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# EVALUATION OF SOILS BAGHDAD GOVERNORATE POLLUTION BY RADIOACTIVE ELEMENTS

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## Abstract

To assess the soil pollution in Baghdad Governorate with some radioactive isotopes ($Ra^{226}$, $Pb^{214}$, $Pb^{212}$, $Ac^{228}$, $K^{40}$, $Cs^{137}$, and $Be^{7}$), the Baghdad Governorate was divided into 13 locations that collected soil samples at a depth of 0-10 cm from the contaminated and comparison sites for all sites. The results showed an increase in the concentrations of radioactive elements in the soil of some of the study sites and they were contaminated compared to their control sites. The internationally permitted limits have exceeded, the Diyala Bridge (Al Tuwaitah) has exceeded the radioisotopes $Ra^{226}$, $K^{40}$ and $Cs^{137}$ internationally and in the Albab Alsharqiu area (Al-tahrir Tower Building) has exceeded the isotopes $Pb^{214}$, $Pb^{212}$ and $Ac^{228}$ The permissible limit, just as the $Be^{7}$ component exceeded the permissible limit in the Kasra and Atash region, but for the rest of the sampling sites for the Baghdad governorate, the specific efficacy values for radioactive elements and their analogues were relatively high but did not exceed the internationally permissible limits and the overall rate of efficacy was , The overall rate of specific efficacy of radioactive elements and their analogues was within the permissible limits globally.
***Keywords***: soils, pollution, radioactive elements

## Introduction

Radiation is defined as a stream of particles such as electrons, neutrons, protons, alpha particles, or high-energy photons, or a combination of them (Known, 2002). Since ancient times, humans have been exposed to radiation by means of cosmic radiation coming from space such as sunlight and rays emitted from rocks and volcanoes, and that all Types of radiation in its natural form that already exist does not adversely affect the elements of the environment or living organisms. Also, all types of natural radiation do not result in radioactive contamination (Putrus, 2002). Now the environment and soil in particular are experiencing a catastrophe that threatens life with horrific dangers from the effects of war destruction and environmental pollution. So the environment and the soil turned into a source of deterioration of the state of health (Selvase, 2000) and through the leakage of complex chemical compounds that are difficult to dissolve in the soil through the movement of water or the leakage of industrial radioactive materials that raise the radioactive level of natural radiation present in the soil from the three elements potassium 40 and the thorium family 232 the Uranium 238 family leading to a disturbance of the natural balance in the relationship between the safety of life of living organisms and their surrounding environment (Sharaf, 2005) and (Hussein, 2007). The concept of Radiation Pollution is a recent matter dating back to the period of second world war when it ended with the first nuclear explosion in the history of mankind by the United States of America when two bombs were dropped on the Japanese cities of Hiroshima and Nagasaki in 1945 AD, radioactive pollution is one of the forms of pollution with global impact it is not limited to soil only, but also includes water and air. Therefore, the risk of environmental pollution of all three types is contained as a result of increased human use of natural or industrial radioactive materials. Radiation has appeared since the German scientist Röntgen discovered X-rays in 1895, in order to diagnose pathological conditions and bone fractures in humans (Nashwan, 2002). The Iraqi environment is currently experiencing radioactive contamination as a result of the wars that Iraq fought and the types and quantities of weapons it was exposed to, and as a result of the extensive military operations in Iraq during the first Gulf War of 1980-1988 and the second gulf war in 1991 and the resulting exposure to the intense bombing of conventional and prohibited weapons such as cluster bombs and those coated with depleted uranium alloy, The Iraqi soil received a large amount of it, which spread throughout the center and south of Iraq, from the Military vehicles and contaminated with uranium 238 radioactive and toxic chemical (Bob Newcastle, 2005).

The sources of radiation in the environment are divided into two parts: -

- Natural sources: Include cosmic rays and nuclides generated by their interaction with some air components, terrestrial radionuclides such as $K^{40}$, $U^{238}$, $U^{238}$, $Th^{232}$, and Actinium Series, $Ac^{235}$.
- Industrial sources: the nuclear fuel cycle and the remnants of the nuclear industry or the peaceful uses of nuclear radiation in the medical, agricultural, industrial and astronomical fields, or by means of nuclear weapons tests and may be a significant source of radiation sources in the environment (Al-Wandawe, 1999)

**Table 1 :** Sampling sites for the Baghdad governorate soil

| No. | Sampling locations |
|---|---|
| 1. | Kasra and Atash |
| 2. | Diyala Bridge (Tuwaitha) |
| 3. | Albab Alsharqi (Al-tahrir Tower Building) |
| 4. | Alshaeb |
| 5. | Alsalikh |
| 6. | Alttaji |
| 7. | Abu Ghraib and warehouses Khan Dhari |
| 8. | Alridwania |
| 9. | Alrashid |
| 10. | Eawrij |
| 11. | Aldawra (Hwr Rjb) |
| 12. | Hayi Aljhad |
| 13. | Mahmudiyah |

## Materials and Methods

### Sample preparation

Thirteen soil samples were collected from different locations from the city of Baghdad and its suburbs randomly, including sites affected by the military operations and wars that the city witnessed during the past years and shown in table 1. by radiation monitor (CRM100) of the surface layer of soil at a depth of 10 cm and physical modeling was conducted on the models by removing impurities and drying processes using a 80 °C convection oven for 24 hours, then they were grinded using a ceramic hammer and sieved through a 2mm diameter sieve to obtain homogeneous models with a weight of 1 kg and put them in plastic bags and left the models for 30 days in order to stabilize the radioactive decay of the nuclear The radioactive compositions found in the soil.

