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DETERMINATION OF RADIONUCLIDE CONCENTRATION LEVELS IN SOME BATHING SOAPS USED IN NIGERIA

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Abstract

In this paper, we investigated the concentration of natural radionuclide levels of local bathing soaps in Ibadan city, Nigeria. The specific activities of 40K, 238U and 232Th, were determined using gamma-ray spectroscopy. Calculations of radiological parameters were also made to estimate associated radiation hazard. The activity concentrations in the local soap samples ranged from 6.8±14.3-931.7±39.0, 3.2±5.1-128.6±10.0 and 2.2±13.1-144.0±16.8 Bq/kg with corresponding mean activities of 207.9±24.5, 28.7±8.5 and 51.2±12.5 for 40K, 238U and 232Th respectively. The radium equivalent activities in the local soap samples ranged from 34.3±13.1 to 246±24.1 Bq/kg with a mean of 118±21.6 Bq/kg. The mean external hazard and internal hazard indices were 0.4. The radiological hazard was found to be less than the safe limits as recommended by ICRP and UNSCEAR. It suffices to say that the locally produced bathing soaps used in Nigeria are safe and may not pose any significant health risks to users.

Keywords: Radionuclides, radiological hazard, bathing soap, health risk

1.0 INTRODUCTION

In physics, radiation is a process in which energetic particles or energy waves travel through a vacuum or through matter- containing media that are not required for their propagation. Radiation can be classified as either ionizing or non- ionizing. Ionizing radiation is known to have sufficiently high energy required to ionize atom. In Non- ionizing radiation, the kinetic energy of particles is too small to produce charged ions when it passes through matter. For non-ionizing electromagnetic radiation, the associated particles (photons) have only sufficient energy to charge the rotational, vibrational or electronic valence configuration of molecules and atoms.

Soaps are naturally radioactive, primarily because of their raw materials content.

Soaps are the oldest cleaning products. They are usually potassium or salts of water – soluble of fatty acids. From chemistry point of view, they are manufactured by saponification of fats and oils or their fatty acids, chemically treated with a strong alkali. It has good ability to emulsify oils and be suspended on water. Though it has a disadvantage of forming insoluble calcium salts that are deposited on fabrics, when used with hard water.

Naturally, all minerals and raw materials are radionuclides .However, some certain human activities may result to an increase in the exposures of Naturally Occurring Radioactive Materials (NORM) and they need to be controlled by regulations. Primordial radionuclides have been deposited in the earth ever since it was created. They are typically long- lived with half-lives of the order of 109 years. They include 235U, 238U, 226Ra, 222Rn and 40K [1]. Radium and uranium may be taken up by different cleaning materials such as soap and powder detergents which are usually used by human beings. Therefore there is need to estimate the radiological hazards content in the soaps that are from the local market.

The radioactivity measurements in the cleaning materials have been studied by very few researchers. Radium -226, Uranium-238 and Radon-222 in certain samples of toothe pastes which are available in the Iraqi local markets using CR-39 plastic nuclear tract detector is illustrated in [2] while the investigation of the radioactivity levels in detergent powders samples by gamma spectroscopy in [3].

Human beings come in contact with soap virtually everyday in the process of bathing, washing and so forth. Therefore, there is a need to determine the potassium, uranium and thorium levels in different types of bathing soaps. The objectives are to determine the activity concentration in the bathing soaps and also the radiological hazard indices of different types of bathing soaps available in Nigeria. Exposure to these radioactive elements can lead to respiratory diseases such as, asthma, cancer and etc.

2.0 BACKGROUND OF STUDY

2.1 Radium Equivalent (Ra_{eq})

This is a weighted sum of the activity concentrations of ^{40}K, ^{238}U, and ^{232}Th, usually calculated to estimate the radiological hazards associated with the three radionuclides. While defining Ra_{eq} activity, it is assumed that 10 Bq/kg of ^{238}U, 7 Bq/kg of ^{232}Th, and 130 Bq/kg

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of ^{40}K produce equal gamma-ray dose. Its empirical relation is defined in [3] as

$$Ra_{eq} = C_U + 1.43C_{Th} + 0.077C_K \qquad (2)$$

Where C_U, C_{Th}, and C_K are the specific activities of ^{40}K, ^{238}U, and ^{232}Th respectively. The maximum value of Ra_{eq} must be less than the acceptable safe limit of 370 Bq/Kg.

