MPRI-JAVS | INTERNATIONAL JOURNAL OF AGRICULTURAL AND VETERINARY SCIENCE
VOL. 02 NO. 1 OCT-2023 ISSN: 1115 – 831X

NATURAL RADIOACTIVITY CONCENTRATION IN LETTUCE AND AMARANTHUS SAMPLES FROM GASHUA, YOBE STATE

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Abstract

The research carried out to determine the activity concentrations levels of primordial radionuclide in vegetable samples from Gashua area. The objective of the study were to determine the activity concentration of radium, thorium and potassium in amaranthus and lettuce samples. The samples were pulverized using laboratory mortar and pestle. The result reveals that in amaranthus the activity of ^{40}K is distinctly higher than ^{226}Ra and ^{232}Th and it ranges between 1472.96±77.91 Bq/kg and 1663.99±88.01 Bq/kg with a mean value of 6537.08±81.29 Bq/kg. The ^{226}Ra concentration ranges from 13.68±0.71 $Bq/^{-1}$ to 16.97±0.88 Bq/kg with a mean activity of 14.90±0.77 Bq/kg. The ^{232}Th concentration ranges from 5.94±0.33 Bq/kg to 6.03±0.32 with a mean activity of 6.59±0.35 Bq/kg. In lettuce the activity concentration ^{40}K is distinctly higher than ^{226}Ra and ^{232}Th and it ranges between 2079.59±109.99 Bq/kg and 2835.95±150.00 Bq/kg with mean activity of 2338.35±123.68 Bq/kg. The ^{226}Ra concentration ranges from 6.46±0.35 Bq/kg to 9.91±0.54 Bq/kg with a mean activity of 7.72±0.44 Bq/kg. The ^{232}Th concentration ranges from 6.41±0.35 Bq/kg to 9.91±0.54 with a mean activity of 8.25±0.43 Bq/kg. The result further reveals that all the samples tested, potassium shows higher concentration in all tested

Keywords: Natural radioactivity, .Amaranthus, .Lettuce, .Thorium, .Radium, .Potassium

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sample when compared with other elements. The activity concentration value obtained for the amaranthus and lettuce in this study were found to be within the acceptable limits. Most of the values obtained were lower than the global average values. It is therefore recommended that further studies to cover additional vegetables organism to have comprehensive information on radiological activities.

Introduction

Nowadays, environmental contamination becomes spontaneously occurring everywhere, due to human activities and naturally occurring radioactive materials within the earth crush especially in water habitant. Due to these contaminations, man and some other animals became exposed to hazardous chemicals; such as heavy metals, radioactive, few to be mentioned, which cause pollution to the water environment and the aquatic animals via bioaccumulation, e.g. River waters, oceanic and environment. Radioactive elements are said to be the elements that are tend to disintegrate spontaneously with the emissions of some particles; alpha, beta and gamma rays. Alpha particles (α-particle) are positively charge particle which consist of protons and neutrons, while Beta particle (β-particle) are particle which are very small, fast moving particles with 5negative electrical charge that are emitted during radio-active decay, and Gamma particle (γ-particle) are weightless packets of called photons, unlike α and β-particles which have both energy and mass. Gamma rays are also pure energy, act as visible light.

All elements with atomic numbers greater than 83 are naturally radioactive. Naturally occurring radioactive material (NORMs) include; radium, thorium and uranium, sometimes called primordial radionuclide These primordial radionuclides give rises to natural decay series, a sequence of radioactive progenies, including isotopes of thorium, radium, radon, lead and polonium. NORMs are widely distributed throughout the environment, generally in trace amounts in sediments, seafood, air, soil, foodstuff, surface and ground water (Lawluvi, 2011). The concentration of these radionuclides in environmental compartments primarily depends on the geology of the area, with the geochemistry of each element also playing a role in its migration from the soil (Kishe, 2003).

