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# Magnitudes and Effects of Radon Emission from Vitellaria Paradoxa Used for Charcoal Production in Atisbo Local Government, Oyo State

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**Abstract**
Radon is a chemical element with atomic number 86 on the periodic table. It is a radioactive, colorless, odorless, tasteless noble gas, occurring naturally as a decay product of radium. Its most stable isotope, $^{222}Rn$, has a half-life of 3.8 days. It is the only gas under normal conditions that has radioactive isotopes and is considered a health hazard due to its radioactivity. This research project investigated the effect and magnitude of radon emission from Vitellaria paradoxa used for charcoal production in Atisbo local government area of Oyo state. The study area is open woodland vegetation similar to derived savanna ecological zone. An oral interview was conducted on charcoal producers as a pilot study. Radon concentration measurements were carried out in three (3) charcoal production sites at the study area. At each location RAD7 was used to probe 0.6m beneath the soil. The collected data were subjected to analysis of variance (ANOVA) and the means separated using Duncan's Multiple Range Test (DMRT). The concentration in air at $L_1S_{40}$ and $L_1S_{30}$ are not significantly different from each other with the value of 2125.0 and 1947.0 respectively and the radon concentration in soil at $L_1S_0$, $L_1S_{10}$ and $L_1S_{20}$ are not significantly different from one another($p<0.05$) at Kona Owo. The radon concentration in the soil at all distance $L_2S_0$, $L_2S_{10}$, $L_2S_{20}$, $L_2S_{30}$, $L_2S_{40}$ with the value of 2822, 4803, 4140, 3112, 5210 are not significantly different from one another ($p<0.05$) where $L_2S_{40}$ with 5210 is having the highest value of radon and $L_2S_0$ is having low in the soil at Oje Owode. The experiment showed that during the production of charcoal, more radon is emitted to both the air and soil when it is compared to the amount of radon emitted by Vitellaria paradoxa atvthe point of burn. It is recommended that the charcoal workers should wear appropriate protective clothes to protect them from radon emission.
**Keywords:** Radon emission, Shea tree, Soil radon concentration, ionizing radiation, Charcoal production.

## 1. INTRODUCTION

Charcoal is a bye product of wood commonly used in the tropics and sub-tropics as source of energy for cooking and even for heavy equipment. It is locally called firewood in Nigeria and a major component of wood fuel, obtained from the burning or passing of wood through fire. Large-scale charcoal production, primarily in Sub-Saharan Africa (SSA) has been a growing concern due to its contribution to deforestation, land degradation and climate change impacts (Arnold *et al.* 2006; Zulu & Richardson 2013). As a local fuel that has been used for hundreds of years, it serves as a lifeline for the rapidly increasing populations in the urban centres of the region. Charcoal is the dark grey residue consisting of carbon and any remaining of heating wood and other substances in the absence of oxygen, called pyrolysis (Wikipedia 2011) it is an impure form of carbon which contains ash. *Vitellaria paradoxa* C. F. Gaertn., commonly known as the Shea tree is used for charcoal production.

### 1.1 Radon and Charcoal production.

Radon has been implicated to be abundantly found in charcoal production site. Radon gas is a colourless and odourless radioactive gas which occurs naturally from the breakdown of radium and uranium from granites and soil (Wright 2005; WHO 2009). Radon gas has a half-life of 3-8 days and concentrates in close areas such as underground mines and houses. Radon gas concentrates greatly to the ionizing radiation dose received by people (WHO 2009) states that radon is a gaseous and highly radioactive element. Radioactive element is found in naturally occurring sources and artificially produced ones while radon is naturally occurring colourless, tasteless inert gas which is imperceptible to human senses. It is produced from the decay of naturally occurring radionuclide such as uranium-238, uranium-235, and thorium-232.

### 1.2 Charcoal production and Atisbo Local government area of Oyo state Nigeria.

In the study area, charcoal production is predominant. Charcoal producers are unaware of the detrimental effects of radon on human health and its impact on the environment – human, soil, plant and water. Therefore, this study has been carried out to evaluate radon emission level from the charcoal produced from Vitellaria paradoxa and access the presence of heavy metal contaminants in soils around charcoal production sites.