**Measurement**:

- HpGe High Purity Germanium Detector

The detector used is produced by Canberra of the type GC-2520 with a 96cm3 crystal size and has an Energy Resolution of 2.2keV at 1332 keV due to the Cobalt counterpart 60. The detector is equipped with a positive operation voltage of 4000V of TENNELEC High-purity Germanium detector to cool at 77 k by liquid Nitrogen during operation to reduce noise pulses from the leakage stream generated at room temperature (Knoll, 1979).

- Preamplifier.
- Main amplification.
- High Voltage Power Supply.
- Personal Computer Analyze.

## Results and Discussion

### U / Ra Uranium series

### Radium $Ra^{-226}$

The results of a laboratory examination of soil samples for the Baghdad governorate shown in figure 1 show that the highest value for the specific effectiveness of the $Ra^{-226}$ radium isotope in contaminated sites in the Diyala Bridge area (Tuwaitha) which The 390.3 Bq/kg comparison for the same site control treatment was 40.4 Bq/kg and the lowest value for the sites Contaminated in Al-Shaeb area amounted to 117.4 Bq/kg compared to the control treatment of the same site 30.4 Bq/kg, and the overall rate of specific efficacy of the contaminated sites was 256.22 Bq/kg and reached for control 30.58 Bq / kg.

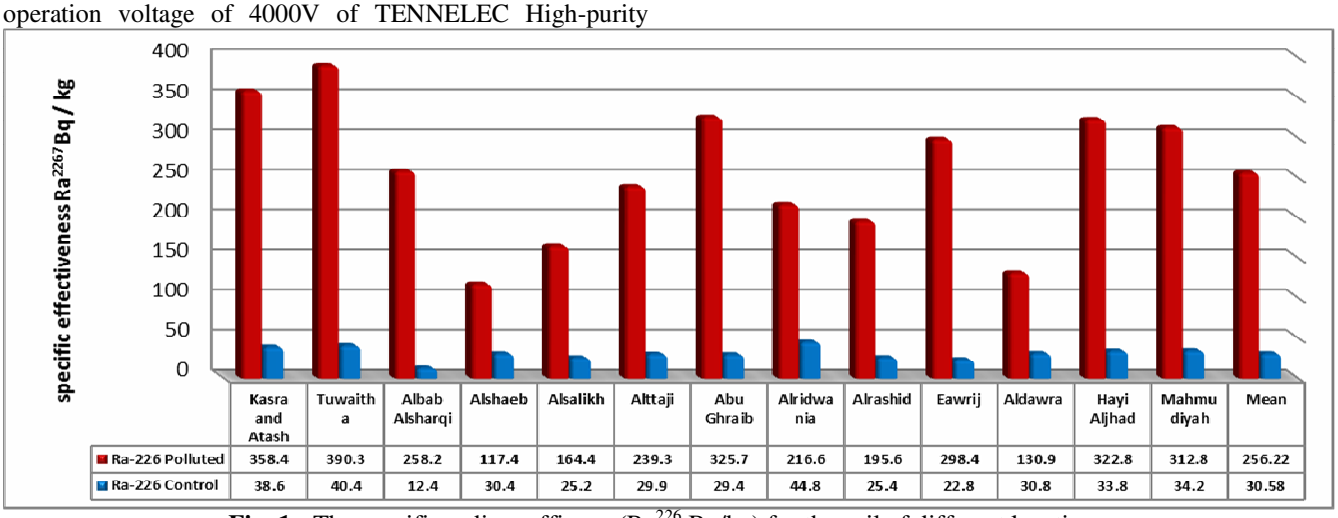



**Fig. 1 :** The specific radium efficacy ($Ra^{226}$ Bq/kg) for the soil of different locations

### Lead isotope $Pb^{214}$:

Figure 2 shows that the highest value of the specific efficacy of the lead isotope $Pb^{214}$ in polluted sites in the Albab Alsharqi (Al-Tahrir Tower building) was 40.0 Bq / kg compared to the control treatment for the same site 8.2 Bq / kg and the lowest value for contaminated sites in the Alshaeb region was 16.6 Bq / kg compared to the control treatment of the same site 14.1 Bq / kg The mean overall efficacy rate for contaminated sites for Pb-214 was 27.84 Bq / kg and for control 12.71 Bq / kg.

