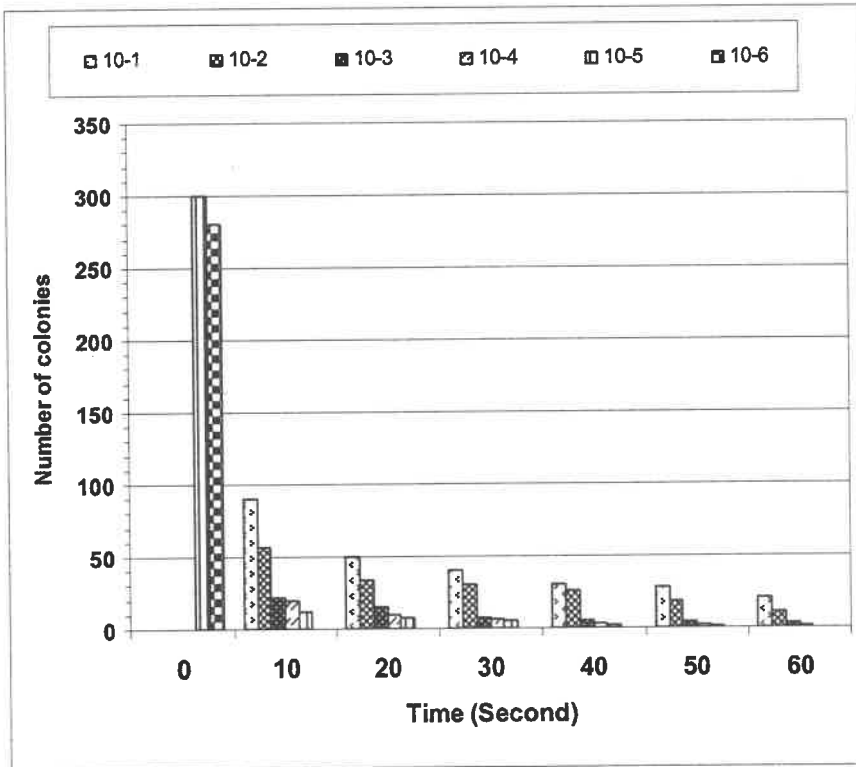


Fig. 1 : Effect of UV on *P. aeruginosa* for different dilutions in different times of exposure.

Table2: Effect of UV irradiation *P. aeruginosa* for 10^{-5} and 10^{-6} dilutions in different times of exposure.

| Time(sec.) | No. of Colonies 10^{-5} | No. of Colonies 10^{-6} |
|------------|---------------------------|---------------------------|
| 0(control) | 300 | 280 |
| 1 | 285 | 240 |
| 2 | 275 | 230 |
| 3 | 211 | 220 |
| 4 | 195 | 34 |
| 5 | 180 | 10 |
| 6 | 134 | 6 |
| 7 | 130 | 1 |
| 8 | 109 | 0 |
| 9 | 106 | 0 |
| 10 | 12 | 0 |
| 20 | 8 | 0 |
| 30 | 5 | 0 |
| 40 | 2 | 0 |
| 50 | 1 | 0 |
| 60 | 0 | 0 |

