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# Public Health Goal for Naturally Occurring Radionuclides in Groundwater

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## ABSTRACT

**Naturally occurring and man-made radionuclide in groundwater may have a health hazardous to some residents. The objective of this work is to provide criteria for safety of drinking-water with respect to the chemical parameters and the radionuclide content.**
**The annual effective dose for the consumption of drinking water was considered. Ground water samples were selected from different sites in Egypt, that have the most population, it were taken from aquifer regions along Giza sites in Egypt. Chemical analyses for the major anions, cations, and the radiological analyses were tested . Activity concentrations (Bq/l) of the gross alpha and the gross beta activities of our investigated samples were compared with the maximum contaminant level (MCL) of the world health organization (WHO). Some of the water samples were found to have a higher of gross beta and alpha particles than the MCL. Alpha activity were found depending on to the total dissolved solids (TDS) content of the water samples. Gamma activity concentrations were analyzed using low background germanium detector, the higher of activity values was found in some investigated samples is due to increasing of $^{226}$Ra and $^{228}$Ra activities. Tritium activity concentrations also were measured using soft beta liquid scintillation counter, it was found lower than the MCL. Our investigated samples were found to have a higher concentrations of the phosphate, nitrites, iron, and manganese contents than the maximum permissible limit, all the ground water samples were found to have a higher of silica and alumina content. Commercial carbon powder and natural clay materials were tested as ion exchangers for the removal of inorganic contaminants in the ground water samples. Clay materials was found to have a higher selectivity than activated carbon for the removal of radionuclides, phosphates, nitrites, and manganese content at the ground water samples.**

***Key Words:*** *Ground Water/Gross Alpha, Gross beta/ Effective Dose*

## INTRODUCTION

Natural Radioactivity are present in a wide range of concentrations in all rocks, soils and water. The common radioactive elements, uranium ($^{238}$U), and thorium ($^{232}$Th) decay slowly produced other radioactive elements (daughter elements), such as radium and radon, which in turn undergo further radioactive decay at a rate faster than of uranium, and thorium isotopes these radioactive daughter decay at different rate emits different levels of radiation energy than either uranium and thorium isotope. Natural radioactive elements in drinking water and its effect on human health recently became the major of our environmental concern. The most common isotopes of radium are $^{224}$Ra, $^{226}$Ra, and $^{228}$Ra. $^{226}$Ra is one of the decay product of $^{238}$U, has a half life of 1,600 years, $^{228}$Ra is the

decay product of $^{232}$Th has a half life 5.8 years. $^{224}$Ra also is a decay product of $^{232}$Th and has a short half – life of 3.6 days. $^{226}$Ra and $^{224}$Ra decay by emitting alpha particles, and $^{228}$Ra decays by emitting beta particles. The maximum concentration limit (MCL) of radioactivity content in drinking water was set at a level of 1 in 10,000 risk of fatal cancer of consumer of 2 liter of water per day within 70 years[1,2]. EPA has revised the current radionuclides regulation since 1977, by requiring monitoring previsions, the current studies are combined $^{226}$Ra/ $^{228}$Ra of 5 pCi/l (excluding radon and uranium) levels do not exceed 15 pCi/l, when tritium do not exceed 20,000 pCi/l, and $^{90}$Sr levels do not exceed 8 pCi/l..

A combined standard of 4 mrem/year for beta emitters, and the maximum contaminated level for uranium was set as 30 μg/l . The guideline levels for radioactivity in drinking water also was recommended in 1984, The U.S environmental protection agency (USEPA) has proposed a maximum contaminated level (MCL) of 20 μg/l that equivalent to an activity of 30 pCi/l, for uranium in drinking water[3].

