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THOMSON REUTERS

[Tawfik* 6(5): May, 2019] ISSN 2349-4506
Impact Factor: 3.799

Global Journal of Engineering Science and Research Management

STUDY THE ECOLOGICAL EFFECTS OF SOME RADIONUCLIDES RESULTING FROM COOLING WATER SYSTEM IN SOME MARINE CRUSTACEAN BIOTA

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DOI: 10.5281/zenodo.3235340

KEYWORDS: Cooling system, Crustacean, Marine biota, Res-RAD BIOTA.

ABSTRACT

Radionuclides presence in the marine ecosystem can be adversely affect human health when it enters the food chain as seafood (crab). This study is simulating the radionuclides released from a proposed site of cooling water system of nuclear power plant such as uranium (^{233}U), (^{238}U), radium-226 (^{226}Ra), Cesium (^{137}Cs) in marine biota crustacean crab, which has the ability to acclimated in high temperature in outlet cooling water system of a certain nuclear power plant, and that had occurred by using the modeling tool Res-rad biota code version (1.8), the results showed that the biological concentration guidelines (BCGs) limits of selected radionuclides are complying of the recommended BCGs limits and on the other hand, the radioactivity concentrations of Ra-226 in crab tissue is higher than radioactivity concentration of Ra-226 concentration in riparian animal while in case of Cs-137 radioactivity concentration in tissue was lower in crab than in riparian animal while crab has higher values of U-233 and U-238 radioactivity concentration in tissue than U-233 and U-238 in riparian animal, this indicates that the concentration of radionuclides inside the tissue of the selected animal depend on the type of animal . Carb also can be used as bio-indicator in cooling water system as its ability of acclimated of the increasing of temperature and salinity in marine water cooling water system.

INTRODUCTION

Natural environmental radioactivity and associated external exposure due to gamma radiation depend primarily on the geological conditions and soil and sediment formations of each region in the world. The amount of cesium in sea water very small and its value of 0.4-1.3 microgram per liter, it was found in experiments with fission product Cs-137 that Cs can penetrate into and is concentrated by marine animals such as crab. it was investigated that there are accumulation of radioactive cesium in certain crustacean biota such as crabs[(1)]. The presence of artificial radionuclides in the marine environment can lead to radiation exposure through the ingestion of sea food. It was reported that a wide variation in the concentrations of uranium and radium in samples from various parts of the world. For example it was found that uranium had a range from 3 to 400 ppm, corresponding to 37–4900 Bq ^{238}U kg-1 (1 ppm U = 12.23 Bq ^{238}U kg-1)[(2)]. Most of radionuclides have a low solubility in water and tend to be adsorbed on the particulate matter, therefore they accumulate in sediments. Fine sediments, with their large surface area, tend to absorb more than coarse sediments [(3)].sea water has a radioactivity of about 12.6 Bq·kg−1, while marine sand has a radioactivity of 200 - 400 Bq·kg−1, and mud 700 - 1000 Bq·kg−1, in parts of the world activities may expose populations of plants and animals to radioactive materials in environmental media, or to radioactive materials released in waste streams [(4)]. The DOE has established biota concentration guidelines (BCGs) based on conservative exposure scenarios for the protection of terrestrial animal populations (DOE 2002) using the RESRAD family of dose codes, specifically RESRAD-BIOTA (DOE 2004). The RESRADBIOTA dose evaluation code was designed to be consistent with the graded approach and the biota concentration guides (BCGs)[(5)].The concentration and distribution of U-series in various environmental components, especially in marine food such as plankton, Macro-algae, corals, molluscs, and crustacean was studied by many authors. There is a direct relationship between temperature and salinity on the survival of certain types of crabs such as Diogenes brevirostris. In marine environment it was found that tolerance to low salinity is greater at lower temperatures than at higher temperatures [(6)]

MATERIAL AND METHODS

A survey had been done to select certain region in Alexandria coast. The selected region is Sidi Abdelrhaman which is an onshore site. Physicochemical analysis had been done measuring pH, temperature, TDS, and alkalinity and also some radionuclides had been measured such as R-226, U-233, U-238, and Cs-237 at the selected region using germanium hyper detector and standard method for water and wastewater analysis[(7)].