Naturally occurring radioactivity are due to bedrock formations which are weathered, resulting in mineral leaching that leads to contamination, surface water and other living organisms. Artificial radioactivity occurs due to human activities, mainly the use of fertilizer, pesticides, medical diagnosis, researches as well as other activities like mining and milling of mineral which exposes to the earth surface. These

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contaminations may have harmful health effects that pose great danger to human and other organisms (Nriagu, 2012).

Human beings became exposed to radionuclides through pollution of the food chain which results from the direct deposit of radionuclide on sedate or water, leave of plant and from drinking contaminated water and eating of contaminated aquatic animals, e.g., fish (Avwiri*et al.,* 2007). Naturally, abundant radionuclides such as Cesium (^{132}Cs), Francium (^{223}Fr), Plutonium (^{244}Pl), Potassium (^{40}K), Radium (^{226}Ra), Radon (^{222}Rn) and Thorium (^{232}Th), occur in the environment. The release of these elements from fertilizers, agrochemicals, research and medical facilities such as X - rays form the bulk of radionuclides in the ground and surface water, which cause an ill-health such as carcinogenic effects (Agbalagba, 2011). The work of Carvalho *et. al*., is relevant to current study and has lead the current authors to hypothesize that NORMs concentration would be elevated in the sediments of river Yobe (Abba *et. al*., 2017). Therefore, the presence of radioactivity in contaminated environment can be attributed to the naturally occurring and artificially sources, which lead to health hazards.

The objective of the study is to determine the activity concentrations of radium, thorium and potassium in amaranthus and lettuce samples from Gashua area.

MATERIALS AND METHODS

Sample collection and preparation

This work focuses on the some selected vegetables consumed by overall public in gashua area, Yobe state. Samples from two selected vegetables were collected in the study area .

The samples were cleaned with normal water and weighed as fresh(wet) for human consumption, each sample is placed in a plastic bag and labeled by name. Then they were kept moisture free before radioactivity measurement in an oven for (2-4) days at a temperature of 42-44°C in order to reach a constant weight and avoid any humidity adsorption. Then the samples were crushed electronically, using electric mill for homogeneity, the sample were sieved (0.8 mm pore size). Samples were packed in marinelli beakers that it is constant volume, to attain a good homogeneity around the NaI(TI) detector. The weighing of samples were measured using digital weighing balance (using a high sensitive digital weighing balance with a percent of 0.06%). At the end, the marinelli beakers were stored for about 1 month before measuring, to permit secular equilibrium to be investigated ^{226}Ra and ^{222}Rn.

Activity concentration

The activity concentrations in the samples were obtained using the equation below (Obed *et al*., 2005, Jibiri *et al*.,, 2007):

$C\ (Bq\ kg^{-1}) = K\ C_n$

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where K = $\underline{1}$

$EPrM_s$, C is the activity concentration of the radionuclides in the sample given in Bq/kg^{-} Cn is the count rate under the corresponding peak, E is the detector efficiency at the specific r-ray energy, P2 is the absolute transition probability of the specific r-ray, and Ms is the mass of the sample (kg). The below detection limit describes its operating capability without the influence of the samples. The BDL given in Bq kg^{-1} which is required to estimate the minimum detectable activity in sample was obtained using the below equation (Jibiri *et al*., 2007):

DL (Bq kg^{-1}) = $4.65\frac{\sqrt{Cb-K}}{tb}$

Where Cb is the net background count in the corresponding peak, t_b is the background counting time (s) and K is the factor that converts counts per second (cps) to activity concentration (Bq/kg) as given in equation above. All the obtained raw data were converted to correctional units using conversion factors of $8.632X10^{-4}$, $8.768X10^{-4}$ and $6.431X10^{-4}$ for ^{40}K, ^{288}Ra and ^{232} Th, respectively to determine their activity concentrations. With the counting time of 29,000 seconds for each sample, the environmental r-ray background of the laboratory site was determined using an empty container under identical measured conditions. This then gave the below detectable limit (BDC) to be 14.Bq/Kg for ^{40}K, 3.84 Bq/Kgfor ^{226} Ra and 9.08 Bq/Kg ^{232}th respectively. This was subtracted for the measured γ -ray spectrum of each sample.

