Journal of
The Nigerian Association of
Mathematical Physics
Journal homepage: https://nampjournals.org.ng

TRANSACTIONS OF THE NIGERIAN ASSOCIATION OF MATHEMATICAL PHYSICS
Published by Nigerian Association of Mathematical Physics

# ASSESSMENT OF RADIOLOGICAL SAFETY OF SOME SACHET (PURE) WATER COLLECTED FROM HADEJIA TOWN IN JIGAWA STATE.

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ARTICLE INFO

*Article history*:
Received xxxxx
Revised xxxxx
Accepted xxxxx
Available online xxxxx

*Keywords:*
Gamma Dose Rate, Annual Effective Dose Equivalent, Radium Equivalent Activity, External and Internal Hazard Indices.

**ABSTRACT**

*Sachet Water samples from Hadejia town in the north eastern part of Nigeria were studied in order to ascertain the suitability and radiological safety of water sold in the town for human consumption. Radioactive measurements, using a lead shielded sodium iodide detector coupled to a multichannel analyser were used to estimate eight radiological parameters of some sachets water samples from Hadejia. The results show that the values of all the parameters fall within the minimum universal standard, indicating that consuming the sachet water in the study area pose no serious radiological hazard, especially for adults. The values of the Absorbed Dose Rate (50.105 nGyh-$^{1}$) and AEDE (12.458 mSvy$^{-1}$) for the infant however portend that infant consumer could be susceptible to radiation hazard on consuming sachet water collected from the study area. It is however recommended that activities that are capable of enhancing the radiological content of should be avoided within the area.*

## I. Introduction

Water is one of the most significant resource to humans and every other life. Several studies have been carried out to assess the quality of our drinking water and yet the assessment of water contamination remains significant especially in developing countries such as Nigeria. There are two sources of water: rain and ground waters. It is found in rivers, wells, lakes and streams. Surface water that penetrated into the ground, filling soil pores spaces, fissures, fractures of the lithological formations, among others, is known as ground water [1]. Pollution is a world serious issue and water pollution is one of the most important problem in developing countries. This is because abundant supply of clean water is necessary for every country. The most crucial natural resources are expected to be free from pollution.

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The quality of the water resources of a country define the quality of food production, public health, industrial development and hence, its economy, [2]. With this regard it is mandatory to study the quality of our water used for consumption and other activities.

Radioactivity of drinking water is an important measure for the quality of drinking water similar to microbiological and chemical criteria. Radioactivity of drinking water is defined as the sum of gross alpha and gross beta activity. Gross alpha activity is the total activity of all alpha emitters such as $^{210}$Po, $^{226}$Ra, $^{238}$U, when radon has been removed while gross beta activity is the total activity of all beta emitters excluding tritium, $^{14}$C and other weak beta emitters. United Nations Scientific Committee on the Effects of Atomic Radiation [3] reported that intake of drinking water and foods contributes about eight percent of the total natural exposure for humans including external and internal sources of radiation. National and international organizations provide maximum recommended level of radioactivity of drinking water. The most acceptable guidelines are that of World Health Organization (WHO) of 0.5 Bq/l for alpha activity and 1.0 Bq/l for beta activity and International Commission on Radiological Protection (ICRP) which states the guidelines for the maximum exposure level of 0.1 mSv/yr [4].

More than 70% of the people in Nigeria depends on the ground water that has not undergone any preliminary test to determine its quality for consumption and other activities. From the previous works, many locations in Nigeria are radiologically contaminated. Therefore, studying the level of radioactivity in drinking water for Hadejia town, Jigawa State, Nigeria is necessary.