**The Effective Dose in Drinking Water**

The guideline activity concentrations values are, 0.1 Bq/l for all gross alpha activity, and 1.0 Bq/l for all gross beta activity that corresponding to an effective dose of 0.1 mSv from 1 year of consumption drinking water was recommended . An effective dose value of 0.1 mSv/y produced from the different radionuclides concentrations that contained in drinking water. The radionuclide reference concentrations (RC) that corresponding to the reference level of an effective dose 0.1 mSv/y were calculated using (Eq.1) of the natural uranium, thorium and radium series concentrations level (Bq/l) and the corresponding dose conversion factors (Sv/Bq) that may be contained in drinking water are shown in Table 1. where the natural $^{40}$K concentrations subtracted from the gross beta activity concentration before an effective dose calculations[4, 5].

$$\mathbf{RC} = \frac{1\times10^{-4}(Sv/year)}{730(liter/year)\times do\,\mathrm{sec}\,onversionfactor(Sv/Bq)} \quad \textbf{(Bq/l)} \qquad \textbf{(1)}$$

**Table 1: Activity Concentration Values of Radium Isotopes that Corresponding to the Dose of 0.1 mSv from 1 Year Consumption of Drinking Water.**

| Radionuclide | Dose conversion factor (Sv/Bq) | Concentration value (Bq/l) |
|---|---|---|
| $^{224}$Ra | $8.0 \times 10^{-8}$ | 2 |
| $^{226}$Ra | $2.2 \times 10^{-7}$ | 1 |
| $^{228}$Ra | $2.7 \times 10^{-7}$ | 1 |
| $^{232}$Th | $1.8 \times 10^{-8}$ | 0.1 |
| $^{238}$U | $3.6 \times 10^{-8}$ | 4 |

## MATERIALS AND METHOD

**Sampling Preparation**

Twenty one of the ground water samples were taken from different depths (m) around Giza site in Egypt. Two liters volume of each water samples were placed in polyethylene bottles, the water sample was shacked and filtered through 0.7 μm filter paper, the ground water samples was preserved in drops of nitric acid aqueous solution, the bottles closed sealed for one month later in order to perform secular equilibrium between uranium, thorium and its progeny. The second liter of the water sample was kept for the physical and chemical analyses, the pH, conductivity, total dissolved solids, the major anions

and alkalinity were determined for unpreserved ground water samples, the major cation concentrations were determined.

**Gross alpha and gross beta radioactivity in drinking water**

Gross alpha, and gross beta activity concentrations (Bq/kg) in the given water samples can be affected by the total dissolved solids (TDS) of the water sample. The solid density limit is 5 mg/cm$^2$ was required for a 2 inch diameter counting planchet (20 cm$^2$) and not more than 10 mg/cm$^2$ for gross beta. Particles[6].

**Calibration**

Americium-241 was used as a standard for calibration of the gross alpha activity. Potassium-40 was used as a standard for calibration of beta activity**.**

**Procedures**

An aliquot of the preserved water samples was transferred to the stainless steel planchet; the water sample dried to a constant weight, reweighed, the dry residual weight was calculated. The volume of the water samples was required for the TDS was not exceed than 100 mg for the gross alpha determinations,

Alpha *(α)* and beta *(β)* activity concentrations (Bq/l) calculated as [(6)] :

$$\alpha = \frac{A \times 1000}{\varepsilon(\alpha) \times V} \qquad \textbf{(Bq/l)} \qquad \textbf{(2)}$$

$$\beta = \frac{B \times 1000}{\varepsilon(\beta) \times V} \qquad \textbf{(Bq/l)} \qquad \textbf{(3)}$$

Where,
*A* and *B* (cpm) are the net alpha and beta count rate (gross alpha count rate minus the background count rate ), *ε(α)* is alpha efficiency factor was determined from counting of the standard $^{241}$Am against different solid content. ε(β) is beta efficiency factor was determined from counting $^{40}$K standards against different solid content and V is the volume of sample aliquot (ml).

High pure germanium spectroscopy was used for the measurement of gamma activity concentrations in the ground water samples which have higher value of the gross alpha activity > 0.1 Bq/l, and having higher value of the gross beta activity of > 1.0 Bq/l.

**Limit of Detection and Error Determination in Gross Alpha and Beta**

The minimum detectable activity (MDA) was calculated using Curie formula[7]

$$\mathbf{L_d(cpm) = 2.71 + 4.65 \times (B \times T)^{1/2}} \qquad \textbf{(4)}$$

$$\mathbf{MDA\ (Bq/kg) = L_d \times (\varepsilon \times T \times Q)^{-1}} \qquad \textbf{(5)}$$

Where ε is the detection efficiency, T is the counting time (s), Q is the solid sample quantity (kg), and B is the background rate ($s^{-1}$).