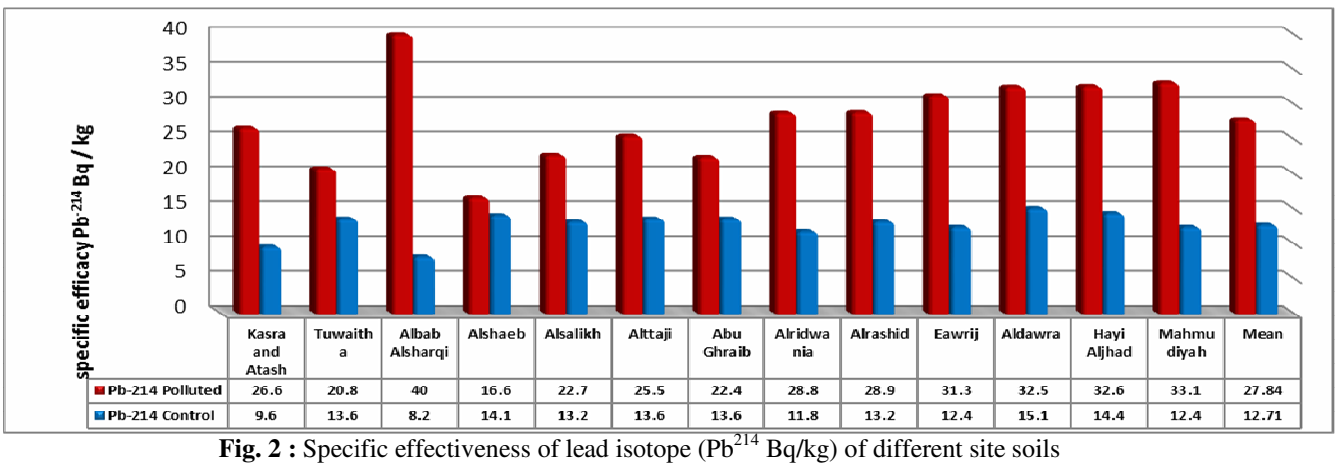
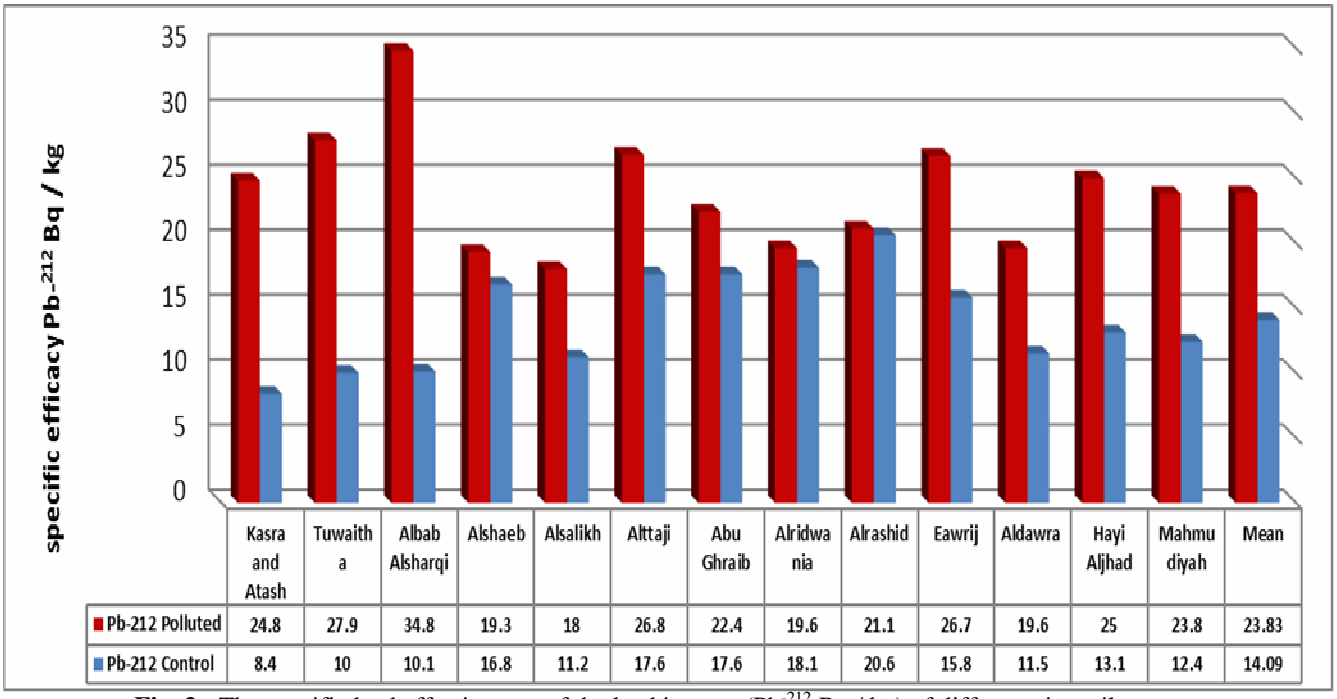