2.2 External Hazard Index (H_{ex})

Regarding dose, the principal primordial radionuclides are ^{40}K, ^{238}U, and ^{232}Th that produce significant human exposure. The external hazard index is given in [3] as

$$H_{ex} = \frac{1}{370}C_U + \frac{1}{259}C_{Th} + \frac{1}{4810}C_K \qquad (3)$$

Where C_U, C_{Th}, and C_K are the specific activities of ^{40}K, ^{238}U, and ^{232}Th respectively. The value of this index must be less than unity for negligible radiation hazard.

2.3 Internal Hazard Index (H_{in})

Internal exposure to radon is very hazardous and this can lead to respiratory diseases like asthma and cancer. The internal hazard index is given in [3] as

$$H_{in} = \frac{1}{185}C_U + \frac{1}{259}C_{Th} + \frac{1}{4810}C_K \qquad (4)$$

Where C_U, C_{Th}, and C_K are the specific activities of ^{40}K, ^{238}U, and ^{232}Th respectively. The internal hazard index should be less than unity for a negligible radiation hazard.

3.0 MATERIALS AND METHODOLOGY

3.1 Sample Collection

Twenty different soaps that are commonly used were bought from the Agbeni market, Oyo state, Nigeria. The details of products that were collected for this study are presented in Table 1.

3.2 Sample Preparation

The samples were dried at 70^0C in a temperature-controlled oven to remove all the moisture. The samples were passed through 1.8 mm sieve to ensure homogeneous particles. The samples were then packed in cylindrical plastic containers (about 70mm height by 60mm diameter) made from polyethylene. The containers were then sealed using adhesive to avoid any possibility of radon leakage and left to cure for 30 days. This was done in other to achieve radioactive secular equilibrium between 238U and its gaseous daughters [4]. An empty container with the same geometry was then sealed and left for 30 days for background measurement. The mass of samples analyzed ranged between 50g and 110g.

Table 1 :- Types of local soaps and manufacturers

No	Samples Code	Name of Samples	State of Manufacture
1.	B1	Lux	Agbrara, Lagos
2.	B2	Septol	Kano
3.	B3	Zenta	Oshiodi, Lagos
4.	B4	S.T	Ijebu, Ogun
5.	B5	Fressia	Ogun
6.	B6	Premier	Ilepuje, Lagos
7.	B7	Tetmosol	Ikeja, Lagos
8.	B8	Medi-Soft	Ogun
9.	B9	Dettol	Yaba, Lagos
10.	B10	Supreme	Ogun
11.	B11	Mojees	Ijebu, Ogun
12.	B12	April	Lagos
13.	B13	Joy	Ibadan, Oyo
14.	B14	Al-Jameelah	Ogun
15.	B15	Dora	Ogun
16.	B16	Chic	Ogun
17.	B17	Farha	Ogun
18.	B18	Dudu Osun	Lagos
19.	B19	Zee	Ibadan, Oyo
20.	B20	Carat	Sango Otta, Ogun

3.3 Determination of Activity Concentration

The sample containers were placed symmetrically on top of the detector and measured for a counting period of 36,000 s (10 h). The activity concentration of the radionuclides in a sample is determined by applying the full energy photo-peak corresponding to the energy of the gamma ray(s) of each radionuclide and integrated to obtain the number of counts C in each defined region of interest.

The net count of the photopeak of each of the radionuclide was found by subtracting the count due to background from the gross count of each of the photopeak.

The activity concentration which is the activity per unit mass of the radionuclide in the sample was calculated using a relation given in [3]:

$$A = \frac{C_N}{\varepsilon t Y M} \qquad (1)$$

Where C_N is the net count, ε is the detector efficiency, t is the counting life time in seconds, γ is the gamma yield per disintegration of the nuclide, and M is the mass of the sample measure in kg.