**Counting error calculation**

$$S_s = ( R_s/T + R_b/T )^{1/2} \qquad (6)$$

Where, $S_s$ is the standard deviation of net count rate of sample, $R_s$ is the gross count rate for sample, $R_b$ is the count rate for background, T is the counting time for sample

**Gamma Spectroscopic Analyses**

One liter of the water sample was packed into the cylindrical screw-cap plastic containers sealed tightly and wrapped with thick vinyl tape. The radioactivity measurements were performed using a high-resolution gamma spectroscopic system. Germanium crystal (HPGe) coupled with multichannel analyzer (TENNELEC); it is a p-type co-axial detector (Nucleus Model No.CPVD530-10195). Radioactivity counting of the samples was measured for about 24 hours.

The background counting measurements also was measured**.** The gamma– transmissions used for the activity calculations are 351,9 ( $^{214}$Pb). 609.3, 1120.3, and 1764.5 kev (Bi-214) for the $^{226}$Ra series, 338.4, 911.1 and 968.9 kev ($^{228}$Ac) for the $^{232}$Th series and 1460 kev for $^{40}$K radioactive isotope. The gamma spectra were calibrated using both uranium and thorium standard source and potassium chloride standard with the same geometry as that of the sample.

**Tritium**

Tritium concentration was measured using low background liquid scintillation counter (LSC) of the PACKARD, Meriden, CT 06450. Canberra Company.

**Chemical Analyses**

Alkalinity, calcium and magnesium hardness were determined by titration, the spectrophotometer of the model 7800 UV/VIS was used for the determination concentrations of phosphates, aluminum, iron, manganese, sulphates and silica in the ground water samples. Phosphorous concentrations was determined using stannous chloride method, silica was determined using ammonium molybdate method[6], iron and aluminum were determined using ferron indicator[7] Manganese was analyzed using ammonium persulphate method. Sulphate was determined using turbidmetric method, nitrite was determined using sulphanilic acid method. Uranium was analyzed using Pyridyl-azo-resorcinol indicator, thorium was determined using thoron indicator[8]. Sodium and potassium concentrations were determined using flame photometer. All the cations and anions concentrations were determined as ppm (mg/l).

**Sorption Experiments**

About 0.5 g of activated charcoal, and very fine sand samples were stirring with 50 ml of the natural ground water samples in 100 ml polyethylene bottles, using the solid to the liquid ratio of 1: 10, the clay sample is the reprehensive sand material have the following compositions: $SiO_2$ 98.8 % FeO 0.0078 %, $Fe_2O_3$ 0.0224, $Al_2O_3$ 0.4500 , Cr, 0.0036 %, Ti, 0.0001 %, CaO, 0.0200 %, $Na_2O$, 0.0650 %, $K_2O$, 0.085 %, was used in our sorption experiments, after two days of stirring the bottles with the sand materials, an aqueous phase was separated from the solid phase by centrifugation, the aqueous phases was analyzed for the gross alpha, gross beta activity concentrations (Bq/l), and chemical contents of the nitrites. iron, manganese, sulphate, and phosphate concentrations (mg/l)

that remained. Concentrations of an elemental adsorbed percentage was calculated by comparison of an element remained with the same element at initial concentrations in the ground water samples.

## RESULTS AND DISCUSIONS

The limit of detection in gross alpha and beta was determined using Eq. 4 and 5, the counting error for the calculations was determined using Eq. 6. Table 2 shows the efficiency, the statistical background limit (cpm), the working limit (cpm), and the counting error calculations for the gross alpha, and beta measurements**.** Table 3 shows the mean activity concentration values (Bq/kg) of the gross alpha and gross beta measurements at the ground water samples having the code numbers 1-21.

