

Biological effect of Americium-241 in different types of bacteria

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Abstract:

In this study, five types of bacterial cells was exposed to radiation from Am-241. There was a difference between these cells in growth reduction after exposed to radiation . The comparison between the control group and the test group show a significant difference for *Escherichia coli* and *Staphylococcus aureus*, but there was no significant difference between them for the other types like *Pseudomonas aeruginosa*, *Proteus spp.* and *Streptococcus spp.*

The inhibition in growth of *Escherichia coli* and *Staphylococcus aureus* is related to the type of radiation used, the time of exposing and type of bacteria used.

Introduction

Increasing of radioactive contamination is an important problem of ecology. Recent years have seen a change in the conceptual approach in radiological studies. Microorganisms are the simplest and basic part of the biosphere, and their physiological state can serve an indicator of condition of the biosphere as whole. Hence, microorganisms can be used as sensors for monitoring the environment radiotoxicity (1,2,3).

Americium exists only in the form of radioactive isotopes; there are no stable forms. Reports of adverse health effects in animals that were administered massive doses of americium are most certainly the result of the ionizing radiation, not the chemical toxicity of americium.

It has a half-life of 430 years and decays by emitting an alpha particle with attendant gamma radiation (4).

The bacteria being mostly unicellular offer an easy system for both metabolic and molecular manipulations to understand the molecular mechanisms of radiation effecting (5).

The effect of radiation on cells by carries enough energy to remove electrons from molecules in a cell. Thereby the Free radicals can be production and cause the damage in most other molecules in a cell, such as DNA or RNA, by oxidizing them (6).

Increasing or inhibition of bacterial luminescence was observed under exposure to radionuclides. Radiation toxicity of Am-241 were demonstrated. Inhibition of bacterial growth was observed under exposure to Am-241(1).

The aim of this study to determined if the americium-241 has enough radiation energy (radiotoxicity) to causes Inhibition of growth rate and kill the bacterial cells.

Material and Method:

The organisms used in this study were *Escherichia coli* , *Proteus spp.*, *Pseudomonas aeruginosa*, *Staphylococcus aureus* and *streptococcus spp.* obtained from Laboratory research in College of medicine – University of Al-Qadisiya / Diwaniya city -Iraq.

The culture medium used as in the following:

Escherichia coli was grown in blood agar (Difco, USA), *Proteus* was grown in heart and brain infusion agar (Difco, USA), *Pseudomonas* was grown in MacConky agar (Difco, USA) and Muller Hinton agar (Oxoid, UK), *Staphylococcus* and *streptococcus* were grown in heart and brain infusion agar (Difco, USA).

Am-241 element was used in this paper as a sources of α -radiation with radiation activity = 102.8 μ Ci and average dose in the surface = 0.35 μ Sv/h (according to IRSRA* test near the time of doing the research).

The plates of culture for each type of bacteria divided by two groups , the first group incubated without Am-241 (control group) and the second group incubated with Am-241 (test group).

Counts of the viable of each type of bacteria were made by dilution plating. Three separate dilution serial (10^{-1} , 10^{-2} , 10^{-3}) cell/ml and three plates were at each dilution level for both groups were always prepared plates were incubated at 37c° for at least three days before counting. Each experiment repeated 6 times for each type of bacteria.

Also counting was done for selective type of bacteria; one of them was significant (*Escherichia Coli*) and the other was not significant (*Pseudomonas aeruginosa*); relative to the time (3,6,9,12) days for the control and test group.

The Results:

The statistical analysis was done by using SPSS-Software and its appear from the comparison between the control group and the test group that There was a significant difference between them for *Escherichia coli* and *Staphylococcus aureus*, but there was no significant difference between them for *Pseudomonas aeruginosa*, *Proteus spp.* and *Streptococcus spp.* The effect of irradiation relative to the time on the No. of *Escherichia coli* for control and test groups can be seen in the figure (1).

