



GAMMA DOSE RATE EXPOSURE LEVEL IN A PLANTED GREEN LEAF VEGETABLE

¹Olawoore, T. O., ¹Akintunde, Z. T., ¹Atilola, O. S. and ²Shittu, G. T.

¹Faculty of Science, Department of Science Laboratory Technology, Oyo State College of Agriculture and Technology, Igboora; ²Department of Integrated Science, School of Science, Micheal Otedola College of Primary Education, Epe, Lagos State

Corresponding E- Mail: olawooretaiwo002@gmail.com

Abstract

Naturally occurring radionuclide's materials are usually absorbed by the plant through their root as nutrients for their growth, which can pose a radiation risk to the human being when they consumed it as food. This study focused on the gamma dose rate exposure levels in a planted green leaf vegetable which was carried out in OYSCATECH botanical garden. The green leafy were planted and watered for four weeks in a nursery bed and measurement and recording were taken by the use of Gamma Survey Meter to measure the dose rate of radiation emitted by green leafy vegetable three times per day for two days. It was analysed using descriptive tools which was tabulated and shown with the aid of Bar chart and compare with United Nation Scientific Committee on the Effect of Atomic Radiation (UNSCEAR) permissible dose rate. The results revealed that all the planted leafy vegetable samples have low gamma dose rate. It was concluded that it would not have effect on consumption on human body and does not pose the risk to any cancer related diseases.

Keywords: Green leaf vegetable; Gamma dose rate; Exposure; Radiation; Survey meter

Introduction

Research on the basic interaction of ionizing radiation with biological systems has contributed to human society through applications in medicine, agriculture, pharmaceutical uses, and other technological processes. Gamma rays have proved to be more economical and effective compared to other ionizing radiations because of their easy availability and power of penetration. The exposure of a biological system to ionizing radiation activates a number of physical and chemical steps between the initial absorption of energy and the final biological injury. One of the most important targets is the water molecule, which is omnipresent in organisms. The ionized water molecule (H_2O^+) and the radicals $\text{H}^\bullet$ and $\cdot\text{OH}$ are produced due to the primary reactions of excitation and ionization. In biological tissues, these ionizations are induced all along the radiation path, leading to chain reactions that produce secondary free radicals as a result of $\text{H}^\bullet$ and e^-_{aq} becoming trapped. These radicals can damage or modify important components of plant cells and affect certain physiological and biochemical processes that might be vital for organism survival. Previous studies have revealed that seed exposure to high doses of gamma rays disturbs the protein synthesis, hormone balance, leaf gas exchange, and enzyme activity. The morphological, structural, and functional changes depend on the

strength and duration of gamma doses of exposure. The measurements of free radicals in food and biological systems by electron spin resonances spectroscopy (ESR) are widely used in the fields of food irradiation, lipid oxidation, antioxidants, and food processing. Free radicals are chemical compounds that possess an unpaired electron in the outer shell of a molecule and due to this unpaired electron, these species are paramagnetic. *Vegetable* is one of the world's most important crop plants, boasting multibillion dollar annual revenue. In addition to its agronomic importance, maize has been a keystone model organism for basic research for nearly a century. Considering the effects of radiation on plants, the present study was conducted to determine the radiation on vegetable growth and development and on the content of photosynthetic pigments. Electromagnetic radiation wave is the essential driver of modern technological and economic growth. Copson (1975) studied heat penetration in agar cylinders. He described a core heating effect in cylinders at 915 MHz caused by focusing of the waves and peripheral heating patterns in the same cylinders at 2450 MHz caused by a limited penetration depth. Similar heating concentrations were found at 2450 MHz in the central part of spheres and cylindrically shaped model foods with diameters between 20 and 60 mm for spheres and 18-35 mm for cylinders (Ohlsson and Risman, 1978). Field distributions in bodies of spherical and cylindrical