**Table 2 : Parameter of the limit of detection in gross alpha and beta in**

| **Parameters** | **Alpha** | **Beta** |
|---|---|---|
| Efficiency | 0.026 | 0.26 |
| Statistical background limit (cpm) | 2.8 – 2.9 | 5.4-7.0 |
| Working limit (cpm) | 13 – 15.6 | 6-7.7 |
| Counting error calculations | ± 0.48 to ± 0.51 | ± 0.44 to ± 0.48 |

The code number of the ground water samples, the depth, (m), conductivity, the total dissolved solids (TDS), of the ground water samples, gross alpha, gross beta and $^{40}K$ radioactivity concentrations values, (Bq/l) were given in Table 3. The mean values of the gross beta activity was found between 0.01 to 0.18 ± 0.003 Bq/l for the ground water samples which is lower than the minimum detectable limit of 1.0 Bq/l of the WHO guidelines[8], the mean activity concentrations values of the gross alpha activity value was found between 0.5 to 4.1 Bq/l was higher than the minimum detectable limit value 0.1 Bq/l of the WHO guideline[8], our results were compared with the other monitoring of water from Milano and its surrounded area[9], the mean values of the gross alpha activity was found 0.107 ± 0.021 Bq/kg at the ground water samples of Milano which was found lower than the mean activity values of the gross alpha activity values of 1.437 ± 0.002 Bq/kg of our ground water samples. The mean values of the gross beta activity values of our ground water samples are found s within the values of the gross beta activity in fresh water samples between 0.030 to 0.073 Bq/kg at Milano. Further investigations of the radionuclides contents was carried out using germanium detector, the ground water samples was found to have Radium -226 with the concentrations ranges between 2 to 8 Bq/l .

The ground water samples were found free of uranium and thorium radioactive isotopes. An exposure rates of these samples calculated for the presence of radium content in the ground water samples according to the Eq. 1, it was found higher than the MCL ( 0.1 mSv/y) of the WHO, 2004, increasing of radioactivity values may be due to the natural occurring of radium radionuclides that is present in the depths of more than 30 m of the ground surfaces[(5)]. The health concerns associated with chemical constituents of drinking-water differ from those associated with radiological, microbial contamination and arise primarily from the ability of chemical constituents to cause adverse health effects after prolonged periods of exposure.

There are few chemical constituents of water that can lead to health problems resulting from a single exposure, except through massive accidental contamination of drinking-water supply. Phosphates, nitrites and nitrate may arise from the excessive application of fertilizers or from leaching of wastewater or other organic wastes into surface water and groundwater., The presence of nitrate and nitrite in water has been associated with methaemoglobinaemia, especially in bottle-fed infants. Table 4 shows, the guidelines of the maximum permissible limits for some chemical parameters in drinking water supply [(5)].

**Table 3: The Radiological Analyses of the Ground Water Samples for, the Gross α, Gross β, Tritium Activities and $^{40}K$ (Bq/l) Radioactive Isotope**

| Code No. | Sample | Cond. ($\mu Sm/cm^2$) | TDS (g/l) | Depth (m) | Gross α | Gross β | $^{40}K$ |
|---|---|---|---|---|---|---|---|
| | | | | | (Bq/l) | | |
| 1 | Ossim | 710 | 35 | 150 | 0.871 | 0.027 | 0.213 |
| 2 | Knater-1 | 620 | 31 | 35 | 2.107 | 0.073 | 0.210 |
| 3 | knater-II | 600 | 30 | 30 | 1.629 | 0.056 | 0.237 |
| 4 | Kanater-III | 1650 | 30 | 30 | 2.148 | 0.078 | 0.840 |
| 5 | nazla Ashter | 780 | 30 | 33 | 1.313 | 0.042 | 0.390 |
| 6 | **Badrashin (sak)** | 1900 | 97 | 35 | 0.607 | 0.012 | 0.195 |
| 7 | Tekla-I | 470 | 25 | 60 | 1.931 | 0.067 | 0.180 |
| 8 | Mit Kados | 1240 | 62 | 33 | 0.452 | 0.006 | 0.180 |
| 9 | Meat-el Kaad | 1300 | 65 | 33 | 1.295 | 0.040 | 0.270 |
| 10 | bani-salama | 520 | 24 | 30 | 0.839 | 0.024 | 0.198 |
| 11 | Kerdassa | 430 | 21 | 32 | 2.658 | 0.090 | 0.252 |
| 12 | Aiat | 1260 | 63 | 60 | 2.891 | 0.100 | 0.240 |
| 13 | badrashin-ker | 1940 | 97 | 30 | 1.039 | 0.035 | 0.225 |
| 14 | Kerman | 520 | 26 | 60 | 0.543 | 0.008 | 0.255 |
| 15 | Wardan | 760 | 37 | 75 | 4.110 | 0.178 | 0.216 |
| 16 | Naseria | 1350 | 68 | 33 | 1.196 | 0.032 | 0.375 |
| 17 | Menwath | 1680 | 84 | 33 | 0.992 | 0.038 | 0.210 |
| 18 | Saff | 1050 | 47 | 65 | 0.915 | 0.021 | 0.315 |
| 19 | Abo-el-nomros | 82 | 41 | 31 | 0.674 | 0.012 | 0.219 |
| 20 | Kababat | 2700 | 135 | 90 | 0.563 | 0.011 | 0.450 |
| 21 | Tekla-II | 27 | 25 | 60 | 0.871 | 0.027 | 0.223 |

