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# DETERMINATION OF THE GROSS ALPHA AND BETA ACTIVITY CONCENTRATIONS IN SOME SELECTED CHILDREN'S DIET IN SABO, KADUNA STATE

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**ABSTRACT**
Twenty samples of different food brands produced locally and internationally that are commonly consumed by children were collected from the local markets in Sabo local government area of Kaduna state and analyzed using a gas proportional counter to determine the gross alpha and beta activity concentration. The results obtained showed that the average gross alpha and beta activity for the children's diet sample was 180 $Bqkg^{-1}$ and 240 $Bqkg^{-1}$ respectively. These results revealed high alpha activity of eight food samples as they were above the World Health Organization (WHO) standard of 100 $Bqkg^{-1}$ while for beta activity, all food samples analyzed were below the WHO standard limit of 1000 $Bqkg^{-1}$. However, the results so obtained, may not pose any immediate health side effects to children consuming these product as further analysis of the specific activity is recommended.

**Keywords**: Food brands, Gas proportional counter, Activity, Analysis

## INTRODUCTION

In recent times, nuclear materials have found extensive medical, industrial and military applications, which in turn brought about a worldwide concern on radiation exposure of human beings. The nuclear weapon tests and radioactive accidents have also triggered public fear and as a result, a considerable amount of research effort was spent over the lastdecades in evaluating the radioactivity content of soil, air, and water (UNSCEAR, 2008). Because the terrestrial or cosmic radioisotopes are always found in the ecosystem and can easily find pathways to enter the metabolisms of plants and animals, such naturally found substances continuously expose people to radiation through the food chain.

Food is known to contain natural and artificial radioactivity that, after ingestion, contribute to an effective dose. It has been estimated that a large portion of at least one eight of the mean annual dose due to natural sources is caused by the intake of food (Giri *et al.,* 2013).The radiological impact arising from the consumption of food contaminated with radioactivity cannot be overemphasized as exposure to them at any level can lead to some deleterious effects on their body. Children in particular, are at risk of illness from such exposure in food as their bodies are still developing since they generally consume more food per unit body weight than adults (WHO, 2001). So the exposure to these hazardous radiations during growth and development can result in a long-term effect on the health of children (WHO, 2001).

The quality of foodstuffs produced is to a large extent dependenton the nutritional status of the soil on which they are grown (Jibiri, 2001), likewise the distribution of radionuclides in the different segments of a plant is dependent on the chemical characteristics and several other parameters contributing to the soil-plant interaction (Shanthi *et al.,* 2009).There are two mechanisms for the contamination of food crops, that is, by root uptake or directly by aerial deposition of fallout radionuclides on plants.

In Nigeria, high concentrations of natural radionuclides were reported in some foodstuffs from some parts of Jos Plateau which is close to the area of study (Jibiri *et al*., 2007). It is necessary to carry out an accurate assessment of the activity of these foodstuffs in order to ascertain the degree of risk and deleterious effects on public health especially children.

## MATERIALS AND METHODS

### Sample collection

Twenty samples of different children's food (0-6yrs) that were produced both locally and internationally were obtained using the "Market Basket" method to attain a proper sampling. They were purchased from the local retail outlet markets in Sabo local government of Kaduna State. The sample selections were strictly based on their accessibility to the children inSabo.The food samples analyzed are; Cheese Balls, Kuli-kuli, Nan-1, Turn-brown, Frisco Gold, Checkers Custard, Rice, Joli-juce, Hot knobs biscuits, Indomie, Center fresh, Pre-Nan, Peak 456, Sma 3, Peak 123, My boy eldorin, Nan Optipro 2, Sma 1 and Nestle Lactogen 1. The sample's country of origin was as follows; Netherland (Pre Nan), Singapore (Sma 3 and Sma 1), Holland (My boy eldorin), Mexico (Nan Optipro 2 and Nestle Lactogen 2), France (Nestle Lactogen 1) and South Africa (Turn brown).

### Sample Preparation for Gross Alpha Beta Analysis

The food samples were acidified with Concentrated$HNO_3$ solution so as to retain the radioactivity content in the samples, prevent the growth of micro-organisms and then to airtight them. The samples were kept in a desiccator until it was ready for counting. An empty Planchettewas weighed after which about 0.077 g of the residue was turned into the Planchette. The planchette plus the residue was then weighed.

A few drops of Vinyl acetate was applied to the samples to make them stick to the planchette in order to prevent scattering of the sample during counting.

**Laboratory background measurement for Gross Alpha Beta Analysis**

A clean empty planchette was counted when dry in order to determine the background radioactivity of the environment by setting a high operational voltage. This allowed the detector to run for five cycles by using the alpha only (1550V), beta only (1650V) and the alpha and beta simultaneous (1750V) modes. The background rate was determined in counts per unit.