geometries irradiated by plane electromagnetic fields have been examined by many research workers properties as in brain tissue was uniformly distributed throughout the sphere. Moten *et al.* (1991) investigated 1,315 GHz plane-wave induced field and specific absorption rate patterns in a sphere model of muscle tissue. They observed an intense hot spot in spheres with radii matching the carriers' wavelength. Chen *et al.* (1993) developed a finite element method for the analysis of temperature distribution in a potato cylinder after microwave heating. Pronounced heating was found along the longitudinal axis passing through the centre point of the vegetable cylinder. Also, rectangular shaped products show typical heating in homogeneities. For example, heating of prepared meals in their retail packaging resulted in hot spots at the corners of the product and low temperatures in the product centre (Burfoot *et al.*, 1988). The process of dielectric relaxation of bound water is governed by the rupture or distort on of one hydrogen bond, linking the solute molecule to its neighboring water molecules (Grant, 1965). The principle relaxation range of proteins is in the low megahertz range but single amino acids and polar side chains of protein molecules can undergo a dielectric relaxation at considerably higher frequencies because of their smaller size. These types of relaxation mechanisms may account for a significant contribution to the loss above 100 MHz, even though changes in permittivity might be small (Poster and Schwan, 1988).. These are charged by surface ionization and surrounded by a layer of counter ions.

Natural sources

Since the creation of the Earth, its environment has been exposed to radiation both from outer space and from radioactive material in its crust and core. There is no way to avoid being exposed to these natural sources, which, in fact, cause most of the radiation exposure of the world's population. The global average effective dose per person is about 2.4 mSv and ranges from about 1 to more than 10 mSv depending on where people live. Buildings may trap a particular radioactive gas, called radon, or the building material itself may contain radionuclides that increase radiation exposure. Although the sources are natural, our exposure can be modified by choices we make, such as how and where we live or what we eat and drink(UNSCEAR 2010).

Gamma radiation

This is a very high energy photon (a form of electromagnetic radiation like light) emitted from an unstable nucleus that is often emitting a beta particle

at the same time. Gamma radiation causes ionization in atoms when it passes through matter, primarily due to interactions with electrons. It can be very penetrating and only a substantial thickness of dense materials such as steel or lead can provide good shielding. Gamma radiation can therefore deliver significant doses to internal organs without inhalation or ingestion.

Statement of the problem

All the researchers have working on how microorganism contact to green leaf vegetable and the effect, but the effect of radiation in green leaf vegetable which may cause cancer has not been analyzed.

Aim and objectives

Aim of the study

To investigate the Gamma dose rate exposure level in some selected green leaf vegetable.

Objectives of the study

To determine the amount of gamma dose rate derived from green leaf vegetable planted at OYSCATECH botanical garden..

To compare level of the gamma dose rate from green leaf vegetable planted to the UNSCEAR permissible dose rate

To determine the safety of the consumption of Green vegetable planted

Methods

The experiment was carried out at Botanical Garden, Oyo State College of Agriculture and Technology Igboora. (OYSCATECH)

Sample collection

The viable seed of vegetable (Green leaf) was bought from Towobowo market in Igboora, and then Nursery bed was prepared to plant the vegetable for four weeks

Experimental procedure

Some portion of land was cleared and nursery bed was made by the use of cutlass and hoe, thereafter the seed of Green leaf vegetable was planted at the OYSCATECH Botanical garden. The vegetable (Green leaf) was watering for four (4) weeks before the measurement was taken Then, the gamma survey meter was used to measure the dose rate in the morning, afternoon and in the evening for two days. The measurement and recording was taken with the use of gamma survey meter in μSv .

Gamma survey meter

The RDS-30 Radiation Survey Meter is a versatile gamma radiation detector, which has designed for a wide range of application involving a possibility for abnormal radiation levels.

It is compact, lightweight and waterproof. Its performance and user friendly interface make the RDS-30 perfectly suited to radiation survey in field conditions as in nuclear industry or for protection against radiological hazards. The radiation meter used is shown in figure below:

Detected Radiation: Gamma and X-ray radiation

Range: 1 mR/hr

Alarm Levels: Adjustable for dose rate and accumulated

Accuracy: +/- 10% over the entire range

Batteries: Two AA cells with 2000+ hrs battery life

Operating condition: -25°C to +55°C

Measurement and displays in $\mu\text{Sv/h}$ or mrem/h

Dose measurement indication

Visual and audible alarms

Large, backlit display

Specifications:



Figure 1: Diagram of Gamma Survey Meter

Results and Discussion

Results

Table 1

The table 1 shows the gamma dose rate of reading taken in the day 1 from vegetable (green leaf) at the OYSCATECH botanical garden.