**Table 4: The Guidelines of the Maximum Limit Concentrations of the WHO, 2004.**

| **Chemical Parameters Limits** | **Concentration (mg/l)** |
|---|---|
| Phosphate | 0.005 |
| Nitrites | 0.005 |
| Iron | 0.3 |
| Manganese | 0.1 |

Most of our investigated ground water samples were found to have a higher values of, phosphates, nitrites, and manganese than the maximum permissible limit values, Phosphates concentrations was found between 0.3 to 10 mg/l, nitrites is between 0.06 to 0.8 mg/l, and manganese is between, 0.06 to 0.8 mg/l . Therefore, eliminating the source of contamination, rather than on installing expensive drinking-water treatment for the removal of the chemical constituent. The health risk associated with the presence of naturally occurring radionuclides in drinking-water should also be taken into consideration.

**Table 4: The pH, the Cation Concentrations (meq/l). and Sum of the Cations Analyses of the Ground Water Samples.**

| Code No. | Sample | pH | K(meq/l) | Na(meq/l) | Ca(meq/l) | Mg(meq/l) | NH4(meq/l) | **Σ cations** |
|---|---|---|---|---|---|---|---|---|
| 1 | Ossim | 7.6 | 0.18 | 3.65 | 4.80 | 1.206 | 0.028 | 10.26 |
| 2 | Knater-1 | 7.76 | 0.13 | 3.70 | 2.56 | 1.53 | 0.03 | 10.10 |
| 3 | knater-II | 7.7 | 0.15 | 3.74 | 2.40 | 0.64 | 0.011 | 7.911 |
| 4 | Kanater-III | 7.5 | 0.28 | 9.14 | 4.00 | 1.61 | 0.04 | 15.07 |
| 5 | nazla Ashter | 7.7 | 0.18 | 3.8 | 5.60 | 1.61 | 0.01 | 10.03 |
| 6 | Badrashin (sak) | 7.5 | 0.28 | 12.62 | 2.40 | 1.61 | 0.028 | 20.13 |
| 7 | Tekla-I | 7.7 | 0.15 | 2.31 | 3.80 | 1.41 | 0.039 | 6.90 |
| 8 | Mit Kados | 7.7 | 0.18 | 9.14 | 5.28 | 0.96 | 0.04 | 19.76 |
| 9 | Meat-el Kaad | 7.8 | 0.71 | 9.57 | 12.00 | 2.89 | 0.02 | 15.92 |
| 10 | bani-salama | 7.5 | 0.17 | 2.39 | 9.60 | 0.80 | 0.04 | 6.60 |
| 11 | Kerdassa | 7.8 | 0.10 | 2.39 | 4.00 | 0.80 | 0.03 | 5.57 |
| 12 | Aiat | 7.5 | 0.20 | 10.01 | 4.80 | 2.41 | 0.02 | 20.63 |
| 13 | badrashin-ker | 7.8 | 0.18 | 9.14 | 8.80 | 1.20 | 0.02 | 18.15 |
| 14 | Kerman | 7.6 | 0.18 | 3.48 | 4.80 | 1.61 | 0.04 | 7.78 |
| 15 | Wardan | 7.8 | 0.19 | 4.83 | 6.96 | 1.85 | 0.04 | 11.46 |
| 16 | Naseria | 7.8 | 0.18 | 10.44 | 8.80 | 1.61 | 0.03 | 19.69 |
| 17 | Menwath | 7.7 | 0.20 | 12.62 | 5.44 | 0.96 | 0.02 | 22.84 |
| 18 | Saff | 7.7 | 0.21 | 10.88 | 5.60 | 3.21 | 0.04 | 18.34 |
| 19 | Abo-el-nomros | 7.8 | 0.18 | 3.83 | 3.44 | 2.41 | 0.01 | 12.82 |
| 20 | Kababat | 7.8 | 0.28 | 18.27 | 3.20 | 2.41 | 0.04 | 33.49 |
| 21 | Tekla-II | 7.9 | 0.18 | 4.35 | 3.20 | 1.20 | 0.02 | 10.56 |

