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Determination of Radiation Background in the Vicinity of Groundnuts Milling Machines In Gombe Metropolis of Gombe State of Nigeria

Hankouraou Seydou and Shittu Abdullahi

Gombe State University, PMB 127, Gombe, Department of Physics.

Abstract

A background radiation survey in the vicinity of groundnuts milling machines in Gombe Metropolis of Gombe State of Nigeria has beencarried out. The area under study was divided into ten locations, and investigated. Measurement was Carriedusing Geiger Mueller counter,a rate meter manufactured by IEC(industrial equipment and control Melbourne Australia) and a handheld Global Positioning System (GPS 76 CSX) equipment. Two (2) readings were taken in each of the two locations making a total of twenty (20)readings inall.The measured average background radiation levels range between 1.72μR/hr(0.0185mSv/yr) to 3.3μR/hr (0.0355mSv/yr) in the study area. The average doseequivalents obtained for most locations within the study area is above the standardbackground radiation of 0.013mR/hr given by ICRP, but is within the safe radiation limitof 1.04mSv/yr. However, results obtained do not indicate any immediate health side effects on the workersand the host communities as the highest radiation exposure level of 0.0355mSv/yr recorded is below the limit value of 10.43mSv/yr set by the Texas Regulation for Control of Radiation andProtection of Public Health.

Keywords: Geiger Mueller counter, handheld Global Positioning System, background radiation Radiation dose, groundnut's milling machines, Gombe Metropolis.

1.0 Introduction

The worldwide expressedinterest for the determination of naturally occurring radiation and environmentalradioactivity has led to the interest of extensive surveysin many countries including Nigeria.About 80% ofthe world population radiationof exposure comesfrom naturalsources[1-3].There are many sources of radiation and radioactivityin the environment. The mainexternal sources of irradiation of the human body are radiation emittedfrom naturally occurring radio- nuclides.Human beings are exposed to radiationcalledterrestrial background radiation from sourcesoutside their bodies. Cosmic rays and gammaray emitters in soils, building materials, water, food,and air are the major exposures [4]. In order to get essential radiological information, the levels of background radiation distributionin the environment have to be investigated.Natural environmental radioactivity and the associatedexternal exposure due to background radiation depend primarily on the geological and geographical locations.

The objectives of the present study are to measure the background radiation levels in the vicinity of groundnuts milling machines in Gombe city and to assess it in terms of exposure, annual effectiveradiation dose, and external radiation hazard index.The data generated in this study will provide baseline values of background radiation in the environment and maybe useful for authorities in the implementation ofradiation protection standards for the populationin the country in general and Gombe state in particular.

2.0 Materials and Methods

Natural background radiation wasmeasured usingGeiger Mueller counter manufactured by IEC industrial equipment and control Melbourne Australia.Handheld Global Positioning System equipment was used in order to determine the geographical coordinates such as longitude, latitude and elevation.

The background radiations were measured at ten locations of groundnuts milling machines as described in Table 1. All readingswere therefore converted into dose equivalent in micro Sievert/year.

Corresponding author: Hankouraou Seydou, E-mail: seydou5k@yahoo.com, Tel.: +2348065631501

The annual effective dosereceived by the population is calculated using thefollowing formula:

$E = T \cdot Q \cdot D \times 10^{-6}$ **(1)**

where D is the absorbed dose rate in air, Q is theconversion factor of 0.7 Sv Gy^{-1}, which converts theabsorbed dose rate in air to human effective dose received [1], and T is the time for 1year, i.e. 8760 hrsor 365 days.

Table 1: Geographical location and sample locations

LOCATION	GEAGRAPHICAL COODINATE	ELEVATION
ABUJA LOWCOST	N010° 16'27.6", E011°10'51.7"	434
MADAKI 1	N010°16'26.8", E011°10'56.7"	427
MADAKI 2	N010°16'14.9", E011°10'53.4"	419
DAWAKI	N010°17'25.8", E011°10'30.3"	440
BOLARI EAST	N010°16'42.2", E011°10'27.2"	434
IDI Quarters 1	N010°17'36.2", E011°10'49.7"	438
IDI Quarters 2	N010°17'37.3", E011°10'43.3"	412
IDI Quarters 3	N010°17'37.6", E011°10'49.4"	494
MANAWACHI1	N010°16'21.1", E011°10'48.9"	449
MANAWACHI2	N010°1'6'24.5", E011°10'51.6"	447

3.0 Results and Discussion

The background radiation obtained from Abuja Lowcost,Madaki1, Madaki2,Bolari East, Dawaki, Idi Quarters1,Idi Quarters2 ,Idi Quarters3, Manawachi 1, Manawachi 2 are 2.45, 3.3, 3.3 ,2.67, 2.26,2.36,2.26,1.95,1.72 and 2.68μR/h respectively as shown in Table 2. The highest value of 3.3 μR/h was obtained atMadaki-1 while a least value of 1.72 μR/h was obtained at Manawachi-2. The values were converted to nGy/h(Table3) then to mSv/year(Table 4) in order to make comparison with the standard limit given the literature [2].