**Fig. 2 :** Specific effectiveness of lead isotope ($Pb^{214}$ Bq/kg) of different site soils

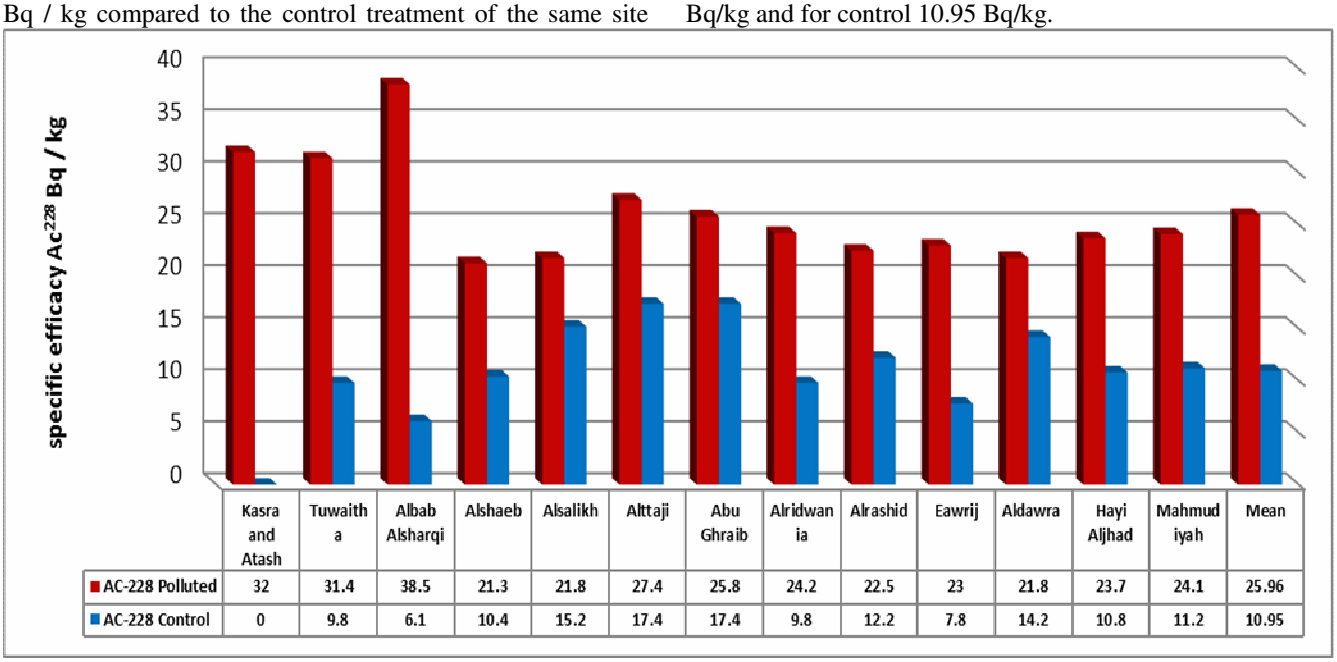
**Thorium Th Series:**
**Lead isotope $Pb^{212}$:**
The results show figure 3 that the highest value of the specific efficacy of the lead isotope $Pb^{212}$ in the contaminated sites in the Albab Alsharqi (Al-tahrir Tower Building) was 34.8 Bq / kg compared to the control treatment of the same site 10.1 Bq/kg and the lowest value of the contaminated sites in the Alsalikh area was 18.0 Bq / kg compared to the control treatment of the same site 11.2 Bq/kg The overall average efficacy rate for the contaminated sites for Pb-212 was 23.83 Bq/kg and for control 14.09 Bq/kg




| | Kasra and Atash | Tuwaitha | Albab Alsharqi | Alshaeb | Alsalikh | Alttaji | Abu Ghraib | Alridwania | Alrashid | Eawrij | Aldawra | Hayi Aljhad | Mahmudiyah | Mean |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Pb-212 Polluted | 24.8 | 27.9 | 34.8 | 19.3 | 18 | 26.8 | 22.4 | 19.6 | 21.1 | 26.7 | 19.6 | 25 | 23.8 | 23.83 |
| Pb-212 Control | 8.4 | 10 | 10.1 | 16.8 | 11.2 | 17.6 | 17.6 | 18.1 | 20.6 | 15.8 | 11.5 | 13.1 | 12.4 | 14.09 |

**Fig. 3 :** The specific lead effectiveness of the lead isotope ($Pb^{-212}$ Bq / kg) of different site soils

**Actinium $Ac^{228}$:**
The results of Figure 4 show that the highest value of specific efficacy of the actinium $Ac^{228}$ isotope in contaminated sites in the Albab Alsharqi (Al-tahrir Tower Building) was 38.5 Bq / kg compared to the control treatment of the same site 6.1 Bq/kg and the lowest value for contaminated sites in the Alshaeb region was 21.3 Bq/kg compared to the control treatment for the same site 10.4 Bq/kg The overall average efficacy rate for the contaminated sites was for $Ac^{228}$ 25.96 Bq/kg and for control 10.95 Bq/kg.