Many works have been done on evaluation of radioactivity and estimated committed effective dose in drinking water within and outside Nigeria. A study was carried out on “Evaluation of the Radiation Hazard Indices and Excess Life Time Cancer Risk due to Natural Radioactivity in Ground Water in Mining Areas of Plateau State”. 48 samples of ground water were collected from both boreholes and wells and the sampling was randomly selected in two litres plastic container, the samples were prepared and later analysed for gross alpha and beta activity concentrations using MPC-2000-DP, a gasless alpha and beta proportional counter. The results obtained in their work showed that the alpha activity for borehole water samples ranges from 0.11 to 1.55 Bq/l and 0.01 to 12.59 Bq/l for well water samples. They also evaluated the hazard indices and excess lifetime cancer risk. The results obtained for borehole water samples of alpha emitting radionuclides were 0.157, 0.039 $0.548\times10^{-3}$ mSv/yr for Annual Effective Dose Equivalent (AEDE), Annual Gonnadal Equivalent Dose (AGED) and Excess Cancer Lifetime Risk (ECLR) respectively while for beta emitting radionuclides were 0.134, 0.668 and $4.68\times10^{-2}$ mSv/yr for AEDE, AGED and ELCR respectively and for well water samples the results obtained were 0.335, 0.084 and $1.172\times10^{-3}$ mSv/yr for AEDE, AGED and ELCR respectively while for beta emitting radionuclides the obtained results were 0.393, 1.964 and $1.375\times10^{-3}$ mSv/yr for AEDE, AGED and ELCR respectively. They observed that almost all the areas were above recommended level and they concluded that the locations have potential radiological hazard which may be due to the mining activities that take place in that area [5]. Another study was carried out on “Determination of Gross α and β Activity Concentration and Estimation of Adults and Infants Dose Intake in Surface and Ground Water of Ten Oil Fields Environment in Western Niger Delta of Nigeria”. 10 water samples were collected from oil field environment and analysed for gross alpha and beta activity using 8 channel gas flow proportional counter. The Alpha activity measured ranges from 0.01±0.002 to 0.7±0.01 (0.15±0.003) Bq/l, 0.01±0.003 to 0.5±0.01 (0.1±0.003) Bq/l and 0.02±0.001 to 35.1±1.1 (4.1±0.1) Bq/l while beta activity concentration ranged from 1.1±0.04 to 13.2±0.1 (6.0±0.1) Bq/l, 0.7±0.1 to 54.7±1.3 (8.9±0.2) Bq/l and 0.7±0.03 to 151.2±1.8 (40.1±0.9) Bq/l for well, tap and river waters respectively. They went further to study annual effective dose per year due to alpha activity for adults and infants; the results obtained were 76.4±1.8 and 20.9±55 μSv/yr, 54.6±1.3 and 14.9±0.4 μSv/yr, and 2118±70 and 584±19.2 μSv/yr in well, tap, and river water samples respectively. The results obtained for the alpha and beta activity were slightly above the maximum recommended level set by WHO and that of dose intake were below the ICRP guidelines for

safe drinking water except for one sample location which was above the ICRP standard. They concluded that the water samples were radiologically contaminated especially samples collected from river water and they finally suggested that an alternative water supply should be provided for the people living around the locations [6]. Studies have been done on "Gross Alpha and Beta Activity Concentrations in Portable Drinking Water in Ado-Ekiti Metropolis and the Committed Effective Dose". They evaluated the gross alpha and beta activity and annual effective dose. The results for gross alpha and beta activity ranges from 20 to 357.8 mBq/l. Annual effective dose for children and adults were 0.15 and 0.03 mSv/yr respectively and the values were below the permissible limit set by WHO of 0.1 mSv/yr [7]. Despite many works within the country but yet there is little data on radioactivity recorded in the north western part of Nigeria. This is due partly to the fact that measurements of radioactivity are done without estimation of effective dose and excess lifetime cancer risk or ascertaining the radionuclides contributing to that radioactivity recorded. It is therefore necessary to examine radioactivity level of drinking water in Jigawa state because the water used for drinking and other domestic activities in study area has not undergone any treatment and to further study the annual effective dose for all age categories.
The aim of the study is to assess the radiological safety of sachet water collected from Hadejia town of Jigawa State, Nigeria.