The chemical balance analyses in the ground water samples was performed in Table 4 and 5, the major cations, and anions was calculated, the concentrations values of, mg/l were converted to the meq/l, and the sum of the meq/l of the cations concentrations values was balanced by the sum of the meq/l of the anions values. The standard error of the mean values of the analyses was found within the value ± 10 %. For the public health protection, an assessment for the adequacy of the chemical quality of drinking-water relies on comparison of the results of water quality analysis with the guideline values after different of chemical treatments.

Commercial powder charcoal and sand material were tested for the reduction and/or the removal of radionuclides and some chemicals from the ground water samples. Fig 1, 2, 3, and, 4, show the gross alpha, manganese , nitrites, phosphates and sulphate sorption percentage by the commercial powder charcoal and silica material as a function of the code number of the ground water samples.

**Table 5: The Anion Concentrations (meq/l) , and Sum of the Anion Analyses of the Ground Water Samples.**

| Code No. | Sample | $HCO_3$ | $SO_4^{2-}$ | $Cl^-$ | $PO_4^{3-}$ | $NO_2^-$ | Σ anions |
|---|---|---|---|---|---|---|---|
| | | meq/l | | | | | |
| 1 | Ossim | 3.05 | 0.69 | 6.20 | 0.138 | 0.013 | 10.09 |
| 2 | Knater-1 | 3.28 | 1.29 | 5.53 | 0.010 | 0.002 | 10.11 |
| 3 | knater-II | 1.64 | 0.98 | 5.41 | 0.04 | 0.002 | 8.09 |
| 4 | Kanater-III | 3.02 | 1.42 | 11.05 | 0.005 | 0.001 | 15.50 |
| 5 | nazla Ashter | 2.62 | 1.31 | 5.98 | 0.073 | 0.001 | 9.99 |
| 6 | Badrashin (sak) | 3.61 | 1.97 | 14.66 | 0.189 | 0.003 | 20.44 |
| 7 | Tekla-I | 2.95 | 0.79 | 2.82 | 0.114 | 0.002 | 6.68 |
| 8 | Mit Kados | 3.12 | 2.63 | 13.54 | 0.133 | 0.015 | 19.43 |
| 9 | Meat-el Kaad | 2.89 | 1.75 | 11.05 | 0.010 | 0.003 | 15.71 |
| 10 | Bani-salama | 3.61 | 0.66 | 2.37 | 0.079 | 0.001 | 6.72 |
| 11 | Kerdassa | 2.10 | 0.92 | 2.03 | 0.324 | 0.002 | 5.38 |
| 12 | Aiat | 3.61 | 2.14 | 14.74 | 0.022 | 0.001 | 20.43 |
| 13 | badrashin-ker | 4.59 | 2.71 | 10.60 | 0.009 | 0.017 | 17.93 |
| 14 | Kerman | 3.28 | 1.13 | 3.27 | 0.035 | 0.002 | 7.72 |
| 15 | Wardan | 2.95 | 1.47 | 6.32 | 0.483 | 0.002 | 11.22 |
| 16 | Naseria | 3.94 | 2.47 | 13.54 | 0.022 | 0.002 | 19.97 |
| 17 | Menwath | 4.26 | 2.54 | 15.79 | 0.010 | 0.009 | 22.61 |
| 18 | Saff | 4.10 | 2.59 | 11.05 | 0.136 | 0.002 | 17.88 |
| 19 | Abo-el-nomros | 3.28 | 2.14 | 7.67 | 0.013 | 0.013 | 13.11 |
| 20 | Kababat | 4.264 | 2.70 | 25.94 | 0.095 | 0.001 | 33.01 |
| 21 | Tekla-II | 2.79 | 1.31 | 6.01 | 0.047 | 0.008 | 10.16 |