Calibration Factors (CF)

Calibration factors for each of the radionuclide implored for the analysis was obtained as follows:

CF ^{40}K = $\underline{CP^S(40K)}$ or $\underline{CP(40K)}$

$Ppm\ (40k)$ $Bq\ (40k)/kg$

CF ^{226}Ra = $\underline{CP^S(^{226}Ra)}$ or $\underline{CP^S(^{226}Ra)}$

$Ppm(^{226}Ra)$ $Bq(^{226}Ra)/kg$

CF ^{232}th = $\underline{CP^S(^{232}Th)}$ or $\underline{CP^S(^{232}Th)}$

$Ppm(^{232}Th)$ $Bq(^{232}Th)/kg$

(Ibeanu, 1999).

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Based on the above, the obtained calibration factors for this work were entered into table below and subsequently the activities at calibration were used to arrive at current activities of the radioisotopes. The calibration factors (CF), were obtained from the experimental works of Ibeanu (1999) on the same instrumental and some set of radionuclides. The resulting table from the stated work on the calibration factors is as below;

RESULTS

Table 1: Mean activity concentration of Radionuclides in Amaranthus samples.

Sample code	Sample number	K-40 (Bq/Kg)	Ra-226 (Bq/Kg)	Th-232 (Bq/Kg)	Coordinates Lat.	Log,
ALH-1	1	1663.99±88.01	16.97±0.88	5.94±0.33	12° 51'43'N	11° 03'00'E
ALH-2	2	1472.96±77.91	14.06±0.73	7.80±0.41	12° 51'45'N	11° 03'05'E
ALH-3	3	1474.05±77.96	13.68±0.71	6.03±0.32	12° 51'42'N	11° 03'04'E
Mean	-	6537.0±81.29	14.90±0.77	6.59±0.35		
Range	-	1472.96-1663.99	13.68-16.97	5.94-6.03		

KEY: ALH-Amaranthus

The activity of ^{40}K is distinctly higher than ^{226}Ra and ^{232}Th and it ranges between 1472.96±77.91 Bq/Kg and 1663.99±88.01 Bq/Kg with a mean value of 6537.08±81.29 Bq/Kg. The ^{226}Ra concentration ranges from 13.68±0.71 Bq/Kg to 16.97±0.88 Bq/Kg with a mean activity of 14.90±0.77 Bq/Kg. T he ^{232}Th concentration ranges from 5.94±0.33 Bq/Kg to 6.03±0.32 with a mean activity of 6.59±0.35 Bq/Kg.

Table 2: Mean activity concentration of radionuclides in Lettuce samples

Sample code	Sample number	K-40(Bq/Kg)	Ra-226 (Bq/Kg)	Th-232 (Bq/Kg)	Coordinate Lat.	Log,
L-1	1	2099.51±111.04	6.80±0.42	8.43±0.43	12° 50'46'N	11° 03'06'E
L-2	2	2835.95±150.00	9.91±0.54	6.41±0.35	12° 50'45'N	11° 03'06'E
L-3	3	2079.59±109.99	6.46±0.35	9.91±0.52	12° 50'46'N	11° 03'03'E
Mean	-	2338.35±123.68	7.72±0.44	8.25±0.43		
Range	-	2079.59-835.95	6.46-9.91	6.41-9.91		

KEY: L-Lettuce

The activity concentration ^{40}K is distinctly higher than ^{226}Ra and ^{232}Th and it ranges between 2079.59±109.99 Bq/Kg and 2835.95±150.00 Bq/Kg with mean activity concentration of 2338.35±123.68 Bq/Kg. The ^{226}Ra concentration ranges from 6.46±0.35 Bq/Kg to 9.91±0.54 Bq/Kg with a mean activity concentration of 7.72±0.44