## II. Materials and Methods

### 2.1. The study area

Hadejia is located in Jigawa state (Latitude 12.64° – 12.65°N and Longitude 10.63° – 10.64°E) bounded by Kano in the south east and Yobe state in the north eastern part of Nigeria. The geology of Jigawa state principally comprises of crystalline and sedimentary rocks, underlain by basement complex rocks. The crystalline rocks are represented by older granites found in pockets part of the study area. The older granite is Precambrian in origin consisting of metamorphic structures of gneiss and amphibolites. The sedimentary rocks that are found in most parts of the area were uncomfortably deposited on the basement crystalline rock [8 - 10]

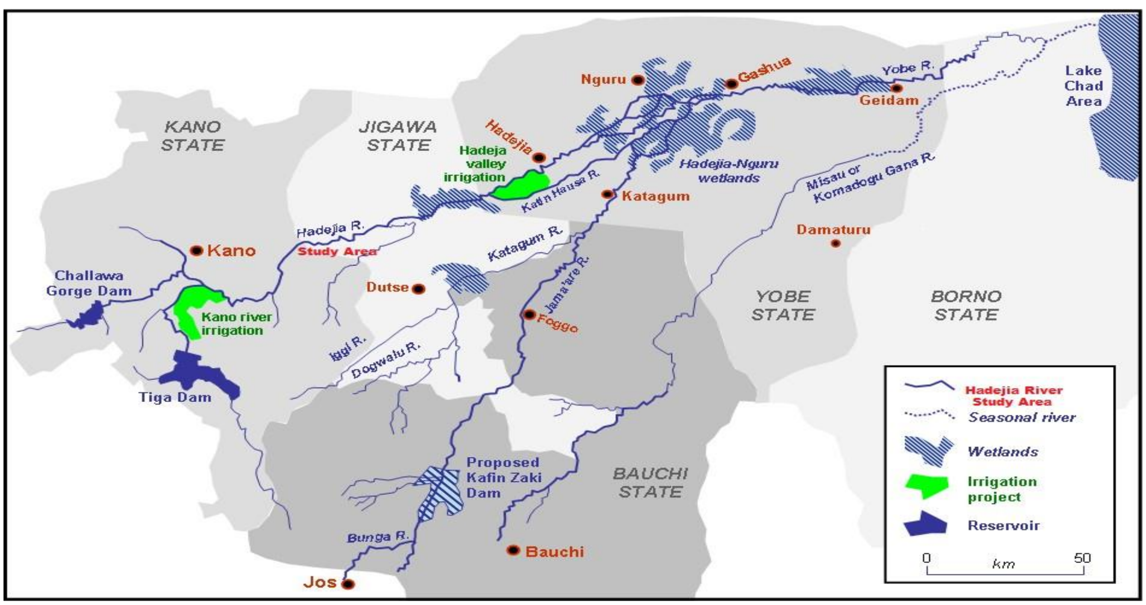

Figure 1: Map of the study area.

## 2.2 Sample Collections and Preparations

A total of ten sachet water samples were collected using 1 litre polythene bottles and labelled appropriately. Samples were collected randomly in 2 litres polythene bottles with tight covers which were carefully washed in the laboratory and rinsed three times with the sample water to be sure that the samples collected are representative of the bulk. The samples were acidified with Hcl, at a rate of 10 ml per litre to prevent the water from biological growth and chemical action with the surface of the container and transferred to laboratory. The samples were then sealed and stored in the laboratory for 28 days before being analysed. This was done in order to allow radon and its short-lived progenies to reach secular equilibrium prior to gamma spectroscopy [6]. The gamma spectrometric measurement was carried out using a well calibrated Sodium Iodide NaI (Tl) detector enclosed in 5 cm thick lead shield to reduce background radiation. The spectra were analysed and activity concentration of the detected radionuclide was computed directly and compared with the recommended standards.

### 2.3. Evaluation of Radiological Hazard Parameters

In order to effectively evaluate the radiological impacts on the samples, there are eight parameters that were estimated using the gamma ray spectrometry results for $^{40}K$, $^{238}U$ and $^{232}Th$ concentrations. These parameters are absorbed dose rate, annual effective dose, radium equivalent index, annual gonadal equivalent dose, external and internal hazard indices, gamma index and excess lifetime cancer risk.