Table 2: Activity concentration in the local soap samples

Sample Code	^{40}K(Bq/kg)	^{238}U(Bq/kg)	^{232}Th(Bq/kg)
B1	55.9±23.2	6.9±8.2	57.2±13.6
B2	84.3±24.3	50.2±9.6	32.9±13.8
B3	112.4±21.1	9.5±7.3	31.6±11.7
B4	71.3±23.5	50.0±9.3	30.9±13.3
B5	161.1±30.3	31.7±10.9	49.5±16.9
B6	226.1±30.0	17.4±10.2	63.0±16.4
B7	165.6±.22.0	46.6±8.3	32.5±11.9
B8	200.1±23.0	28.5±8.1	53.8±12.4
B9	354±28.9	64.6±10.3	107.8±15.2
B10	265.7±27.2	5.1±8.7	64.8±14.5
B11	49.8±27.1	27.3±10.4	75.9±16.5
B12	195.7±29.6	29.4±10.5	70.2±16.5
B13	243.7±25.4	23.4±8.6	2.2±13.1
B14	23.6±13.4	25.8±5.3	57.9±8.1
B15	6.8±14.3	3.3±5.1	21.3±8.4
B16	19.7±17.5	9.0±6.4	57.4±10.6
B17	75.1±18.6	45.8±7.5	47.4±10.7
B18	633.5±29.5	20.0±8.6	25.9±13.3
B19	931.5±38.5	69.4±11.8	70.2±17.1
B20	281.7±22.7	10.5±7.2	71.7±11.9
Mean	207.9±24.5	28.7±8.5	51.2±12.5

4.0: Results and discussion

The specific activities of 40K,238U and 232Th detected in the samples are presented in Table 2 and it can be seen that 40K activity concentrations detected in most samples range from (6.8 ± 14.3) to (931.5 ±39.0) Bq/kg with an average value of 207.9±24.5 Bq/kg. For 238U,themeasured specific activities range from (3.2±5.1) to (128.6 ± 10.0) Bq/kg with an average value of 28.7±8.5 Bq/kg and for 232Th, activity concentrations range from (2.2±13.1) to (144.0±16.8) Bq/kg with an average value of 51.2±12.5 Bq/kg. The highest activity concentration for 40K was observed in B19 (Zee sample) made in Ibadan while the least was found in B15 (Dora sample) made in Ogun state. The highest activity concentration for 238U was observed in B19 (Zee sample) made in Ibadan while the least was observed in B15 (Dora sample) made in Ogun state. The highest activity concentration for 232Th was observed in B9 (Dettol sample) made in Lagos while the least was observed in B15 (Dora sample) made in Ogun state. The calculated Radium equivalent activity values for the soap samples are shown in fig 1 which was calculated using (2). In all samples, the Ra_{eq} values range from (34.3±13.2) to (246±24.1) Bq/kg with an average value of (118±21.6) Bq/kg. It can also be seen that Ra_{eq} values for all studied samples are lower than the recommended maximum value of 370 Bq/kg in [5]. Thus, these samples are within recommended safety limits. The external hazard indices were calculated using (3) and it can be seen they vary from 0.1 to 0.7 Bq/kg with an average value of 0.4. These values are lower than the acceptable value of unity as stated in [6]. The internal hazard index was calculated using (4) and it can be seen that it varies from 0.3 to 0.9 Bq/kg with an average value of 0.4. Therefore, the value of the internal hazard index is less than unity is in line with the benchmark stated in [6].

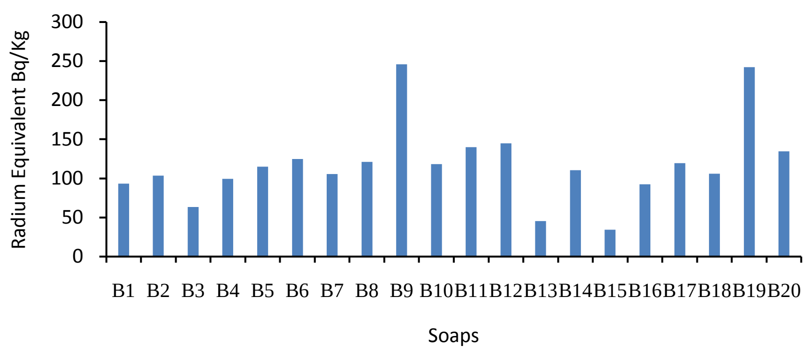

Figure 1: The Distribution of Radium Equivalent Activity in the local Soap Samples