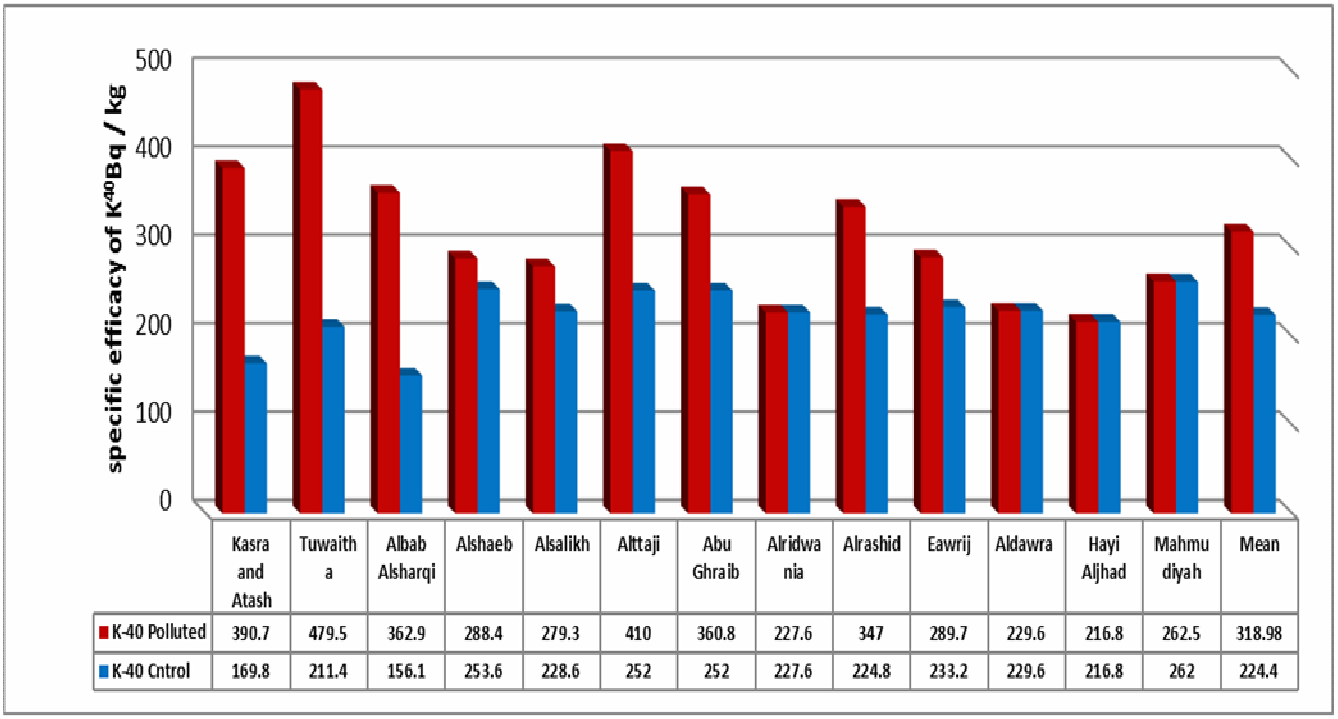



| | Kasra and Atash | Tuwaitha | Albab Alsharqi | Alshaeb | Alsalikh | Alttaji | Abu Ghraib | Alridwania | Alrashid | Eawrij | Aldawra | Hayi Aljhad | Mahmudiyah | Mean |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| AC-228 Polluted | 32 | 31.4 | 38.5 | 21.3 | 21.8 | 27.4 | 25.8 | 24.2 | 22.5 | 23 | 21.8 | 23.7 | 24.1 | 25.96 |
| AC-228 Control | 0 | 9.8 | 6.1 | 10.4 | 15.2 | 17.4 | 17.4 | 9.8 | 12.2 | 7.8 | 14.2 | 10.8 | 11.2 | 10.95 |

**Fig. 4 :** Specific Efficiency of the Actinium Isotope ($Ac^{228}$ Bq / kg) for Soil of Different Locations

**Potassium isotope $K^{-40}$:**

The results of fig. 5 indicate that the highest value of specific efficacy of $K^{40}$ potassium isotope in contaminated sites The Diyala Bridge (Tuwaitha), which amounted to 479.5 Bq/kg compared to the control treatment for the same site 211.4 Bq/kg, and the lowest value for the contaminated sites in the Alshaeb region was 218.8 Bq/kg compared to the control treatment for the same site 216.8 Bq/kg. $K^{40}$ 318.98 Bq/kg and for control 224.4 Bq / kg.