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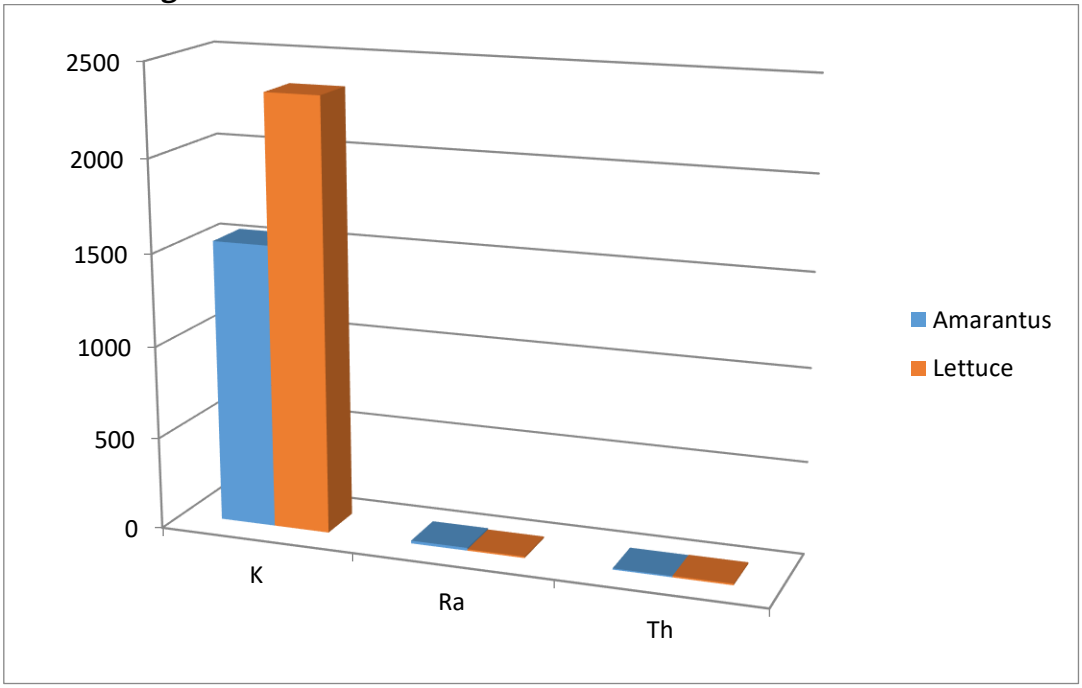
Bq/Kg. The ^{232}Th concentration ranges from 6.41±0.35 Bq/Kg to 9.91±0.54 with a mean activity concentration of 8.25±0.43 Bq/Kg.

Fig. 1: Average Distribution of Naturally Occurring Radionuclide In Samples Collected Along River Gashua



Presents the bar chart of mean activity concentration of ^{226}Ra, ^{232}Th and ^{40}K as obtained during spectrometry for the two samples collected.

It was observed that ^{40}K is having relatively higher concentration ranging from a mean value of 111.38± 0.1 Bq/Kg to 2338.12± 12.54 Bq/Kg in all the samples with the highest mean concentration in lettuce 2338.12± 12.54 Bq/Kg followed by radium -236 ranging from 1.02± 0.08 to 14.46± 0.77 Bq/Kg with the highest mean concentration of 14.9± 0.77 Bq/Kg also in the amaranthus. Thorium 232 is the one having the least concentration ranging from 0.17± 0.02 Bq/Kg to 8.25± 0.34 Bq/Kg with highest mean value of 8.25± 0.43 Bq/Kg. For the entire samples, activity concentration of ^{40}K in lettuce was high when compared to ^{226}Ra and ^{232}Th other sample tested. The elevated concentration potassium -40 and radium-226 in the lettuce and amaranthus could be attributed to the use agrochemical substance such as NPK fertilizer for agricultural practice to maximize yield and combat pest and diseases during crop production season.