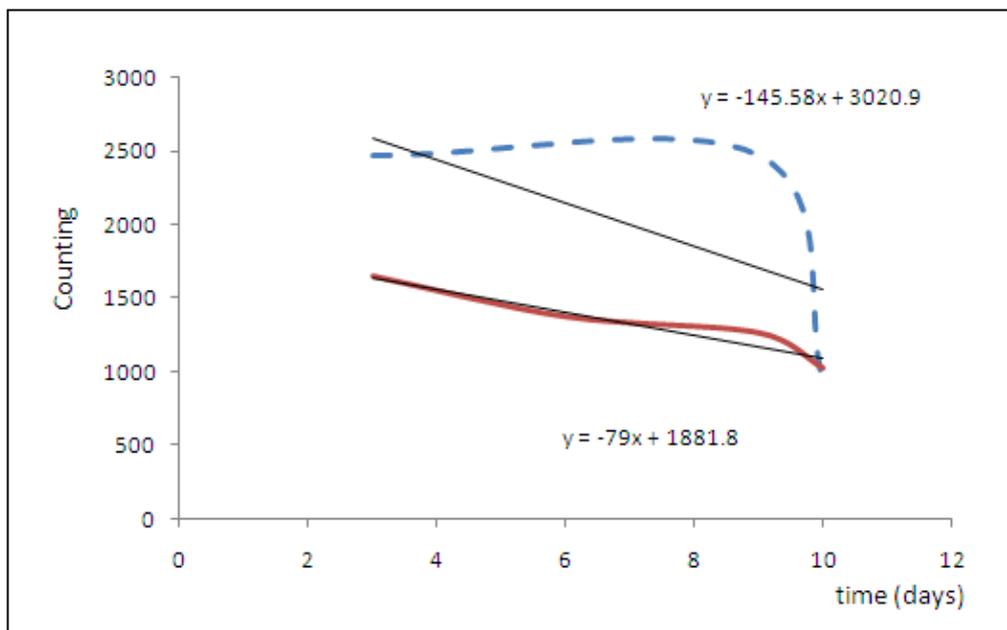


Fig.(1): The counting of *Escherichia coli*

for control (dashed line) and test (continuous line) groups relative to the time in days.

Also, the effect of irradiation relative to the time on the No. of *Pseudomonas aeruginosa* for control and test groups can be seen in the figure (2).

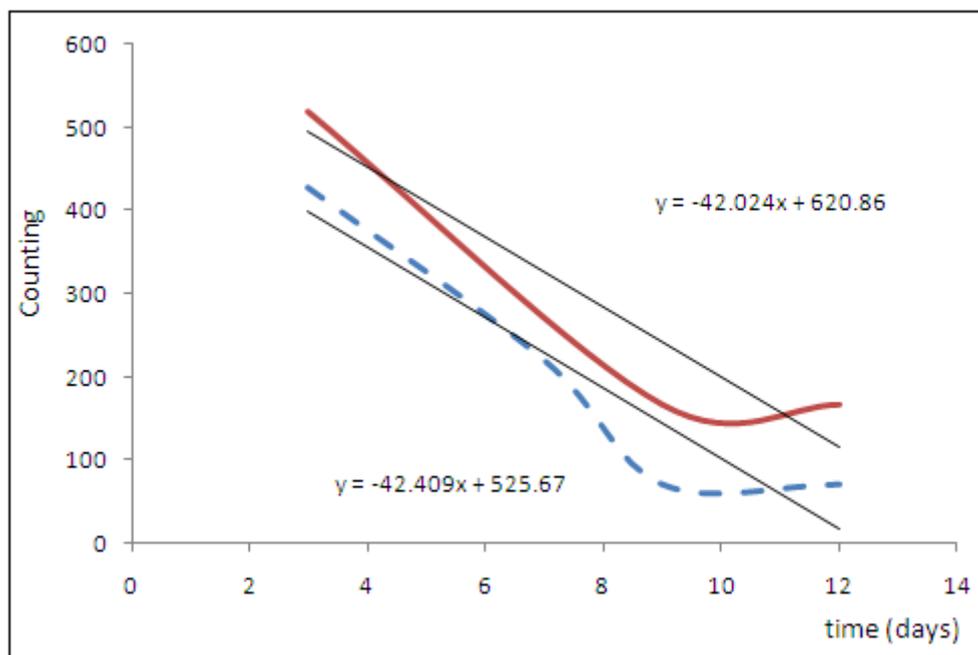


Fig.(2): The counting of *Pseudomonas aeruginosa*

for control (dashed line) and test (continuous line) groups relative to the time in days.