**2.1 Methods used for the Study.**

Study was carried out in Atisbo Local Government Area (L.G.A) of Oyo state. It is situated in the northern part of Oyo state in tern part of Oyo state in Western Nigeria and is located at Oke-Ogun part of Oyo state on the Latitude $8^0$40'N, $3^0$24'E, Longitude $8^0$667'N, $3^0$40'E. It is bounded in the North by Kwara state, in the East by Osun state, in the south by Ogun state and in the west partly by Ogun state and the Republic of Benin. It is often referred to as the food basket of Oyo state because, it is primarily an agrarian community where the people are living in rural villages and engaged in cultivating crops such as maize, soybeans, cowpea, yam, cassava, and livestock reared include cattle, sheep, goat, pigs and poultry. (Wikipedia 2016; Kolajo 2007).

The study area (Kona Owo and Oje Owode) is an open woodland vegetation similar to derived savannah ecological zone with two distinct seasons namely, wet and short dry seasons. The rainfall ranges between 1000mm and 1500mm while the raining days starting from the month of March to October and dry season from the month of November to February. The soil is considered naturally fertile due to its climate and presence of natural vegetation.

**2.2 Pilot study.**

Oral interview was conducted for charcoal producers in order to establish some facts. The interview comprised of questions relating to their personal life, health and economic related and occupational safety and operation questions. Some of the questions asked during the interview are stated below;

1. For how long have you been in the occupation?
2. What is the age of the farmer?
3. Do you use any personal protective equipment now or before?
4. Which type of tree is most preferred?
5. Will you like to leave this job?
6. Where did you source for the tree used?
7. What machine was used in felling the tree used?
8. What are the factors that determine the price of charcoal?
9. What type of disease do you encountered?

**2.3 The actual measurement carried out.**

Concentration measurements were carried out in two (2) charcoal production sites in Atisbo Local government area, Oyo state. At each location, the equipment was placed 0 m above the ground at the spot of the charcoal concentration in the air and the probe is inserted into the soil (0.6m beneath the soil) to measure the radon in the soil. This process was carried out from 10m, 20m, 30m, 40m, and 50m respectively away from the peat.

The equipment used is RAD7.The Durridge RAD7 is a solid-state detector that converts alpha radiation directly to an electrical signal. This equipment is able determine the energy of each of the signal electronically. Before radon measurements, the RAD7 was free of radon, for this, the equipment was purged by using a desiccant tube for 5minutes until the relative humidity reaches the lowest possible value of about 8%. After that the equipment uses four (4) cycles of 5minutes each to measure both the radon in the air as well as radon in the soil at each location.

On-site soil and plant materials were obtained using hoe, cutlass, meter rule and brown envelope. Three sites were used of which the control was in LAUTECH (a plot of land believed to never have been subjected to charcoal processing), while the two others are charcoal processing sites from the study area. Top soil samples were collected from the peat at 0 m, 10 m, 20 m, 30 m, 40 m, and 50 m away from charcoal processing sites. Plant samples were plucked from trees. Soil and plant samples were oven-dried and sun-dried respectively for laboratory analysis. The collected data was subjected to analysis of variance (ANOVA) and the means was separated using 5 % level of significance using Minitab statistical tool

The result from well water around the charcoal production site was assay to check the level of radon in the water, the value is 14380 Bq/m$^3$. The radon concentration from *Vitellaria paradoxa* was measured for 21 hrs. This is to check the radon content of the plant used for charcoal production. The value ranges from 67.56076 Bq/m$^3$ to 11.70423 Bq/m$^3$ and the average value 37.84 Bq/m$^3$. (Figure 3).

**3.1 Radon emission results**

The radon concentration in air at $L_1S_{40}$ and $L_1S_{30}$ are not significantly different from each other with the value of 2125.0 and 1947.0 respectively ($p<0.05$). The radon concentration in air at $L_1S_0$ and $L_1S_{10}$ are not significantly different from each other but $L_1S_{10}$ had the higher value of 460.0 but significantly different from $L_1S_{30,}$ $L_1S_{40}$ and $L_1S_{20}$ with the value of 1947.0, 2125.0 and 1331.3 respectively. The radon concentration in soil at $L_1S_{0,}$ $L_1S_{10}$ and $L_1S_{20}$ are not significantly different from one another and having the following value of 3835, 2369 and 4793 respectively but significantly different from $L_1S_{30}$ and $L_1S_{40}$ with the value of 1740 and 5745 respectively.

