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INDOOR RADIATION MONITORING FOR CONSUMER PROTECTION IN THE DEVELOPING WORLD

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Abstract

The amount of radiation emanating from some fruits have been assessed within the department of Physics laboratory, University of Benin, Benin City, Nigeria for 8days with a Nuclear Radiation Monitor, Digilert-50. The fruits that were under study were palm fruits (Elaeis guinensis) and Oranges (Citrus sinensis). The method and techniques used for the analysis of samples, apparatus/equipments for the study were also highlighted. Results obtained gave insight on the net radiation dose rate emanating from the samples considered. Palm fruits and Oranges gave out radiations with a standard mean deviation value of 0.0144 µSv/hr (0.1265 mSv/yr) and 0.01257 µSv/hr (0.1101 mSv/yr) from the background mean respectively. These values, when compared with standard derived intervention levels of 5mSv/yr for radio-nuclides in food allowed by WHO(1988) and ICRP(1979), it is relatively insignificant to cause health hazards to consumers of these fruits, even when harvested and stored up to 8days.

Keywords: Radiation, Dose rate, Palm fruits, Oranges.

1.0 INTRODUCTION

The radiation environment has been of utmost concern in the field of medical physics in recent times due to the proven correlation that exist between radiation and cancer; one of the world's most deadly disease now. Unfortunately, radiation monitoring and reporting have not received much attention as much as it ought to be, especially in most developing nations around the world.

With various radiation projects ongoing around the world for energy generation and other purposes, a couple of radiation incidences do occur periodically which in one way or the other contribute to the increase in the level of background radiation around most of the power plant sites. Also minute amount of these radiation emitted gets into the ecosystem by means of air pollution and thus, plants and animals alike and other bio-ecological components would be affected [2].

Radiation is commonly made up of $\alpha - particles,\ \beta - particles\ and\ \gamma - rays,$ and obeys certain laws of interactions [3] among which are: the disintegration law, decay law and ionization depending on the type of interaction taking place. We thus discover that radioactive materials tends to disintegrate in whatever form or medium they are resident in and undergo decay also and thus are emitted consequently.

The amount of radiation present in the fruits under assessment can thus be characterized and quantified to implement safety and control on consumption of these fruits even after harvested and stored up to certain periods before possible decay sets in.

The radioactive decay process begins with a radioactive atom in its original form and with the passage of time; fewer and fewer atoms are left in a sample of a decaying isotope. As far as it is known, radioactive atoms decay spontaneously at random [4]. In any short time interval Δt, the change ΔN in a large number of atoms of a radioisotope is proportional to the number of atoms N of the isotope and to the length of the time interval Δt;

$$\Delta N \propto -N\Delta t \quad \text{(i)}$$

The negative sign appears because N decreases, denoting the constant of proportionality by $\lambda(s^{-1})$ which is called the decay constant of the radioisotope.

$$\Delta N = -\lambda N\Delta t \quad \text{(ii)}$$

$$\therefore \frac{\Delta N}{\Delta t} = -\lambda N \quad \text{(iii)}$$

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Integrating equation (3) from zero (0) to infinity (∞) we have

$$\int_0^\infty \frac{\Delta N}{\Delta t} = -\int \lambda N$$

$$\therefore N = N_0 e^{-\lambda t} \qquad \text{(iv)}$$

Where N is number of atoms present after an elapsed time (t), N_0 is the number of atoms present at time t=0. At half life τ, where half the original atoms have decayed we have

$$\tau = \frac{0.693}{\lambda} \qquad \text{(v)}$$

Exposure to radiation could be external or internal. External exposure consist of an individual being exposed to a radioactive substance that emits radiation or an accelerator, X-ray generator. Internal exposure result when radioactive substances penetrated the human body via inhalation in the form of dust or gas, ingested as solids or liquids or entering the body through cuts or external wounds or by absorption directly through the skin [5].

Exposure of the whole body to massive radiation of 10Gy or more in a short time period will quickly result in symptoms such as nausea, vomiting, diarrhea, feebleness, fever, skin erythema and edemas, which may be followed within several days by death from respiratory or circulatory failure. Where there has been local exposure to a high radiation dose, temporary hair loss and burn-like skin symptoms will occur.

Exposure of the genital organs to radiation will result in sperm deficiency, sterility or early menopause. Exposure also leads to cancer or leukemia. However, it is yet to be determined if radiation dose of no more than 50mSv increases risk of cancer. Children who as fetuses where exposed to 0.1 Gy or more of radiation in the 8th to 25th week of pregnancy have an increased risk of deformity, diseases of various kinds and congenital abnormality such as mental deficiency.

Also, risk of cancer following exposure to radiation is higher in children compare to adults. For example, the risk of thyroid cancer from exposure to radioactive iodine is highest in babies, high in children, and fairly high in adolescents, decreases as one moves up the age range with the risk almost disappearing in adults over 40 years [5]

2.0 MATERIALS AND METHOD

The radiations emitted from fruits have been assessed using a nuclear radiation Monitor, Digilert-50. A retort stand, stop watch, sizable plastic plate, a table and a thermometer were also used in the measurement. The fruits under study are those that were commonly consumed by humans and include: palm fruits (*Elais guinensis*) and oranges (*Citrus sinensis*). The samples were obtained fresh from the market few kilometers from the Department of Physics, University of Benin, where radiation measurements were carried out on the samples. The entire measurement lasted for eight (8) days. For each of these days, the background radiation was taken and noted, as well as the temperatures of the environment and the samples. The Digiler-50 was fixed to a retort stand for support, the samples in the container and the entire setup was placed on a table to aid measurement and accurate observation. The samples were maintained at constant distance of 10cm from the detector to prevent errors in reading which may arise due to variations in distance of measurement. The nuclear radiation monitor is switched on with its meter set to display readings in hr^{-1} . As the samples emits radiation, the readings on the meter fluctuated and with the stop watch, reading for every minute was taken for a period of one hour for each sample each day, during the entire period of the work. After day five (5), the palm fruits were subsequently enclosed in polythene to hasten up the decay process.