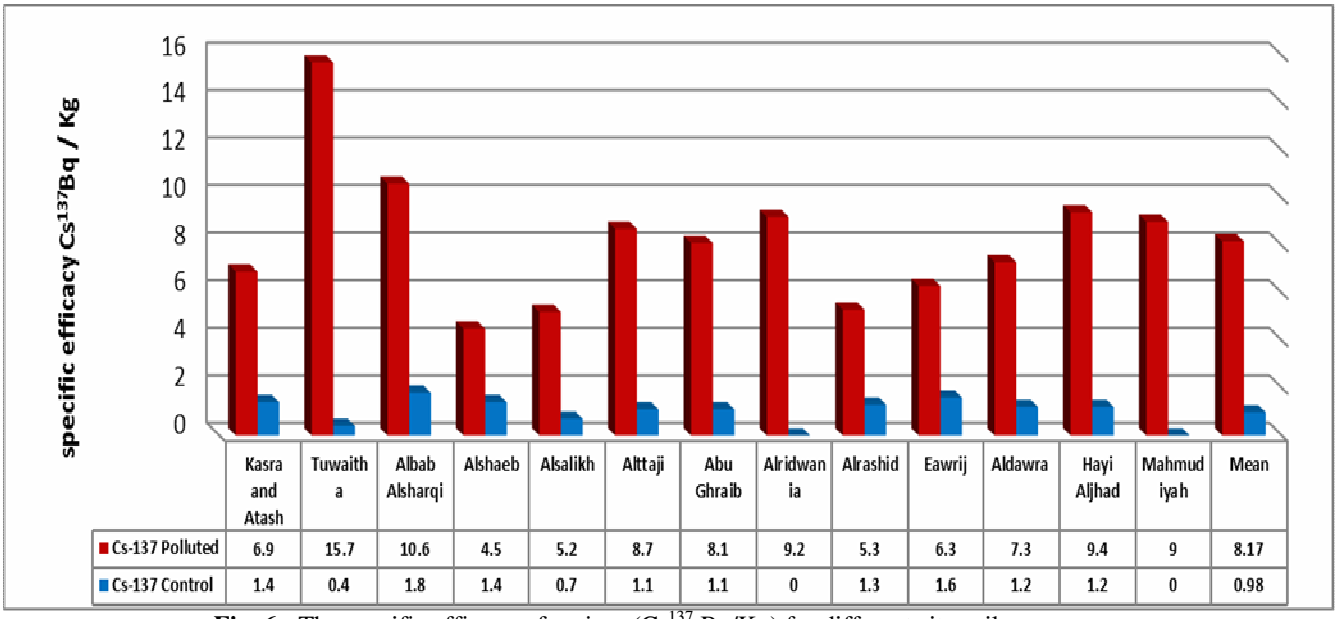



| | Kasra and Atash | Tuwaitha | Albab Alsharqi | Alshaeb | Alsalikh | Alttaji | Abu Ghraib | Alridwania | Alrashid | Eawrij | Aldawra | Hayi Aljhad | Mahmudiyah | Mean |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| K-40 Polluted | 390.7 | 479.5 | 362.9 | 288.4 | 279.3 | 410 | 360.8 | 227.6 | 347 | 289.7 | 229.6 | 216.8 | 262.5 | 318.98 |
| K-40 Cntrol | 169.8 | 211.4 | 156.1 | 253.6 | 228.6 | 252 | 252 | 227.6 | 224.8 | 233.2 | 229.6 | 216.8 | 262 | 224.4 |

**Fig. 5 :** The specific of K-40 Bq / kg isotope for different site soils

**Cesium Isotope $Cs^{-137}$:**

The results of fig. 6 show that the highest value of the specific efficacy of the cesium-$Cs^{137}$ isotope in contaminated sites in the Diyala Bridge (Tuwaitha) was 15.7 Bq / kg compared to the control treatment of the same site 0.4 Bq / Kg and the lowest value for contaminated sites in the Alshaeb region was 4.5 Bq / kg compared to the control treatment of the same site 1.4 Bq / kg and the overall average efficacy of the specific sites of polluted sites for Cs 137 8.17 Bq / kg and for control 0.98 Bq / kg.