Commercial powder charcoal was found removed 33 to 34 % of the gross alpha activity, removed 29 to 100 % of the manganese concentrations, and removed 2 to 24 % of the sulphates concentrations, while, sand materials was found reduced 76.6 % of the gross alpha activity, 82 to 100 % of manganese concentrations. Most of the nitrites and phosphates in the ground water samples were found greatly removed by sand material than the commercial charcoal materials. Generally speaking, sand material is considered a good adsorbent for the reduction of the gross alpha, manganese, nitrites, phosphates and sulphates in the ground water samples. All Figs, (1-4) show a great relation between the removal of radium with other anions in ground water, these results was accounted by the facts, radium forms complex compounds with iron, manganese, and other anions that are found in the environments[10] . Radium reacts with carbonates, sulphates, phosphates, and nitrites in ground water to form the complexes of radium carbonates, radium sulphates, radium phosphates and radium nitrites respectively, and the solubility and mobility of radium will not thus be significantly affected by the concentrations of the anions and cations in drinking water. Sand material contains an active part of the silica particles, therefore, sand material is also considered a good adsorbent may be used for the removal of natural radioactivity of radium, and other chemicals such as; sulphate, phosphates, nitrites, iron and manganese at drinking water, these results were found agreed with that reported by other investigators [10-12], and radium may form very effectively adsorbs onto iron and manganese hydroxides [13-15].

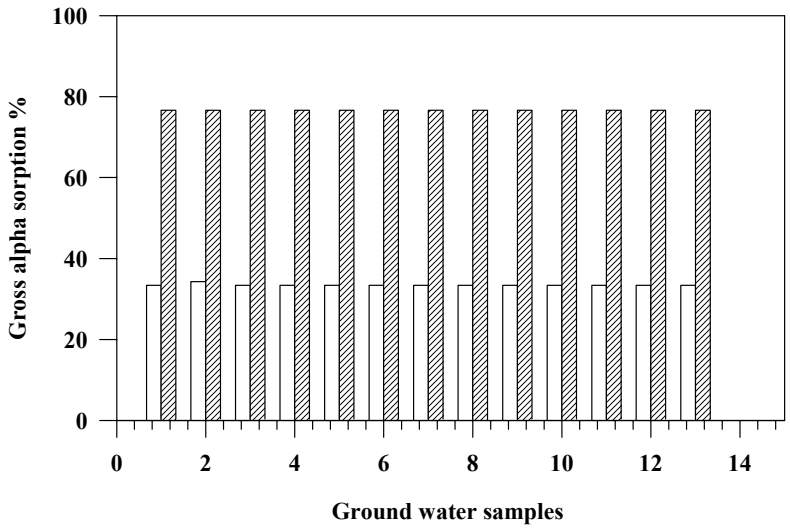


**Fig. 1: The gross alpha sorption percentage as a function of the ground water samples by: commercial powder charcoal, and Clay Material**

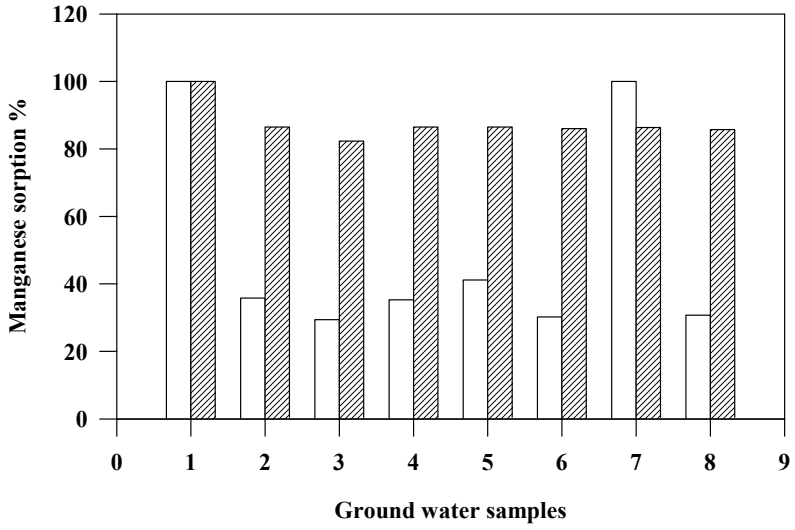


**Fig. 2: The mangane sorption percentage as a function of the ground water samples by: commercial powder charcoal, and Clay material**