### 2.3.1. Absorbed Dose Rate.

The absorbed dose is a measure of the energy deposited in a medium by ionizing radiation per unit mass. It may be measured as joules per kilogram and represented by the equivalent S.I. unit, gray (Gy) or rad. The health risk due to radiological and clinical effects of radiation is directly related to the absorbed dose rate hence, estimation of this parameter is the first step to evaluating health risk [11] and [12]. The unit of absorbed dose rate is nano Gray per hour (nGy/h). The absorbed dose rate D (nGy/h), due to activity concentration of $^{238}U$, $^{232}Th$ and $^{40}K$ was calculated using;

$$D = C_U A_U + C_{Th} A_{Th} + C_K A_K \qquad (1)$$

where $A_U$, $A_{Th}$, $A_K$ are the radioactivity concentration in Bq/L and $C_U$, $C_{Th}$, and $C_k$ are dose conversion factors which are 0.462, 0.604 and 0.0417 for $^{238}U$, $^{232}Th$ and $^{40}K$ respectively. Average value is given as 57nGy/h [3] and [13].

### 2.3.2. Annual Effective Dose (AED).

Effective Dose is a dose quantity defined by the International Commission on Radiation Protection to monitor and control human exposure to ionizing radiation. It is the tissue-weighted sum of the equivalent doses in all specified tissues and organs of the body and represents the stochastic health risks to the whole body. It takes into account the type of radiation and the nature of each organ or tissue being irradiated, and enables summation of organ doses due to varying levels and types of radiation, both internal and external, to produce an overall calculated effective dose. This combines both internal and external exposures. The Annual Effective Dose (AED) is the sum of the effective dose over a year.

**Annual Effective Dose for Ingested Radionuclide ($AED_{Internal\ Exposure}$):** The annual effective dose rate for all the ingested radionuclides from water was calculated using equation (3) below.

$$AED_{Internal\ Exposure} = i\ Ii \times 365 \times Di \qquad (3)$$

where $I_i$ is the daily intakes of radionuclide. Intake (Bq/d) = (concentration of radionuclide in food or water in Ci/lb or Bq/kg) × (consumption rate of water or food in lb/day or kg/day) and the ingestion dose coefficient (dose conversion factor) Di for adults for $^{40}K$, $^{232}Th$ and $^{238}U$ is $6.2 \times 10^{-9}$, $2.3 \times 10^{-7}$ and $4.5 \times 10^{-8}$ Sv/Bq, respectively [14] and [3]. The annual effective dose resulting from the ingestion of water was estimated based on the assumption that a daily intake of water per person is 2 l/d for adults and 1 l/d for lower ages and 0.5 l/d for infants [5]. The Dose Conversion Factors for ingestion of radionuclides for members of the public for all ages provided by [14] is giving in Table 1.

(a) **Annual Effective Dose for External Exposures ($AED_{external\ Exposure}$):**

The annual effective dose received outdoor and indoor by a member of the public is calculated from the absorbed dose rate by applying dose conversion factor of 0.7Sv/Gy and occupancy factor for outdoor and indoor was 0.2 and 0.8 respectively [5]. AED is determined using the following equations [1], [5] and [15].

$$AED_{outdoor}\ (\mu Sv/y) = D(nGy/h) \times 8760h \times 0.7\ (Sv/Gy) \times 0.2 \times 10^{-3}$$

$$ED_{indoor}\ (\mu Sv/y) = D(nGy/h) \times 8760h \times 0.7\ (Sv/Gy) \times 0.8 \times 10^{-3}$$

The $AED_{indoor}$ occurs within a house whereby the radiation risks due to use of the soil as building material is taken into consideration. $AED_{outdoor}$ involves a consideration of the absorbed dose emitted from radionuclide in the environment such as $^{238}U$, $^{232}Th$ and $^{40}K$.

### 2.4.3. Radium Equivalent Activity Index ($Ra_{eq}$).

The radium equivalent ($Ra_{eq}$) activity represents a weighted sum of activities of $^{238}U$, $^{232}Th$ and $^{40}K$. It is based on the estimation that 1 Bq/kg of $^{238}U$, 0.7 Bq/kg of $^{232}Th$ and 13 Bq/kg of $^{40}K$ produce the same radiation dose rates. This allows a single index or number to describe the gamma output from different mixtures of $^{238}U$, $^{232}Th$ and $^{40}K$ in a material. It was calculated using the formula [15] and [11].

$$Ra_{eq} = C_U + 1.43C_{Th} + 0.077C_K \qquad (6)$$

Where $C_U$, $C_{Th}$, $C_K$ are the radioactivity concentration in Bq/Kg of $^{238}U$, $^{232}Th$ and $^{40}K$.