**Gross Alpha and Beta Counting**

The single-channel analyzer (Protean Instrument Cooperation) was used for the gross alpha and beta counting. The sample was placed in a 5cm diameter stainless steel planchette and later placed in a sample carrier which is then placed on the sample drawer and closed. By setting some factors such as the current time, number of the cycles and the operational voltage, the counting will be done according to the selected count mode with the appropriate sample information (channel efficiency and background count rate, volume of the sample used and sample efficiency) was selected coupled with an operating voltage being 1650 V. The System which is calibrated for alpha and beta energies by preparing standard samples which contains equal concentrations of $^{241}$Am and $^{90}$Sr, has detector efficiencies to be 87.95% for alpha and 42.06% for beta. A high voltage of 1650V was used in a selective counting for gross alpha and beta measurement in 5cycles of 2700 sec per cycle. The alpha and beta count rate and activity were calculated using equations 3, 4, 5and 6.

An empty Planchette is weighed after which about 0.077g of the residue is added to the planchette and then, the placket plus the residue was weighed.

A few drops of Vinyl acetate was applied to the sample to make them stick to the planchette in order to prevent scattering of the sample during counting. The volume V, of the sample that produced 0.077g was calculated using equation 1(Ibeanu, 1999).

$$0.077\text{g} \times V_T = T_R V \quad (1)$$

$V_T$ = Volume that produce the total residue
$T_R$ = Weight of the total residue
V = Volume that gave 0.077g

The sample preparation efficiency could be obtained from the relation in equation 2

$$\text{Efficiency of Preparation} = \frac{weigh\ of\ residue}{0.077g} \times 100 \quad (2)$$

A high voltage of 1650V was used in a selective counting for gross alpha and beta measurement in 5cycles of 2700 sec per cycle. The alpha and beta count rate and activity were calculated equations 3, 4 5 and 6 (Ibeanu, 1999).

$$\text{The alpha activity } (\alpha) = \frac{rate(\alpha) - Bgd(\alpha)}{Channel\ efficiency \times Sample\ efficiency \times Volume} \times 0.0167 \quad (3)$$

$$\text{The alpha count rate } (\alpha) = \frac{Raw\ (\alpha) Count}{count\ time} \quad (4)$$

$$\text{The beta activity } (\beta) = \frac{rate\ (\beta) - Bgd(\beta)}{Channel\ efficiency \times Sample\ efficiency \times Volume} \times 0.0167 \quad (5)$$

$$\text{The beta count rate } (\beta) = \frac{Raw\ (\beta)\ count}{Count\ time} \quad (6)$$

The Sample Efficiency S.E is calculated as follows;

$$\text{Sample efficiency} = \frac{(W_{B+S} - W_B)}{W_{B-S} - W_B} \times 100 \quad (7)$$

Where $W_{B+S}$ is the weight of the empty placket plus sample after desiccation

$W_B$ is the weight of the empty placket

$W_{B-S}$ is the weight of the empty placket – sample

While the Channel Efficiency (C.E) is given as follows

$$E_C = \frac{cpm\ (\alpha,\beta)}{Activity\ of\ source} \times 100 \quad (8)$$

Where CPM is the background count per minute

A = Activity of the source used (Pu-239) for alpha and Sr-90 for beta. (Ibeanu, 1999).

## RESULTS AND DISCUSSION

**Gross Alpha Beta Analysis on the food samples**

As can-be observed from the Table 1 and Figure 1, the values of gross alpha activity ranged from 280 to 20 Bgkg$^{-1}$, with an average activity of 109 Bqkg$^{-1}$. The mean and range distribution of the gross beta activity concentration were 142 Bqkg$^{-1}$ and 380 to 20 Bqkg$^{-1}$ respectively. The highest concentration of alpha activity in the study was obtained in sample Q with 280 Bqkg$^{-1}$ whereas that of beta activity concentration is sample T with 380 Bqkg$^{-1}$. In sample K (Chewing gum), the gross alpha and beta activity was below the detected limit due to the nature of sample hence, gross alpha and beta activity could not be detected. Also, in samples B and L, the gross beta activity concentrations were below detection limit (BDL).

The gross alpha and beta activity concentrations were not uniformly distributed throughout as presented in Table 1 which is in agreement with the works of (Zorer and Oter, 2015). Only alpha activity concentration was detected and found to be as low as 60 Bqkg$^{-1}$ in sample B and L. These samples are considered to be safer than other samples with respect to gross radioactivity. When all samples are compared, the highest mean of gross alpha and beta activity was obtained from milk samples of which are mostly imported as stated earlier.

The gross alpha activity for eight samples were found to be higher than the recommended guideline value of 100 Bqkg$^{-1}$ (WHO, 2008) but the beta activity were all below the standard limit of 1000 Bqkg$^{-1}$ in all the children food samples analyzed.Generally, the ranges of gross beta activity concentration were observed to be higher than that of the alpha activity concentration which is in agreement with the works of (Shanthi *et al*., 2009; Zorer and Oter, 2015; Amakom *et al*., 2018).

The elevation in the activity concentration values when compared to the rest of the samples might be due to differences in soil features as most of them are from different countries, geological formations and human activities related to radiation and radioactivity. In addition, usage of phosphate fertilizers in farming can lead to elevation of radionuclides in farm produce, consequently increasing the gross activity in the food chain.