Table 2: Measured values in counts/min

Location	MEAN IN DOOR(COUNT/MIN)	MEAN OUT DOOR(COUNT/MIN)
Abuja Lowcost	24.5	25.8
Madaki 1	33	22.5
Madaki2	23.5	21.5
Bolari East	26.7	25
Dawaki	22.6	21.6
Idi Quarters1	23.6	19.8
Idi Quarters2	22.6	22
Idi Quarters3	19.5	20.8
Manawachi	17.2	21.6
Madawaki	26.8	24.9

Table 3: Measured values converted to μR/h and nGy/h

Location	MEAN IN DOOR(μR/h)	MEAN OUT DOOR(μR/h)	MEAN IN DOOR(nGy/h)	MEAN OUT DOOR(nGy/h)
Abuja Lowcost	2.45	2.58	21.47	22.61
Madaki 1	3.3	2.25	28.92	19.72
Madaki2	3.3	2.15	20.59	18.84
Bolari East	2.67	2.5	23.39	21.91
Dawaki	2.26	2.16	19.80	18.93
Idi Quarters1	2.36	1.98	20.68	17.35
Idi Quarters2	2.26	2.2	19.81	19.28
Idi Quarters3	1.95	2.08	17.09	18.23
Manawachi	1.72	2.16	15.07	18.93
Manawachi	2.68	2.49	23.48	21.82

Table 4: Values converted to dose rate in mSv/yrand μSv/yr

Location	DOSE EQUIVALET IN DOOR(mSv/yr)	DOSE EQUIVALENT OUT DOOR(mSv/yr)	DOSE EQUIVALENT IN DOOR(μSv/yr)	DOSE EQUIVALENT OUT DOOR(μSv/yr)
Abuja Lowcost	0.0263	0.0277	26.33	27.73
Madaki 1	0.0355	0.0243	35.47	24.18
Madaki2	0.0253	0.0231	25.26	23.11
Bolari East	0.0287	0.0268	28.69	26.87
Dawaki	0.0243	0.0232	24.29	23.22
Idi Quarters1	0.0254	0.0213	25.36	21.28
Idi Quarters2	0.0243	0.0236	24.29	23.65
Idi Quarters3	0.0209	0.0224	20.96	22.36
Manawachi 1	0.0185	0.0232	18.48	23.22
Manawachi 2	0.0288	0.0267	28.80	26.76
MEAN ±SD	0.0258±0.0044	0.0242±0.0020	25.80±4.40	24.20±2.00

The study shows that the absorbed dose rate due toterrestrial gamma radiation in the range of 0.0185 to 0.0355 mSv/year, in Gombe, Gombe State North –East of Nigeria, is very lowcompared to the world average of 70 mSv/year [5]. These values are less than 0.05 % of the world average. This shows that the backgroundradiation burden on the masses of the Gombe town andits consequent health hazard is not significant.The data obtained in this work can reliably serve asthe local baseline data for the assessment of anyfuture environmental radioactivity contamination or pollutionfrom, nuclear weapons tests,radioactive waste dumps or industrial emissions in thestudied environment in respect of dose rate.

However, staff and other users that use the industries and their immediate neighborhood areexposed to insignificant health risks as the values of the meandose equivalent recorded in this work are consistently less thanthe worldwide average dose of 2.4mSv/yr for ahuman being[6]. All radiation levels in studied areas were lower than the above recommended value.

The corresponding worldwide average values rangefrom 18-93 nGy h^{-1}[1] and the population-weighted valuesgave an average absorbed dose rate in air outdoors fromterrestrial gamma radiation as 60 nGy h^{-1}. This showsthat the mean value obtained by this study as shown in Table 3 is less thanpopulation-weighted worldwide average as the highest is recorded 28.92nGy h^{-1} for indoor.

The estimated indoor and outdoor effective doses according to equation 1 for the sites presented in Table 1,rangefrom 18.48-35.47μSv y^{-1} and 21.28-27.73 μSv $y^{-1}$with a mean of 0.0258 and 0.0258mSv y^{-1}respectivelywhich are significantly lower than the worldwide averageexposure of 0.7 mSv y^{-1}[7,8].Thus, the exposure level for the public is within therecommended value of 1 mSv y^{-1} UNSCEAR [5] (SafetySeries No. 115-I).The highest and lowest indoor effectivedoses of35.5and 17.2 μSv y^{-1}were registered at Madaki 1 and Manawachi 1respectively. For the outdoor,the highest value of effective dose of 27.73μSv y^{-1} was obtained at Abuja Low-cost against a lowest value of 21.28 μSv y^{-1} at Idi quarters 1. The variation between the indoor and the outdoor values are not much significant in most of the areas of study as shown in Figure1and the values are belowthe limit value of 10.43mSv/yr set by the Texas Regulation for Control of Radiation and Protection of Public Health as reported by Lowder[9].