The results reveal that, in all the samples tested, potassium shows higher concentration levels when compared with other elements. This shows that the high concentration of this element may pose high health risk to consumers of the produce . This in agreement with the finding of Margret et al., 2019 which shows that at high concentration rate there is a potential radiological effects on the health of the public

from the consumption of vegetable cultivated through irrigation water. The use of uncontaminated water for irrigation and locating uncontaminated agricultural land are ways to reduce this incidents.

Further studies reveals that naturally occurred potassium in leafy vegetables has health benefits on children and elderly person, however the artificially induced potassium that exceeded the normal daily intakes also had detrimental effects in human body. (Morran, 2012 Based on this study , it is reveals that all the tested samples had reduced level of macro elements and the element had no detrimental effect on human body when consumed.

Table 3: Comparison of the specific activities from present study with the data in literature for different countries

Sample	^{40}K	^{226}Ra	^{232}Th	Reference
L-1 Lettuce	2099.5±1110.04	6.80 ±0.42	8.43 ± 0.43	This Work
L-2Lettuce	2388.595±150.00	9.91 ±0.54	6.41 ± 0.35	This Work
L-3 Lettuce	2079.59±109.99	6.46 ± 0.35	9.91±0.52	This Work
Lagos Spinach	68.62±5.22	1.59 ± 0.49	0.31±0.85	Ibiora et al. (2018)
African	90.62±5.87	1.622 ±	0.382±0.09	Adedokun et al.
Spinach	103.26±6.08	0.44	6.58±0.76	(2019)
Bitter Leaf	118.96±22.43	8.63± 3.45	7.87±1.89	Chijoke et al. (2021)
Water Leaf	59.79± 2.10	8.63± 3.45	-	Ibiora et al. (2018)
Egypt Lettuce	400	0.18±0.26	30	Harb (2015)
UNSCEAR (2000)		35		

UNSCEAR, 2000 presumable values.

DISCUSSION

The table above summarizes the activity concentration (in Bq/Kg) for the radionuclide content of the leafy vegetable considered in this work. The radionuclide content ranged from 2079.59 to 2835.95 Bq/kg for 40k, 6.46 to 9.91 Bq/Kg for ^{226}Ra, 6.41 to 9.91 Bq/Kg for ^{232}Th, from the table ^{236}R and ^{232}Th. From all the vegetable were less than the UNSCEAR permissible level for leafy vegetable, while with the exclusion of Lagos spinach, African Spinach, Bitter leaf, water leaf and Egypt lettuce, the radionuclide content for ^{40}K from the vegetables were all higher than the UNSCEAR permissible levels. In all cases, lettuce, L-3 had the least. The value obtained in this work were also observed to be higher than what was obtained in the other parts of the country by Ibitola et al, (2019), Chijioke et al, (2021) and Harb (2015). Thus suggesting that the amount of radionuclides in the plant system is not only influence by the geological formation and composition of the soil on which a given plant grows, but also fertilizer and other pesticide used to improve soil fertility is also seen to have enhanced the quantity of these radionuclides in the soil.

Whole in present study, the results indicates that activity concentration ^{226}Ra in lettuce sample was 6.8± 0.42 Bq/Kg which is contrast to the finding of Adijiracker et al., (2017) who obtained 13.4±1.1 Bq/Kg on lettuce, which indicate that is slightly higher

than what was obtained. In same studies that activity concentration of ^{40}K 1598.2±1.3 Bq/Kg was obtained while in present study 2099.51±111.04 Bq/Kg which was higher than one reported by (Adijiracker et al., 2017). In a study conducted by Al-Absi et al., 2015 the activity concentration of ^{226}Ra and ^{40}K of the vegetable samples ranged between 7.1±1.1 Bq/Kg and 11.7±3.4 Bq/Kg and 201±10 Bq/Kg and 684±15 Bq/Kg respectively. ^{226}Ra 11.7±3.4 Bq/Kg reported to be higher than the present study. ^{226}Ra 11.7±3.4 Bq/Kg reported to be slightly higher than 9.91±0.54 Bq/Kg in present study. While ^{40}K 684±15 Bq/Kg which was lower 2079.59±109.99 Bq/Kg in present study.