Using RESRAD-BIOTA was developed as a tool for implementing screening and analysis methods contained in the DOE Technical Standard, "A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota" (DOE 2002). The use of the RESRAD-BIOTA interface simplifies the input of the necessary parameters involved in the screening and analysis process.

RESULT AND DISCUSSION

Table1. The average mean concentrations of physicochemical parameters had been measured during summer 2016 and for six months at the selected site

Average mean	TDS mg/l	Water temperature Degree centigrade	*pH
Sidi Adelrhaman	38338	29	8.72

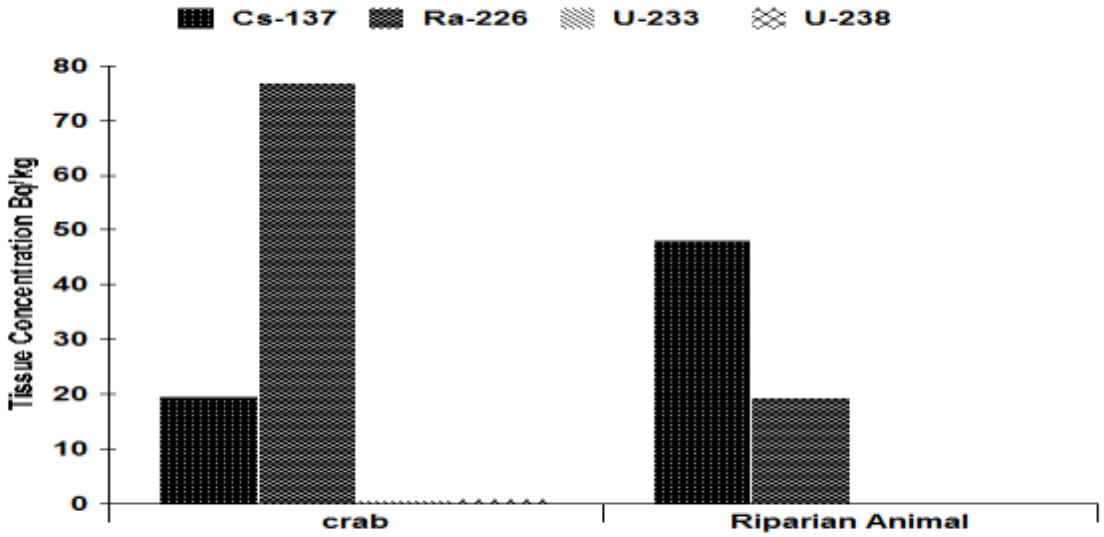
**pH is not average mean*

Table 2. The average mean radioactivity concentrations in Sidi Abdelrhaman site with biological concentration guideline[(5)] during summer 2016

Nuclide	Average mean radioactivity concentration in water In Bq/m^3	Biological Concentration Guideline BCG in Bq/Kg	Recommended Limited Biological Concentration Guideline in Bq/Kg
Ra-226	1.65	1.51×10^2	4.1×10^2
U-233	0.51	6.9×10^3	7×10^3
U-238	0.78	7.6×10^3	8×10^3
Cs-137	0.89	1.58×10^3	4×10^4

Table1.& table2.had showed that the mean average radioactivity concentration of the measured radionuclides in selected area in Alexandria coastal (Sidi Abdelrhaman) Ra-226, U-233, U-238, and Cs-137 are respectively 1.65, 0.51, 0.78, and 0.89 Bq/m^3 and by using Res-Rad biota to calculate their BCGs values which were 1.51 $x10^2$, 6.9 $x10^3$, 7.6 $x10^3$, and $1.58x10^3$ Bq/Kg respectively . These calculated BCGs values are complying with recommended BCGs values of IAEA guidelines [(5)].