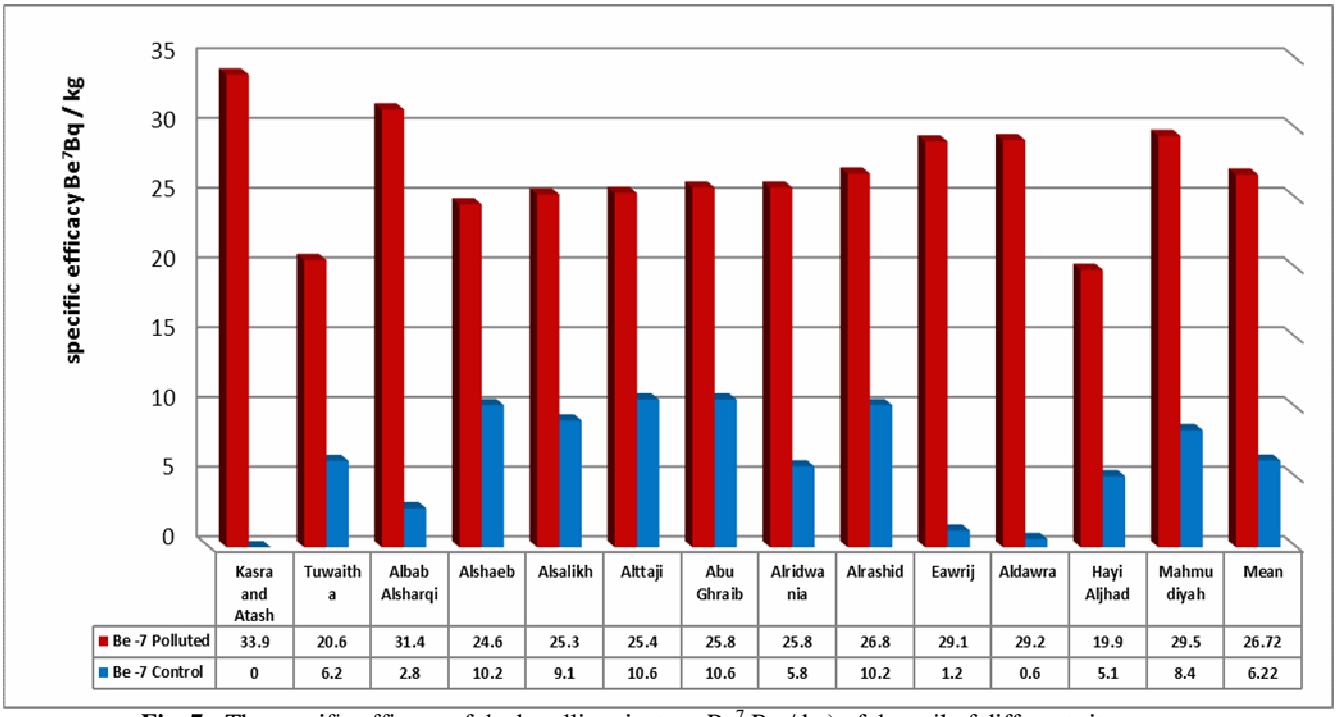



| | Kasra and Atash | Tuwaitha | Albab Alsharqi | Alshaeb | Alsalikh | Alttaji | Abu Ghraib | Alridwania | Alrashid | Eawrij | Aldawra | Hayi Aljhad | Mahmudiyah | Mean |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Cs-137 Polluted | 6.9 | 15.7 | 10.6 | 4.5 | 5.2 | 8.7 | 8.1 | 9.2 | 5.3 | 6.3 | 7.3 | 9.4 | 9 | 8.17 |
| Cs-137 Control | 1.4 | 0.4 | 1.8 | 1.4 | 0.7 | 1.1 | 1.1 | 0 | 1.3 | 1.6 | 1.2 | 1.2 | 0 | 0.98 |

**Fig. 6 :** The specific efficacy of cesium ($Cs^{137}$ Bq/Kg) for different site soils

**Beryllium isotope $Be^7$**

The results of Fig. 7 indicate that the highest value of the specific efficacy of the Beryllium isotope in $Be^7$ at contaminated sites in the kasra and Atash region was 33.9 Bq / kg compared to the control treatment for the same site BDLB and the lowest value for the contaminated sites in the Hayi Aljhad was 19.9 Bq / kg compared to the control treatment For the same site 1.3 Bq / kg, the overall average efficacy rate of the contaminated sites for $Be^7$ was 26.72 Bq / kg, and for control 6.22 Bq / kg.




| | Kasra and Atash | Tuwaitha | Albab Alsharqi | Alshaeb | Alsalikh | Alttaji | Abu Ghraib | Alridwania | Alrashid | Eawrij | Aldawra | Hayi Aljhad | Mahmudiyah | Mean |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Be -7 Polluted | 33.9 | 20.6 | 31.4 | 24.6 | 25.3 | 25.4 | 25.8 | 25.8 | 26.8 | 29.1 | 29.2 | 19.9 | 29.5 | 26.72 |
| Be -7 Control | 0 | 6.2 | 2.8 | 10.2 | 9.1 | 10.6 | 10.6 | 5.8 | 10.2 | 1.2 | 0.6 | 5.1 | 8.4 | 6.22 |