CONCLUSION

In conclusion, the study used gamma spectrometer techniques analyzed the representative samples collected at national Institute of Radiation Protection and Research. The instrument was subjected to analyses for radiation counting. The result revealed that, in all the samples tested, potassium shows higher concentration levels when compared with other elements. This shows that the high concentration of this element may pose high health risk to consumed of the products.

Based on this study, it is concluded that all the tested samples had reduced level of macro elements and the elements had no detrimental effect on human body when consumed. However, care has to be taken since it is believed that radiation at any given level pose a risk.

REFERENCES

Abba, H. T. and Yusuf, M. A. (2020) Radiation Impact Assessment of Quarrying Activities. A Case Study of Buni Gari Town, Yobe State, Nigeria Department of Physics, Yobe State University, Damaturu, Nigeria. Dutse Journal of Pure and Applied Sciences (DUJOPAS), *Vol. 6 No. 2 June 2020 ISSN (Print): 2476-8316*

Agbalagba, E. O., & Onoja, R. A. (2011). Evaluation of natural radioactivity in soil, sediment and water samples of Niger Delta (Biseni) flood plain lakes, Nigeria. *Journal of Environmental Radioactivity*, *102*(7), 667–71. doi:10.1016/j.jenvrad.2011.03.002

Avwiri, G. O., Tchakossa, P., Mokbia, C. E., (2007). Natural radionulcides in bore-hole water in port Harcourt, rivers state, Nigeria. Radiation protection Dosimentry 123 (4), 509-514.

Carvalho, F. P., Oliveira, J. M., & Malta, M. (2014). Radioactivity in Soils and Vegetables from Uranium Mining Regions. Procedia Earth and Planetary Science, 8(0), 38-42. doi:http://dx.doi.org/10.1016/j.proeps.2014. 05.009

Harb, S. (2015), Natural radioactivity Conc. And annual effective dose in selected reportedly and fruits. Journal of nuclear and particularly physics 5, 70-73.

Ibeanu, I. G. E (1999): Assessment of radiogical effects of Tin mining activities in Jos and its

Environs. A Thesis (Unpublished) Submitted to the Post- Graduate School of Ahmadu Bello University, Zaria, Nigeria.

Jibiri, N., Farai, I., & Alausa, S. (2007). Activity concentrations of 226Ra, 228Th, and 40K in different food crops from a high background radiation area in Bitsichi, Jos Plateau, Nigeria. Radiation and environmental biophysics, 46(1), 53-59.

Kishe, M. A., &Machiwa, J. F. (2003). Distribution of Heavy Metals In Sediments of Mwanza Gulf of Lake Victoria, Tanzania. *Environment International*, *28*(7), 619–625.

Lawluvi, H., Darko, E. O., Schandorf, C., Fannu, A., Awudu, a. R., &Kpeglo, D. O. (2011). Natural radioactivity concentrations in beach sands from some tourists' resorts. *Research Journal of Environmental and Earth Sciences*, *3*(6), 729–736.

Marganet, B.A, Moses, A.A., Pane, P., Maleka, R.I obed, K.,I., Ogungbemi&Zacchaeus, A.I (2019) Journal of Radiation research and applied sciences

Nriagu, J., Nam, D.-H., Ayanwola, T. a, Dinh, H., Erdenechimeg, E., Ochir, C., &Bolormaa, T.-A. (2012). High levels of uranium in groundwater of Ulaanbaatar, Mongolia. *The Science of the Total Environment*, *414*, 722–762. doi:10.1016/j.scitotenv.2011.11.037

Obed R.I, I.P Farai and N.N. Jibiri (2005) Population dose distribution due to soi radioactivity concentration levels in 18 cities across Nigeria.