### 2.4.4. Radiation Hazard Indices.

The external radiation hazard ($H_{ext}$) and the internal radiation hazard ($H_{int}$) was calculated as follows:

$$H_{ext} = \left(\frac{C_U}{370}\right) + \left(\frac{C_{Th}}{259}\right) + \left(\frac{C_K}{4810}\right) \qquad (7)$$

$$H_{int} = \left(\frac{C_U}{185}\right) + \left(\frac{C_{Th}}{259}\right) + \left(\frac{C_K}{4810}\right) \qquad (8)$$

$H_{int}$ should be less than unity for the radiation hazard to be negligible. Internal exposure to radon is very hazardous which can lead to respiratory diseases like asthma [5]. Natural radionuclide in soil, sediment and rocks produce an external radiation field to which all humans are exposed. $H_{ext}$ must be less than unity for this external radiation hazard to be negligible. $H_{ext}$ equal to unity corresponds to the upper limit of radium equivalent dose (370 Bq/kg) [5], [7], [15], [16], [2] and [13].

### 2.4.5. Excess Lifetime Cancer Risk (ELCR).

The Excess Lifetime cancer risk (ELCR) was calculated using the following equation [5]:

$$ELCR = AED \times DL \times RF \qquad (9)$$

Where, AED is the Annual Equivalent Dose Equivalent, DL is the average duration of life (estimated to 70 years), and RF is the Risk Factor ($Sv^{-1}$), i.e. fatal cancer risk per Sievert. For stochastic effects, ICRP uses RF as 0.05 for public [5]. Average value of ELCR is given as $0.2 \times 10^{-3}$ [3] and [13].

### 2.4.6. Annual Gonadal Equivalent Dose (AGED).

The gonads, the bone marrow and the bone surface cells are considered as organs of interest by [3] because of their sensitivity to radiation. An increase in AGED has been known to affect the bone marrow, causing destruction of the red blood cells that are then replaced by white blood cells. This situation results in a blood cancer called leukemia which is fatal. The AGED for the resident using such material for building was evaluated by the following equation;

$$AGED\ (\mu Sv/y)\ C = 3.09C_U + 4.18C_{Th} + 0.314C_K \qquad (10)$$

Where, $C_U$, $C_{Th}$, and $C_K$ are the radioactivity concentration of $^{238}U$, $^{232}Th$ and $^{40}K$ in soil and water samples.

2.4.7. **Representative Gamma Index ($I_\gamma$).**

This is used to estimate the gamma radiation hazard associated with the natural radionuclide in specific investigated samples. The representative gamma index was estimated as follow [5]:

$$I_\gamma = C_U/150 + C_{Th}/100 + C_K/1500) \leq 1 \quad (11)$$

Where, $C_U$, $C_{Th}$, and $C_K$ are the radioactivity concentration of $^{238}U$, $^{232}Th$ and $^{40}K$ in soil and water samples. The $I_\gamma$ is correlated with the annual dose rate due to the excess external gamma radiation caused by superficial material. An increase in the representative gamma index greater than the universal standard of unity may result in radiation risk leading to the deformation of human cells thereby causing cancer. Values of $I_\gamma = 1$ corresponds to an annual effective dose of less than or equal to 1 mSv, while $I_\gamma = 0.5$ corresponds to annual effective dose less or equal to 0.3 mSv [5] and [15]. Thus, $I_\gamma$ should be used only as a screening tool for identifying materials that might be of concern to be used as construction materials, though materials with $I_\gamma > 1$ should be avoided [11], since these values correspond to dose rates higher than 1 mSv/y, which is the highest value of the dose rates recommended for humans [3].