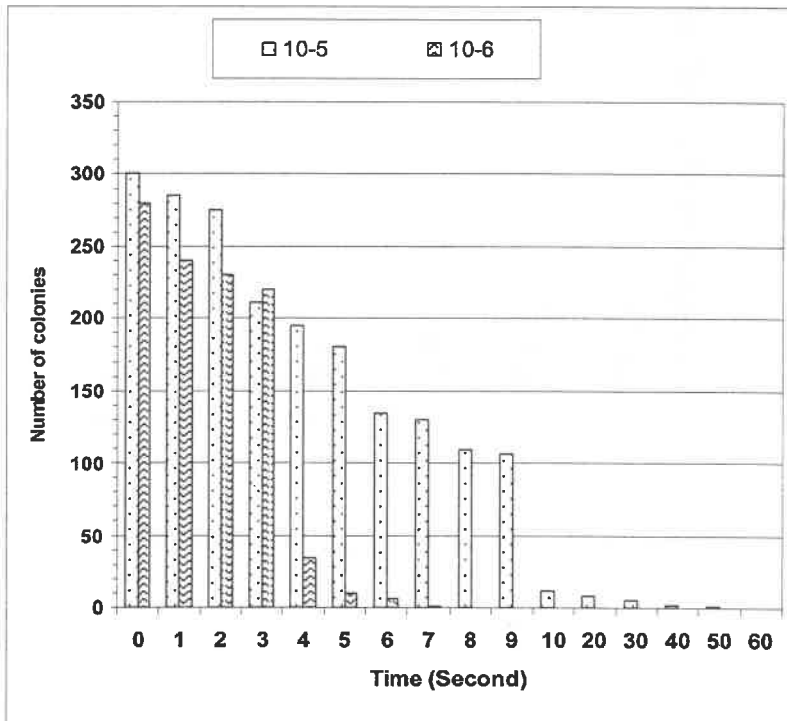


Fig 2: Effect of UV on *P. aeruginosa* for 10^{-5} and 10^{-6} dilutions in different times of exposure.

b- Effect of magnetic field:

We found that magnetic fields have increased the growth rate in the first time then caused decrease in the growth rate. After the analysis of the data, we ascertained that the slope of the dependence of number of colonies on the time of the exposure does not equal to zero. We suppose that cells under magnetic field exposures do not lose their ability to divide. The decrease of the number of colonies is caused by the death of some bacteria in the culture. The effect of magnetic fields probably is not bacteriostatic. From all the results, we assume that the magnetic fields kill part of the exposed bacteria. The main theories that try to explain the biological effect of electromagnetic field are based on the permeability of the ionic channels in the membrane.

This can effect the ion transport into the cells and it can result in biological changes of the organism. The other possible effect is the formation of free radicals due to magnetic field exposure (Ludek, *et al* 2002). On the other hand, the magnetic fields did not damage the DNA of the exposed bacteria (Strasak, *et al.* 1998).

These results are in agreement with Jan, *et al.* 2007. The latest found that, magnetic fields kill a part of yeasts and the bigger part of them survives and continues in their growth. Masahiro *et al.* 2000 reported that, the ferrite magnet caused strength-dependent decreases in the growth rate and growth maximum number of bacteria for *Staphylococcus mutans* and *S. aureus* when cultured under anaerobic conditions, but that their growth was not inhibited under aerobic conditions.

Table 3 : Effect of Magnetic Field on *P. aeruginosa* for different dilutions in different times of exposure.

| Time(min.) | No. of Colonies 10^{-4} | No. of Colonies 10^{-5} | No. of Colonies 10^{-6} | No. of Colonies 10^{-7} | <i>f</i> -test | <i>p</i> -value |
|------------|---------------------------|---------------------------|---------------------------|---------------------------|----------------|-----------------|
| 0(control) | 300 ± 0.0 | 200 ± 11.43 | 121 ± 0.82 | 5 ± 2.16 | 1831.3 | 0.0 |
| 5 | 208 ± 2.16 | 111 ± 4.08 | 135 ± 1.41 | 5 ± 1.41 | 4455.7 | 0.0 |
| 10 | 210 ± 1.41 | 224 ± 2.16 | 141 ± 1.41 | 6 ± 0.82 | 17030.1 | 0.0 |
| 15 | 244 ± 1.41 | 230 ± 0.82 | 145 ± 3.56 | 9 ± 2.16 | 9318.9 | 0.0 |
| 20 | 227 ± 1.63 | 180 ± 2.94 | 71 ± 1.41 | 1 ± 0.0 | 12644.3 | 0.0 |