3.0 RESULTS AND DISCUSSION

An in situ measurement of the level of radiation emitted by fruits was carried out on Palm fruits and Oranges with variation in temperature. The results are shown in Figures 1-3. The variation of dose rates with mean temperatures for palm fruits and oranges as shown in Figures 2 and 3 is erratic because radiation does not depend on temperature [1]. The pattern of activity was however similar in both fruits as seen in Figure 1. The maximum radiation dose for Palm fruits and Oranges are 0.0222 $\mu Sv/hr$ and 0.0195 $\mu Sv/hr$ respectively, and these were recorded on the 8th day of the measurement which indicates a gradual increase in the amount of radiation being released by these fruits as decay begins to sets in. Generally, there was no correlation between temperature and emitted radiation dose, as confirmed in literature. However, the amount of radiation measured from these fruits when compared with the World Health Organization (WHO), 1988 and ICRP (1979) limits for intake of radio-nuclides by workers of 5 mSv/yr, were significantly low to result in any health concern on the part of consumers even when they have been harvested and stored for up to 8 days.

4.0 CONCLUSION

Data on the net radiation emitted from fruits (palm fruits and oranges) for 8 days have been presented. It was found that the net radiation dose increased sparsely with time and independent of temperatures. From results obtained, it has been established that the level of radiation emanating from these fruits were considerably insignificant and thus would pose no health challenge to consumers of these fruits even after harvest and storage for 8 days. However, continuous monitoring of these fruits and others is encouraged to ensure maximal protection of consumers. In areas where there have been a nuclear fallout, serious attention will be needed in making sure the food from such a region is properly screened for possible radiation pollution.

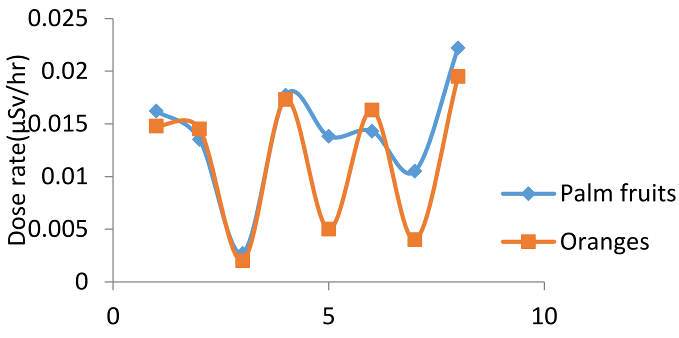

Fig. 1: Dose rate against days of measurements for Palm fruits and oranges

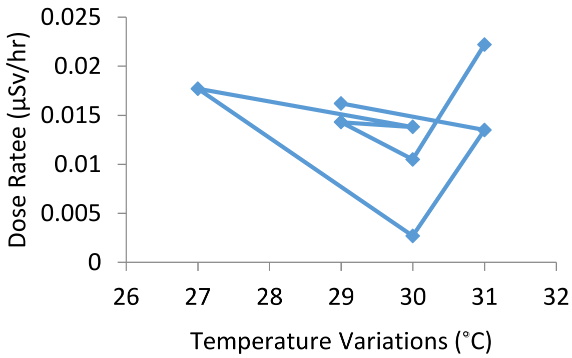

Fig. 2: Dose rate with Temperature variations for Palm fruits.

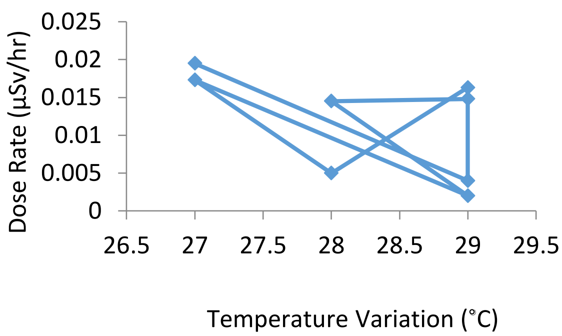

Fig. 3: Dose rate with Temperature variations for Oranges.

REFERENCES

[1] Osahon O.D. and Abiola J.A. (2014). Assessment of Background Gamma Radiation Within Geo Works Quarry Site in Igarra Akoko Edo Local Government Area Edo State Nigeria. Journal of the Nigerian Association of Mathematical Physics Vol. 28, 213-222.

[2] Bhattacharyya et al. (1992). Guidebook for the Treatment of accidental internal radio-nuclides contamination of workers. Radiat. Protect. Dosimet. 41:1.

[3] International Commission for Radiological Protection. (1979). Paris: Limits for intakes of Radio-nuclides by workers. ICRP, 2(3/4).

[4] World Health Organization. (1988). Derived Intervention levels for radio-nuclides in food. WHO, Geneva. Pp 26.

[5] Glean F.K. (1989). Radiation Detection and Measurement. Wiley 2nd edition, New York.

[6] Hurst G.S. and Turner J.E. (1970).
Elementary Radiation Physiccs. Wiley, New York, London, Sidney. Toronto.

[7] Stewart C.B. (1980). Radiological Science for Technologist. The Mosby Company 2nd edition. St Louis, Toronto London.

[8] Akpabio G.T. and Bassey B.E. (2009). Appropriate Technlogies for Environmental Protection in the Developing World. Springer Netherlands.

[9] Godwin P.N., Quimby E.H. and Morgan R.H. (1970). Physical Foundations of Radiology. 4. edition. New York: Harper and Row.