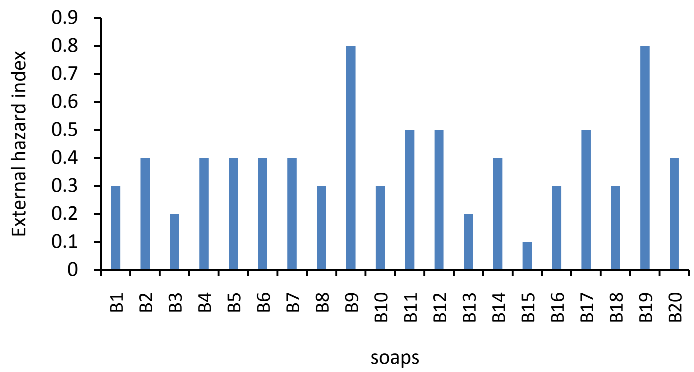

Figure 2: The Distribution of External Hazard index in the Local soap Samples

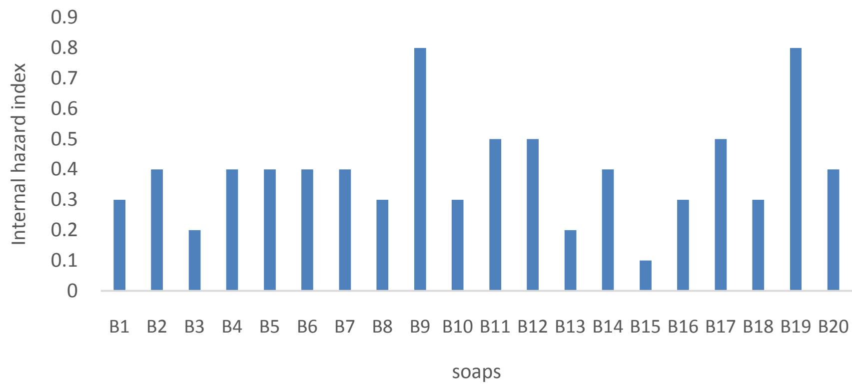

Figure 3: The Distribution of Internal Hazard index in the Local soap Samples

5.0 CONCLUSION

The natural concentrations in some local bathing soaps used in Ibadan, Nigeria have been determined. The mean activity concentration, radium equivalent activities, external and internal hazard indices were found to be less than the safe limits recommended by [5-7]. Therefore, it suffices to say that the locally produced bathing soaps used in Nigeria are safe and may not pose any significant radiological health risk to users

REFERENCES

[1] Salihu Mohammed, Musa L. Bosso, Bala Suleiman, Aminu B. Usman (2016). Assessment of Naturally occurring Radioactive materials in soils from selected school playgrounds in Zungeru.

[2] Hana NA. Determination of uranium in teeth paste by using CR-39 detector. Thesis. MSC .college of science, The university of Mosul, 2002

[3] Abojassim A.A., Abd H.H., Hamed D. N., (2014). Study of radioactivity levels in detergent powders samples by gamma spectroscopy. Journal of Radiation Research and Applied Sciences 7. 532-535.

[4] Nasim A, sabiha L &Tufail M (2012) . Enhancement of natural radioactivity in fertilized soil of Faisalaba, Paskitan.Environmental science and pollution research 19, 3327-3328

[5] OECD, Organization for Economic Cooperation and Development. (1979).Exposure to radiation from the natural radioactivity in building materials. Report by a group of experts of the OECD Nuclear Energy Agency, Paris, France.

[6] ICRP. (2000). ICRP Publication 82. Protection of the public in situations of prolonged radiation exposure (pp. 1e2). Oxford: Pergamon Press. Ann. ICRP, 29.

[7] United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR), (2008). Sources and Effects of Ionizing Radiation. UNSCEAR 2008 Report to the General Assembly, with Scientific Annexes. United Nations, New York.