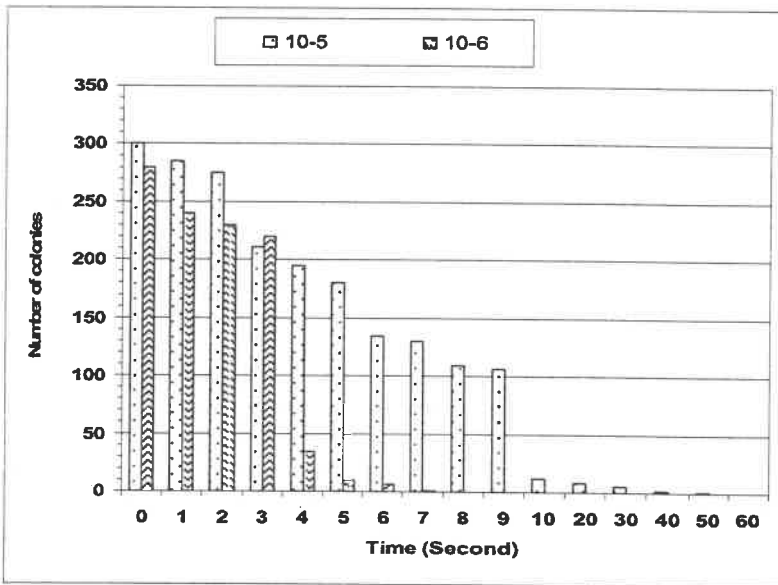
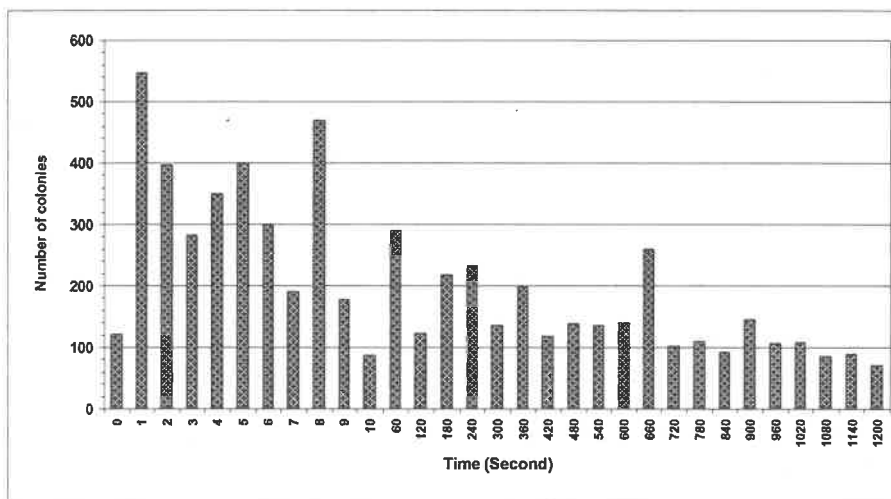


Fig. 3 : Effect of Magnetic Field on *P. aeruginosa* for different dilutions in different times of exposure.

Table 4: Effect of Magnetic Field on *P. aeruginosa* for 10^{-6} dilution in different times of exposure.

| Time(sec.) | No. of Colonies 10^{-6} | Time(sec.) | No. of Colonies 10^{-6} | Time(sec.) | No. of Colonies 10^{-6} |
|------------|---------------------------|------------|---------------------------|------------|---------------------------|
| 0(control) | 121 | 60 | 290 | 720 | 101 |
| 1 | 547 | 120 | 123 | 780 | 109 |
| 2 | 396 | 180 | 217 | 840 | 92 |
| 3 | 283 | 240 | 232 | 900 | 145 |
| 4 | 350 | 300 | 135 | 960 | 106 |
| 5 | 400 | 360 | 199 | 1020 | 108 |
| 6 | 300 | 420 | 118 | 1080 | 86 |
| 7 | 190 | 480 | 138 | 1140 | 88 |
| 8 | 470 | 540 | 136 | 1200 | 71 |
| 9 | 177 | 600 | 141 | - | - |
| 10 | 87 | 660 | 260 | - | - |

Fig 4: Effect of Magnetic Field on *P. aeruginosa* for 10^{-6} dilution in different times of exposure.



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