## III. Results and Discussions

The result of the gamma ray spectrometry of the water samples is presented in Table 2. The radionuclide observed with reliable regularity belonged to the decay series chain headed by Uranium, $^{238}U$ and Thorium, $^{232}Th$ as well as the non-series Potassium, $^{40}K$. The $^{40}K$ activity concentration dominated over the $^{238}U$ and $^{232}Th$ elemental activities as expected. The activity concentration of $^{40}K$ ranges between 25.42±9.65 and 93.95±32.57 $Bql^{-1}$ with a mean of 70.13667 $Bql^{-1}$ in the water samples. The activity concentration for Uranium, $^{238}U$ in the water samples ranged between 41.78±12.47 and 66.94±18.72 $Bql^{-1}$ with a mean of 55.41444 $Bql^{-1}$. For Thorium, $^{232}Th$ the activity concentration ranged between 6.64 ± 2.94 and 56.87 ± 61.94 $Bql^{-1}$ with a mean of 35.68778 $Bql^{-1}$. The activity concentration of $^{40}K$,$^{238}U$ and $^{232}Th$ in all the samples exceed the world safe limit of 10.0, 10.0 and 1.0 $Bql^{-1}$ respectively for water samples by [3] standards and hence poses a serious health effect.

**Table 1:** Activity concentration of $^{40}K$, $^{238}U$ and $^{232}Th$ in the water samples.

| Sample | K-40 ($Bql^{-1}$) | Th-232 ($Bql^{-1}$) | U-238 ($Bql^{-1}$) |
|---|---|---|---|
| PW1 | 70.14 | 35.69 | 55.41 |
| PW2 | 25.42 | 12.18 | 63.66 |
| PW3 | 77.86 | 51.01 | 44.92 |
| PW4 | 37.21 | 31.63 | 43.97 |
| PW5 | 91.86 | 33.91 | 64.82 |
| PW6 | 85.60 | 50.25 | 41.78 |
| PW7 | 47.28 | 34.54 | 66.94 |
| PW8 | 84.49 | 44.16 | 46.36 |
| PW9 | 93.95 | 36.64 | 65.61 |
| PW10 | 87.56 | 56.87 | 60.67 |
| Mean | 70.14 | 38.69 | 55.41 |

The mean Absorbed Dose Rate for the water samples is 50.105nGyh$^{-1}$. The mean Absorbed Dose Rate for the water is slightly below the general average value of 57nGyh$^{-1}$ [3]. The mean AEDE for the ingested radionuclide in drinking water from the area for infants, 1year, 5years, 10years, 15years and adults is 0.012458, 0.009332, 0.006734, 0.005481, 0.0048 and 0.00807mSvy$^{-1}$ respectively. These average values of AEDE for the different age groups are within the acceptable safe limits of 0.1 mSv/year, for the general public. Although it should be noted that daily intake of water per person of 2 ld$^{-1}$ for adults, 1 ld$^{-1}$ for lower ages and 0.5 ld$^{-1}$ for infants was used as the intake of water varies among these age groups. It is clear that the infants as expected are more susceptible to radiation hazards in the area followed by 1year then adults, 5years, 10years and then 15years respectively. They are all within the safe limits of 0.1 mSvy$^{-1}$.

The mean $Ra_{eq}$ for the water samples is 109.290Bql$^{-1}$. The estimated average value is lower than the recommended maximum value of 370 Bql$^{-1}$ for the safe use of materials in the construction of buildings. This means that the water from this area can safely be used for building and other purposes without much fear of radiological hazards.

**Table 2:** AEDE for different age categories for the people in the study area.

| Sample | AEDE (mSvy$^{-1}$) | | | | | |
|---|---|---|---|---|---|---|
| | **ADULTS** | **INFANTS** | **1YEAR** | **5YEARS** | **10YEARS** | **15YEARS** |
| PW1 | 0.00807 | 0.012458 | 0.009332 | 0.006734 | 0.005481 | 0.00100 |
| PW2 | 0.00425 | 0.00542 | 0.00517 | 0.00361 | 0.00298 | 0.00273 |
| PW3 | 0.01000 | 0.01670 | 0.01150 | 0.00845 | 0.00688 | 0.00596 |
| PW4 | 0.00692 | 0.01070 | 0.00769 | 0.00562 | 0.00461 | 0.00406 |
| PW5 | 0.00824 | 0.01240 | 0.00981 | 0.00696 | 0.00563 | 0.00493 |
| PW6 | 0.01010 | 0.01650 | 0.01130 | 0.00832 | 0.00676 | 0.00584 |
| PW7 | 0.00821 | 0.01220 | 0.00932 | 0.00674 | 0.00554 | 0.00491 |
| PW8 | 0.00932 | 0.01480 | 0.01050 | 0.00767 | 0.00662 | 0.00539 |
| PW9 | 0.00369 | 0.00450 | 0.00540 | 0.00351 | 0.00277 | 0.00247 |
| PW10 | 0.01190 | 0.01890 | 0.01330 | 0.00973 | 0.00794 | 0.00691 |
| Mean | 0.08070 | 0.01245 | 0.00933 | 0.00673 | 0.00552 | 0.00480 |