Date of measurement day 1: 21-10-2021

Day1	Readings μSv					Range	Average
Vegetable	1	2	3	4	5	Min -Max	
Morning	0.026	0.035	0.026	0.025	0.027	0.025-0.035	0.0278
Afternoon	0.024	0.022	0.023	0.025	0.026	0.022-0.026	0.024
Evening	0.021	0.031	0.028	0.020	0.022	0.020-0.031	0.0244

Table 2

The table 2 shows the gamma dose rate of reading taken in the day 2 from vegetable (green leaf) at the OYSCATECH botanical garden.

Date of measurement day 2: 22-10-2021

Day2	Readings μSv					Range	Average
Vegetable	1	2	3	4	5	Min -Max	
Morning	0.021	0.025	0.017	0.019	0.025	0.017-0.025	0.0214
Afternoon	0.025	0.026	0.024	0.027	0.028	0.024-0.028	0.026
Evening	0.024	0.032	0.023	0.033	0.035	0.023-0.033	0.0274

Table 3

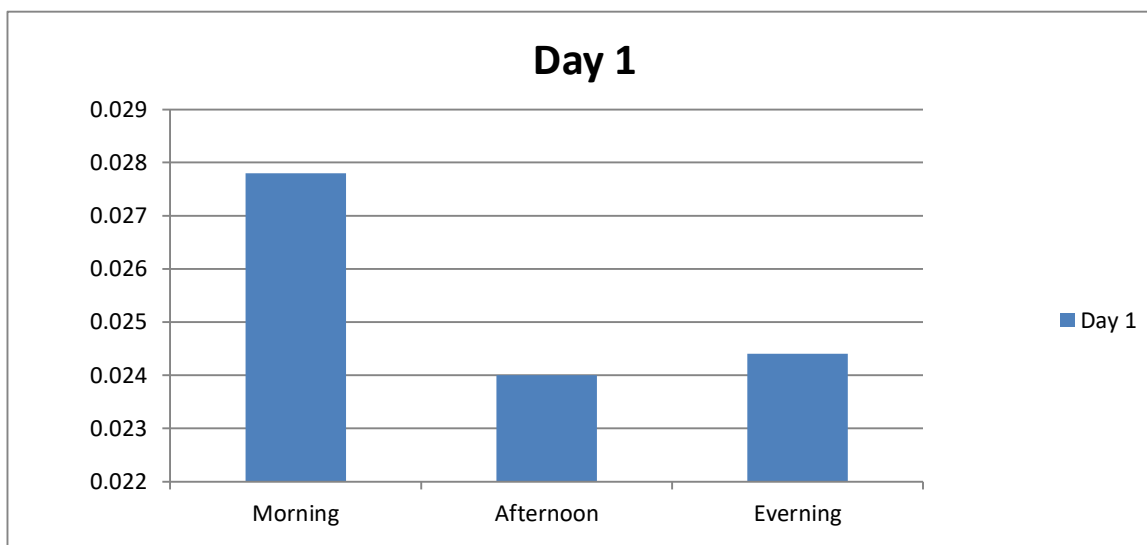
The table 3 shows the gamma dose rate of reading taken in the day 1 and day 2 from vegetable (green leaf) at the OYSCATECH botanical garden.