**Fig. 7 :** The specific efficacy of the beryllium isotope $Be^7$ Bq / kg) of the soil of different sites

Results of the specific activity of radioactive elements in some areas of Baghdad city show that they have exceeded the International permissible limit Surveys in the Diyala Bridge (Tuwaitha), the radioisotopes $Ra^{226}$, $K^{40}$ and $Cs^{137}$ have exceeded the internationally permitted limits, and in the Albab Alsharqi (Al-tahrir Tower Building), the isotopes $Pb^{214}$, $Pb^{212}$ and $Ac^{228}$ have exceeded the permissible limit As for $Be^7$, it has exceeded the allowable limit in the region of kasra and Atash, and this may be due to the wars and military operations that have passed in Iraq in general and in the city of Baghdad in particular since the eighties and the second Gulf War in 1991 and the war in 2003 as there was destruction and looting of the Iraqi nuclear energy center In Tuwaitha (Lama) containers of dangerous radioactive materials and heavy elements, Some areas were also subjected to direct air strikes and internationally prohibited weapons, as well as remnants of wars from tanks, destroyed and buried military machines and scrap squares in different locations of the city of Baghdad that led to a high specificity of radioactive elements and their analogues in the soil, and this is consistent with the study of Al-Ani and others (2016) who explained in their evaluation of the radioactivity levels in the soil of the battery factories in Al-Waziriya, as it was found that the values of $Pb^{214}$ and $Pb^{212}$ were high and exceeded the internationally permitted limit and this was due to the wars that passed in Iraq since 1991 to 2003 and also showed high values of $K^{40}$ as it reached 730.61 Bq / kg ware the values of the $Cs^{137}$ element exceeded the internationally permitted limits, as it is an industrial component, and Iraq was affected by the Chernobyl accident because of its geographical proximity. The study of AL-Bakhat et al. (2014) on assessing the radiological state of the nuclear fuel industry facility destroyed in Tuwaitha eara, as the results of the radioactive description showed that the site is contaminated with the isotopes of $Uranium^{238}$ and $Uranium^{235}$ at levels that exceeded the standards of exemption from regulatory control approved by the International Atomic Energy Agency, Jabil and Said (2018) study on the identification of radioactive elements in the soil of the Tigris river in Baghdad Governorate showed that the results indicated that the concentrations of $K^{40}$ and $U^{238}$ series and $Th^{232}$ series were within the internationally permitted range while $Cs^{137}$ exceeded the permissible limit and may be attributed to nuclear activities For this site, the reason may also be attributed to the dust storms that strike the country, which may be loaded with some of these elements and their radioactive isotopes. The study of Muhammad and others (2013) on assessing the radioactivity of dust storms showed that the results showed the presence of traces of some natural radioactive elements such as $K^{40}$ and $Be^7$, which is formed as a result of the nuclear interaction between cosmic rays and some elements present in the atmosphere such as oxygen and nitrogen as well as the presence Radioisotopes belonging to the natural uranium and thorium chains. The results also showed the presence of industrial radioisotopes such as $Cs^{137}$. The concentration of the potassium isotope $K^{40}$ 467.7 Bq / kg and lead Pb-214 was 33.6 Bq / kg and lead $Pb^{212}$ was 18.8 Bq / kg and Actinium $Ac^{228}$. It reached 30.3 Bq / kg, while the highest $Cs^{137}$ industrial cesium concentration was 26.8 Bq / kg, and the specific efficiency of radioactive elements and radioactive natural and industrial isotopes give internal and external radiation dose as possible to affect human health as a result of inhalation or exposure to dust containing radioactive elements. Ridha et al. (2016) study on evaluating the natural

radial activity of soil samples from different regions in Baghdad governorate showed that the average concentration of Uranium$^{238}$, Thorium$^{232}$ and Potassium$^{40}$ 55.30, 49.18 and 545.24Bq / kg sequentially, which is higher than average global. Jarallah *et al*., 2014 study on measuring the radioactivity effectiveness of Beryllium$^{7}$ isotope for soil samples from Baghdad city, as the results indicated that the effectiveness values of Beryllium-7 isotope in surface soils from Baghdad city for Rusafa and Karkh sides ranging from BDL- 32.8 ± 6.46 Bq/kg for Al-Rusafa soils. As for karkh, ranged between BDL - 23.66 ± 3.70 Bq / kg. The results showed that most of the samples taken contain specific efficacy of the Beryllium$^{7}$ isotope, which is higher than the internationally approved natural levels. As for the rest of the sampling sites for the city of Baghdad, the specific efficacy values for radioactive elements and their analogues were relatively high, but they did not exceed the permissible limits internationally as well as the general average for the specific efficacy of radioactive elements and their analogues were all within the permissible limits globally.

**Table 2 :** Critical limits of radioactive elements in the soil.

| Radioactive elements | Allowable limit Bq/kg (UNSCEAR,1993 ) |
|---|---|
| $Ra^{226}$ | 370 |
| $Pb^{214}$ | 35 |
| $Pb^{212}$ | 30 |
| $AC^{228}$ | 30 |
| $K^{40}$ | 400 |
| $Cs^{137}$ | 14.8 |
| $Be^{7}$ | 30 |

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