**Table 3: Radiation hazard parameters for the water samples**

| Sample | D (nGyh$^{-1}$) | AED (ADULTS (µSvy$^{-1}$) | $RA_{eq}$ (Bql$^{-1}$) | $H_{EX}$ | $H_{IN}$ | ELCR | AGED (µvy$^{-1}$) | I γ |
|---|---|---|---|---|---|---|---|---|
| PW1 | 50.105 | 0.00807 | 109.290 | 0.302 | 0.452 | 0.1012 | 342.429 | 0.773 |
| PW2 | 37.835 | 0.00425 | 83.034 | 0.224 | 0.396 | 0.0665 | 255.604 | 0.563 |
| PW3 | 54.833 | 0.01000 | 123.859 | 0.334 | 0.456 | 0.1225 | 376.473 | 0.861 |
| PW4 | 40.982 | 0.00692 | 92.066 | 0.249 | 0.368 | 0.0875 | 279.764 | 0.634 |
| PW5 | 54.287 | 0.00824 | 120.384 | 0.325 | 0.500 | 0.1050 | 370.882 | 0.832 |
| PW6 | 53.248 | 0.01010 | 120.229 | 0.325 | 0.438 | 0.1155 | 366.023 | 0.838 |
| PW7 | 53.774 | 0.00821 | 119.973 | 0.323 | 0.505 | 0.1050 | 366.072 | 0.823 |
| PW8 | 51.661 | 0.00932 | 116.015 | 0.314 | 0.440 | 0.1085 | 354.371 | 0.807 |
| PW9 | 38.269 | 0.00369 | 82.339 | 0.223 | 0.401 | 0.0560 | 259.990 | 0.566 |
| PW10 | 66.057 | 0.01190 | 125.712 | 0.402 | 0.566 | 0.1440 | 452.681 | 1.031 |
| Mean | 50.105 | 0.00807 | 109.290 | 0.302 | 0.452 | 0.1012 | 342.429 | 0.773 |

The estimated hazard indices $H_{in}$ and $H_{ex}$ for the water samples are 0.452 and 0.302 respectively. These values of $H_{in}$ and $H_{ex}$ in water are less than unity which follows that hazardous effects of these radionuclides and their short-lived progenies are negligible. The estimated ELCR for the water samples is 0.1012 ($1.012\times10^{-3}$). The estimated value of ELCR is higher than the average value of $0.2\times10^{-3}$. The high value of the ELCR index for the water samples is due to high AEDE caused by high specific activity of $^{40}$K radionuclide in the samples. This high value implies that the probability of developing cancer over a lifetime considering seventy years as the average life span of humans is high. The estimated mean value for the AGED in the water samples is 342.429 μSvy$^{-1}$. The estimated mean Iγ for the water samples is 0.773Svy$^{-1}$. These values are within the safe limits.

## IV. Conclusion

A radiological study of some sachets (pure) water collected from Hadejia town have been carried out by the estimation of the eight radiological parameters using data obtained from the gamma ray spectrometry of the samples. The results showed trends that are generally low for most radiation hazard indices calculated except for few indices whose values are above the UNSCEAR recommended thresholds. Therefore, there may be no serious immediate radiological effects to the general populace as a result of consuming sachet water in the study area. However, considering the fact that artificial radionuclides are synthetic radionuclide produced by human activities like high use of chemical fertilizers and agrochemicals, it is hereby recommended that all activities that enhance or introduce radio-nuclides to the environment be discouraged or prohibited within the study area and environ to avoid any possibilities of radiological hazards.

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