Date of measurement day 1 and day 2: 21 and 22 -10-2021

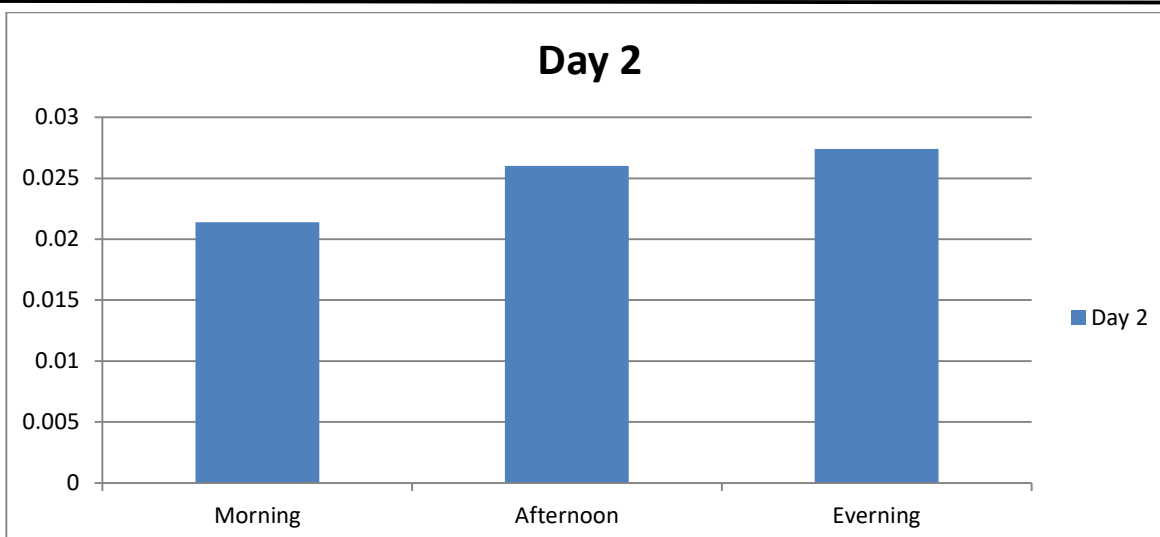
Day1	Readings μSv					Range	Average
Vegetable	1	2	3	4	5	Min -Max	
Morning	0.026	0.035	0.026	0.025	0.027	0.025-0.035	0.0278
Afternoon	0.024	0.022	0.023	0.025	0.026	0.022-0.026	0.024
Evening	0.021	0.031	0.028	0.020	0.022	0.020-0.031	0.0244
Day2	Readings μSv					Range	Average
Vegetable	1	2	3	4	5	Min -Max	
Morning	0.021	0.025	0.017	0.019	0.025	0.017-0.025	0.0214
Afternoon	0.025	0.026	0.024	0.027	0.028	0.024-0.028	0.026
Evening	0.024	0.032	0.023	0.033	0.035	0.023-0.033	0.0274

Bar chart 1

The Fig 1 showing the maximum gamma dose rate (μSv) of radiation emitted from green leaf vegetable in the day 1.

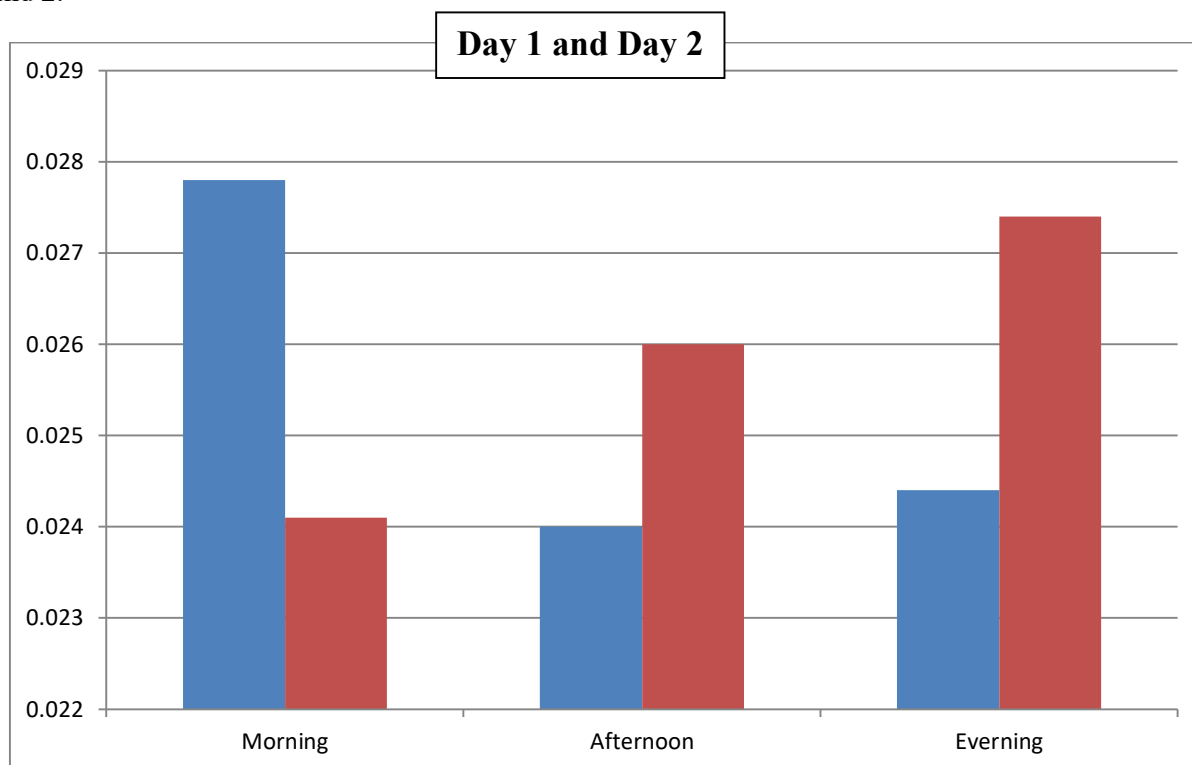


The bar chat 2 showing the maximum gamma dose rate (μSv) of radiation emitted from green leaf vegetable in the day 2.