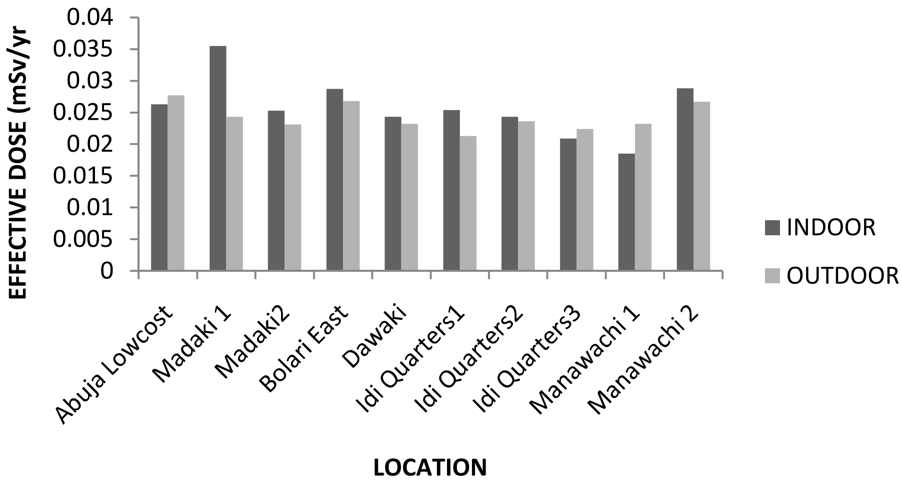

Figure 1: Comparison between indoor and outdoor effective doses for the various locations.
The outdoor and indoor variations with elevation are shown in Figure 2 and 3 respectively.
Altitude and latitude are two determining factors on background radiation level [8]. According to the results of these studies, there is a linear relationship between altitude and annual effective dose from background gamma radiation as given by the following equations for outdoor and indoor respectively:

$$y = -0.035x + 39.04 \quad (2)$$

$$y = -0.104x + 70.86 \quad (3)$$

where yis the background radiation and x is the elevation.
The results indicate the higher the elevation the lower the background radiation. This shows that there are other factors like human activities that may likely contribute to the increase in the radiation background in the areas of lower elevation. The low values obtained from the areas of high elevations might also be attributed to the low level of waste generated in these areas, due to low population density [10].The low coefficients of correlation R^2= 0.097and 0.202 for outdoor and indoor respectively indicate that there is very poor relationship between the elevations and the measured radiation doses.
It is recommended that regular and periodic monitoring of the background ionizing radiation level should be carried out to assessthe health risks to staff, and the general public that maybe exposed to danger. Proper ventilation of the milling machines environment should be carried out daily by at least opening the windows to prevent the accumulation of the emerging radiation inside the factories.Future work should be carried to evaluate the indoor and outdoor backgroundradiation of the remaining industries situated in the town apart from those covered in this work.

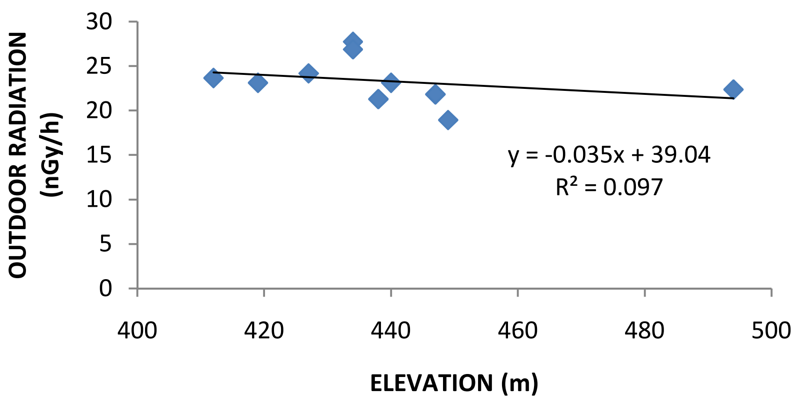

Figure 2: Background Radiation Outdoor versus Elevation

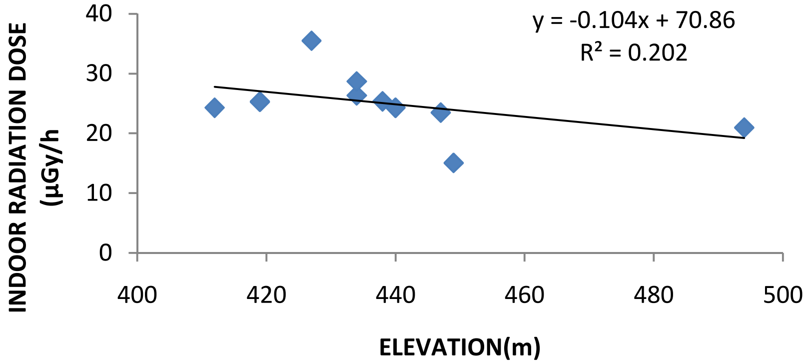

Figure 3: Background Radiation Indoor versus Elevation

4.0 Conclusion

The average annual effective doses from background radiation in Gombe city were0.0258 mSv/y for indoor and 0.0242mSv/y these are lessthan the world wide exposure limitof 70 mSv/y. The results of the presentstudy revealed that milling machines plants have not significantly affected background radiation level in Gombe Metropolis from the time of their installations to date.

5.0 References

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