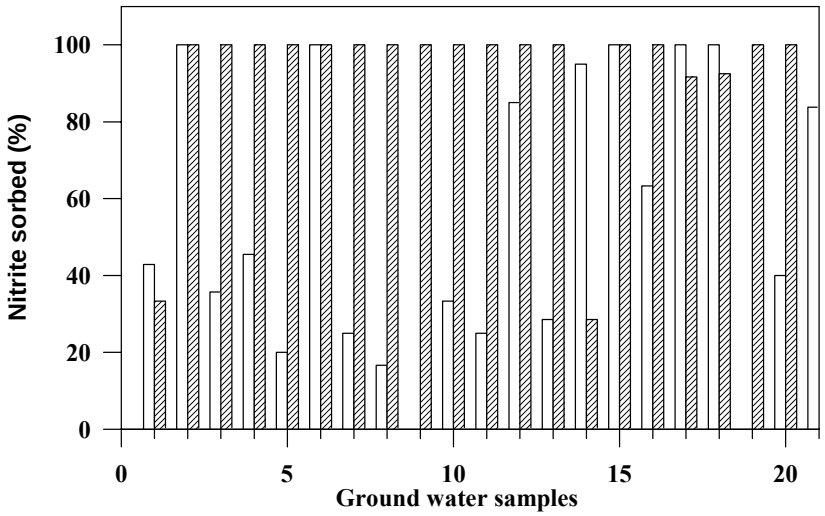


**Fig. 3: Nitrite sorbed % against the ground water samples numbers using: commercial powder charcoal, and, clay mineral**

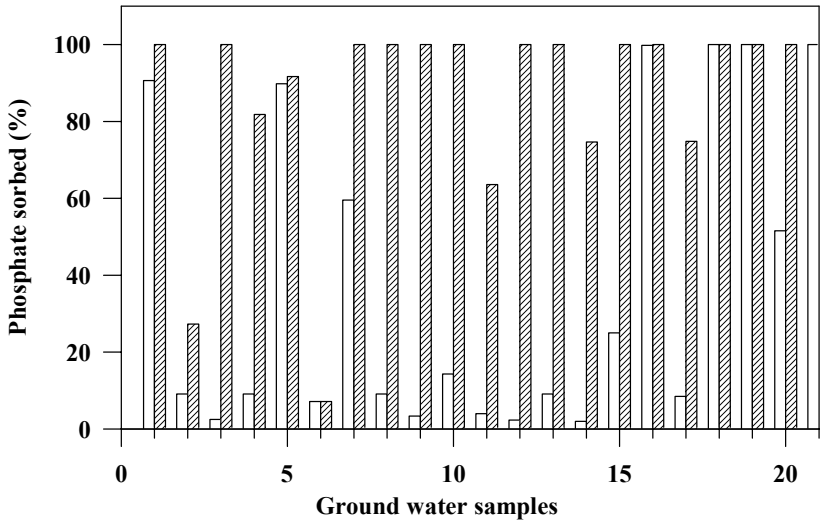


**Fig. 4: Phosphate sorbed % against the ground water samples using: commercial powder charcoal, and, clay material**

## CONCLUSIONS

The world health organization (WHO. 2004) has been recommended the guidline values for the maximum concentrations limit (MCL) of the radioactivity and other chemical parameters contents in drinking water . The purpose of this research is to identify of an effective exposure rate (mSv/y) as a results of presence of radioactivity concentrations, and other chemical parameters in drinking ground water. Twenty one of the ground water samples were taken from the sites that more crowded with population. Chemical and radiological analyses were carried out. The ground water samples were found to have a higher of the gross alpha and gross beta activities than the maximum concentrations limits, the effective exposure dose was expected higher than the MCL. Inorganic chemicals such as; phosphates, sulphates and manganese contents also were found higher than the MCL in ground water samples. Natural clay material was found more selective for the removal of radium radioactivity, phosphates, sulphates, nitrites and manganese in ground water samples than the commercial powder charcoal materials.

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