Bar chart

The bar chart 3 showing the maximum gamma dose rate (μSv) of radiation emitted from green leaf vegetable in the day 1 and 2.



Discussion

The table 1 show above the result of gamma dose rate readings taken and recorded three times from five samples in a day i.e morning, afternoon and evening the result indicated from the bar chart that morning has the average highest average value of $0.0278\mu\text{Sv}$, evening has the average value of $0.0244\mu\text{Sv}$ and afternoon has the lowest average value of $0.024\mu\text{Sv}$. The day 2 table show above the results of gamma dose rate of readings taken and recorded three times from five samples i.e morning, afternoon and evening the

result indicated from the bar chart that Evening has the highest average value of $0.0274\mu\text{Sv}$, Morning has the average value of $0.024\mu\text{Sv}$ and afternoon has the lowest average value of $0.026\mu\text{Sv}$.

The table shows above the results of gamma dose rate of readings taken from the day 1 and day 2 sampled in the morning, Afternoon and evening. The results indicated from the bar chart of day 1 morning has the highest average value of $0.0278\mu\text{Sv}$, day 2 morning has the average value of $0.024\mu\text{Sv}$ and afternoon has the lowest average value of $0.026\mu\text{Sv}$. The average

value of 0.026 μSv of day 2 afternoons is higher than day 1 afternoon average value of 0.024 μSv . The average value of 0.0274 μSv of day 2 higher than day 1 average value of 0.0244 μSv .

It can be deduced that gamma dose rate emitted from sampled green leaf vegetable from botanical garden from the reading taken for the average values from day 1 and day

2 the highest average values were compared to the international recommended value by United Nation Scientific Committee on the effect of Atomic Radiation (UNCEAR) have the gamma dose rate within the acceptable and permissible dose rate of radiation.

Conclusion

The research carried out based on measurement of gamma dose rate emitted from planted green leaf vegetable. It was deduced that from the tabulated table and bar chart drawn from green leaf vegetable. That all the green leaf vegetable have low gamma dose rate in the day 1 and day 2, which are not harmful to the body. The activity concentration gamma absorbed dose rate from the average values indicated that these vegetable have a level of consumption safety when compared with the world permissible values by UNCEAR. It could be concluded that these gamma dose rate on leaf vegetable from the sample area would not have effect on consumption on human body and does not pose the risk to any cancer related diseases.

References

- Berlan, J., Giboreau, P. Lefeuvre S. and Marchand C. 1991. *Synthese organique sous champ microondes: premier exemple d'activation specifique en phase homogene*. Tetrahedron Letters.
- Bigio, I.J., Gosnell, T.R., Mukherjee, P. and Saffer, J.D. 1993. *Microwave absorption spectroscopy of DNA*. Biopolymers 23: 147-150
- Bond, G. R.B. Moyes, S.D. Pollington and D.A. Whan, 1991. *The super hearing of liquids by microwave radiation*. Chemistry and Industry 16 Sept.: 686-687
- Bone, S., Gascoyne C. and Pethig, R. 1977. Dielectric properties of hydrated proteins at
- Banik, B. 9.9 GHz. J.
- Brown, G.H. and Morrison, W.C. 1954. An exploration of the effects of strong radio-frequency fieldson micro-organisms in aqueous solutions. Food Technol. 8: 361-366.
- Calvante, M.J.B. and Muchovej, J.J. 1993. Microwave irradiation of seeds and selected fungal spores. *Seed Sci. and Technol.* 21: 247-253
- Carroll, D.E. and Lopez, A. 1969. Lethality of radio-frequency energy upon microorganisms in liquid, buffered and alcoholic food systems. *J. of Food Sci.* 34: 320-324 *Chem. Soc., Faraday Trans. 1* 73(10): 1605-1611 *chemistry 2. Simplified techniques. J. of Organic Chem.* 50 (25): 6968-6970
- Distribution in microwaved cylindrical potato tissue. *J. of Food Engineering* 18: 351-368
- Food Eng.* 8: 145-156