**Table 1. Alpha-beta activities of all food samples.**

| SAMPLE CODE | ALPHA CONCENTRATION ($Bqkg^{-1}$) | BETA CONCENTRATION ($Bqkg^{-1}$) |
|---|---|---|
| A | 130.0 ± 20.0 | 330.0 ± 30.0 |
| B | 60.0 ± 20.0 | BDL |
| C | 200.0 ± 20.0 | 260.0 ± 30.0 |
| D | 40.0 ± 20.0 | 100.0 ± 30.0 |
| E | 130.0 ± 20.0 | 40.0 ± 30.0 |
| F | 150.0 ± 20.0 | 90.0 ± 30.0 |
| G | 90.0 ± 20.0 | 70.0 ± 30.0 |
| H | 180.0 ± 20.0 | 360.0 ± 30.0 |
| I | 20.0 ± 20.0 | 50.0 ± 30.0 |
| J | 80.0 ± 20.0 | 140.0 ± 30.0 |
| K | BDL | BDL |
| L | 60.0 ± 20.0 | BDL |
| M | 60.0 ± 20.0 | 50.0 ± 20.0 |
| N | 140.0 ± 20.0 | 210.0 ± 30.0 |
| O | 100.0 ± 20.0 | 150.0 ± 30.0 |
| P | 50.0 ± 10.0 | 220.0 ± 30.0 |
| Q | 280.0 ± 20.0 | 340.0 ± 30.0 |
| R | 120.0 ± 20.0 | 30.0 ± 20.0 |
| S | 80.0 ± 20.0 | 20.0 ± 20.0 |
| T | 210.0 ± 20.0 | 380.0 ± 30.0 |
| TOTAL | 2180.0 | 2840.0 |

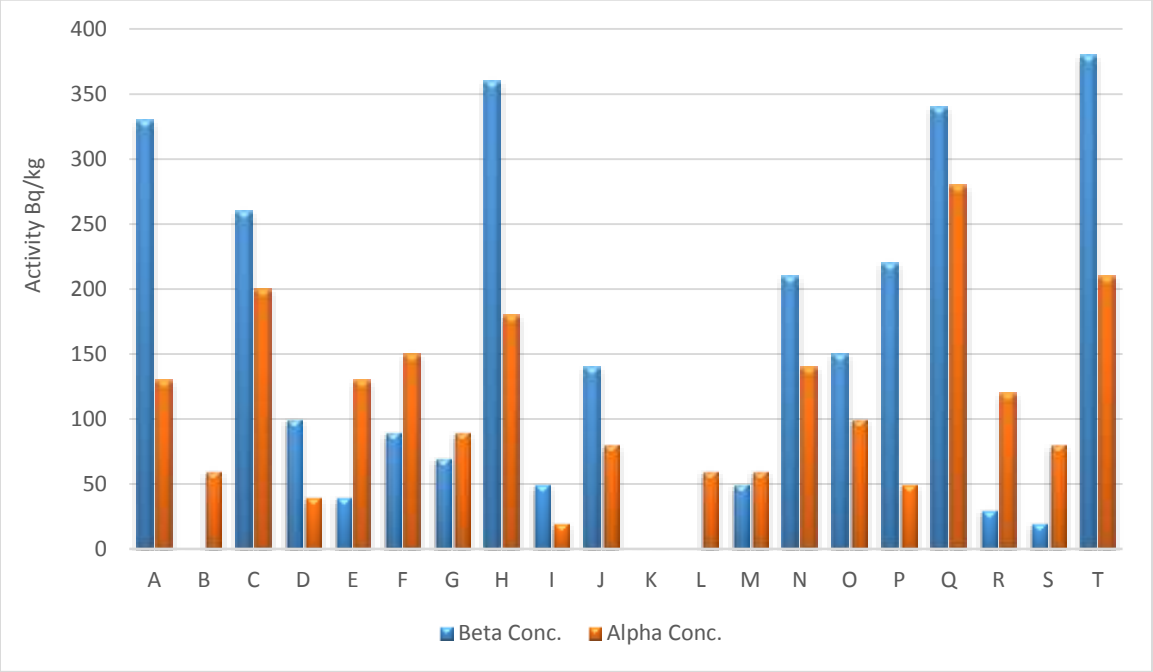


Fig.1: A graphical representation of the grossalpha-beta activities of all food samples.

**CONCLUSION**

The gross alpha and beta activity concentrations in some selected children's diets have been determined using a proportional counter. These results revealed high alpha activity of eight food samples which were above the World Health Organization standard of 100 $Bqkg^{-1}$ while for beta activity, all food samples analyzed were below the W.H.O standard limit of 1000 $Bqkg^{-1}$. This is due to alpha emitters such as $^{238}U$, $^{234}U$, $^{226}Th$, $^{226}Ra$ and $^{210}Po$ that are present in those food samples. However, the results so obtained may not pose any immediate

radiological threat to the public but further analysis using gamma spectroscopy is recommended as this will give the activity concentration of the radionuclides

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