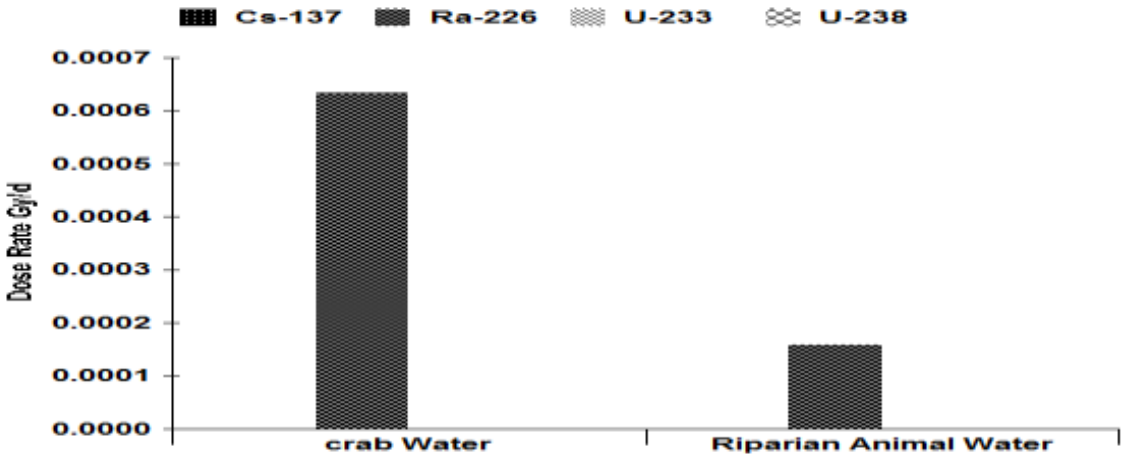
Figure: 1



The measured tissue concentration of the selected radionuclides in both crab and the receptor riparian animal

In Figure:1 It was found that tissue concentration of the selected radionuclides : Ra-226, U-233, U-238, and Cs-137, inside the selected Crustacean marine biota (crab) were 75,2.4,3.5 and 19 Bq/Kg respectively, while in riparian receptor animal were 19,1.2,2.2,43 Bq/Kg respectively , that indicates that Ra-226 concentration in crab tissue is higher than Ra-226 concentration in riparian animal while in case of Cs-137 tissue concentration was lower in crab than tissue concentration in the riparian animal while crab has higher values of U-233 and U-238 tissue concentration than U-233 and U-238 tissue concentration in riparian animal, this indicates that the concentration of radionuclides inside the tissue of the selected animal depend on the type of animal and also the different parameters of bio-magnification between the two animals such as temperature, and pH and salinity, as shown in Table1.which showed that crab has the ability to acclimated the degree of temperature and salinity which effect on the food chain and the bio-accumulation of radionuclides in the tissue of crab and also in tissue of the receptor which in our case was riparian animal as resulted from using Res-Rad biota modeling code.

Figure: 2



The measured dose rate of the selected radionuclides in both crab and the receptor riparian animal

Figure (2) showed that the dose rate of crab water was higher than dose rate of riparian animal, this indicate that dose rate of Cs-137 in crab was $6x10^{-4}$Gy/d while it was $2x10^{-4}$Gy/d in case of riparian animal on the other hand the dose rate of Ra-266, U-233, and U-238 were less than $1x10^{-4}$Gy/d for both crab water and riparian animal water.

CONCLUSION

- Carb can be used as bio-indicator in cooling water system as its ability of acclimated of the increasing of temperature and salinity in marine water cooling water system
- The calculated BCGs of Cs-137, Ra-226, U-233, and U-238 values are complying with the recommended limiting BCGs values of Res-Rad biota guidelines (IAEA).
- Ra-226 radioactivity concentration tissue in crab higher than Ra-226 radioactivity concentration tissue in riparian animal, while in case of Cs-137 radioactivity concentration tissue in crab is lower than in riparian animal, on other hand crab has higher values of U-233 and U-238 radioactivity concentration tissue than U-233 and U-238 radioactivity concentration tissue in riparian animal. This indicated that the radioactivity concentration of radionuclides, inside the tissue of the animal depend on the type of animal and depend also on the different parameters of bio-magnification.

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