Discussion:

Although the Alpha particle has a little effect on the surrounding because of its low tracing but there was an effect of Am-241 in the *Escherichia coli* and *Staphylococcus aureus* and this effect was also shown in the figure (1) where the reduction in the counting of the No. of test group is effected more than control group after taking the counting relative to the period of time for *Escherichia coli*. This effect can be seen clearly in the middle of the two curves.

That has acceptance with other researchers where, It was observed the proportional of the surviving *Escherichia coli* cells decrease exponentially with the increase in radiation dosage at a given some wavelength (uv and visible light) 265 nm (7).

It was suggested that when *Escherichia coli* was exposed to Am-241, there was a production of some toxic substance or destructive of some essential compound in the cells (1).

The gram negative bacteria which are sensitive as a result of specific DNA repair deficiencies. (DNA dark repair e.g. post replication repair).

It was observed some of strains of *Staphylococcus spp.* may reflect a deficiency in post replication repair (8).

Am-241 inhibit bacterial growth and degrading of organic matter was delayed (9).

The effect of Am-241 is not seen in the other types of bacteria as in the *Pseudomonas aeruginosa* , *Proteus spp.* and *streptococcus spp.* Where the test group and the control will have the same reduction in counting. Figure (2) consist on this fact and we can show the reducing in counting is the same in the test group and in the control group for *Pseudomonas aeruginosa* after taken the counting for interval of time.

The low effect of Am-241 on the *Pseudomonas aeruginosa*, *Proteus spp.* and *streptococcus spp.* may related to the low level alpha irradiation and the type of exposing.

It was appeared that, Am-241 was non toxic on the microbial community including *Pseudomonas aeruginosa*. This result was not agreed with Goering and Pattee (9).

This difference may related to the type of exposing, in our research the exposing was done by using a metal source near the bacteria while other researches use solution of Am-241; where the use of solution will be more effective in bacteria because it will be within the bacteria.

Many workers have grown bacteria successfully in radioactive culture media, where equal or smaller radiation levels have been shown to be rapidly lethal to the organisms. Radioactive material must be present in ambient medium in order to have the isotope take up (10).

In bioremediation process, it is well known that toxicity from heavy metals can affect the biota, inhibiting microbial growth and affecting the performance of the microorganism as well as the biodegradation velocity (9)

We suggest that the type of culture medium in some types of bacteria effect the repairing of the cells and that has acceptance with (11).

It was appeared from previous study on the *luminous* bacteria (Photo bacterium phosphoreum) that radioactive solution of Am-241 suppressed bacterial growth (12).

Conclusions:

1. Am-241 can be used to make reduction in growth in some types of bacteria as in the *Escherichia coli* and *Staphylococcus aureus*, but its effect was not seen in other type like *Pseudomonas aeruginosa* , *Proteus spp.* and *streptococcus spp.*

2. This difference in response to Am-241 between the cells was not related to the type of the cell only, but may related to the type of the culture medium.

Recommendation:

When doing such type of experiment, it must take in consideration the type of culture medium and the type of exposing (metal or solution) in addition to the type of bacteria, type of radiation and exposure time.

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التأثير البايولوجي للعنصر المشع أمريسيوم (Am-241) على عدة أنواع من البكتريا.

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الخلاصة:

في هذه الدراسة، خمسة أنواع من خلايا بكتيرية عُرضت للإشعاع من المصدر المشع Am-241. وجد ان هناك أختلاف بين هذه الخلايا في قلة النمو بعد تعرضها للإشعاع. ولقد تبين من خلال المقارنة بين مجموعة control ومجموعة test أن هناك اختلاف معنوي لبكتريا *Escherichia coli* و *Staphylococcus aureus*، لكن ليس هناك اختلاف معنوي بين المجموعتين في الأنواع الأخرى مثل *Streptococcus spp.* و *Proteus spp.* و *Pseudomonas aeruginosa*.

التثبيط في النمو لبكتريا *Staphylococcus aureus* و *Escherichia coli* يعود الى نوع الاشعاع المستخدم و زمن التشعيع ونوع البكتريا المستخدمة.