The radon concentration in the soil at $L_1S_{30}$ and $L_1S_{40}$ are significantly different from each other with value of 1740 and 5745.The radon concentration in the air and soil at $L_1S_{20}$ are not significantly different from each but radon in the soil is higher in value with 4793. Also, radon concentration in the air and soil at $L_1S_{40}$ are not significantly different from each but radon in soil is higher in value with 5745 ($p<0.05$).

Radon is not a stable element, so as result it disintegrates into heavy metals that includes Lead, Chromium, Zinc, Nickel and Cadmium which is release to the soil by bio-accumulation and is transferred to both plants and animals by bio-accumulation as shown in table 1 and table 2. These heavy metals are responsible for the various diseases which include lung cancer and other related diseases in animals and also, abnormal growth seen in plants that later result low yield in crop production. It is noticed from Table 1 and Table 2 that the presence of heavy metals in the site of charcoal production is abundant compared to where charcoal production has not taken place at all (control).

**3.2 Negative effect of radon.**

The results obtained from this study, it is necessary to take into account the negative effect of ionizing radiation and its sources. Radon being one of these alpha emitters, having being observed to be affected by human activities (charcoal production), there is need for proper awareness to educate the public on its effects on human.

**4 Conclusion.**

The results in the study indicated that the area investigated has different radon concentration; radon in air increases gradually from the site of production 309.4 Bq/m$^3$ at 0 m from the site and 2125 Bq/m$^3$ at 40 m whereas, the radon in soil fluctuates between 5745 Bq/m$^3$ and 1740 Bq/m$^3$ at Kona Owo. This shows that during charcoal production, the radon concentration within the 40 m radius is very high. The radon emission from the plant (***Vitellaria paradoxa***) is the source of the radon preponderance in the study area. Though the plant is preferred to other plant materials in the study area, caution must be taken so that using the tree species for charcoal production will not become a springboard for lethal occurrences to humans.

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**APPENDIX**

**Table 1: Effects of distance on radon air and soil around charcoal production site in Kona Owo**.

| Description | Air (Bq/m$^3$) | Soil (Bq/m$^3$) |
|---|---|---|
| $L_1S_0$ | 309.4$^{bc}$ | 3835$^{ab}$ |
| $L_1S_{10}$ | 460.0$^{bc}$ | 2369$^{ab}$ |
| $L_1S_{20}$ | 1331.3$^{ab}$ | 4793$^{ab}$ |
| $L_1S_{30}$ | 1947.0$^{a}$ | 1740$^{b}$ |
| $L_1S_{40}$ | 2125.0$^{a}$ | 5745$^{a}$ |

* Means within the interaction table followed by the same letter (s) are not significantly different 5% probability level according to Minitab.

$L_1S_0$ = Location 1 at distance 0m.
$L_1S_{10}$ = Location 1 at distance 10m.
$L_1S_{20}$ = Location 1 at distance 20m.
$L_1S_{30}$ = Location 1 at distance 30m.
$L_1S_{40}$ = Location 1 at distance 40m.

**Table 2: Effects of distance on radon air and soil around charcoal production site in Oje Owode.**

| Description | Air ($Bq/m^3$) | Soil ($Bq/m^3$) |
|---|---|---|
| $L_2S_0$ | $1040.3^{abc}$ | $2822^{ab}$ |
| $L_2S_{10}$ | $210.0^{bc}$ | $4803^{ab}$ |
| $L_2S_{20}$ | $00.0^{c}$ | $4140^{ab}$ |
| $L_2S_{30}$ | $41.3^{a}$ | $3112^{ab}$ |
| $L_2S_{40}$ | $650.0^{bc}$ | $5210^{ab}$ |

* Means within the interaction table followed by the same letter (s) are not significantly different at 5% probability level according to Minitab.
$L_2S_0$ = Location 2 at distance 0m.
$L_2S_{10}$ = Location 2 at distance 10m.
$L_2S_{20}$ = Location 2 at distance 20m.
$L_2S_{30}$ = Location 2 at distance 30m.
$L_2S_{40}$ = Location 2 at distance 40

The graph below shows the magnitude of heavy metals that is present in the soil as a result of disintegration of radon produced from the charcoal production at kona Owo.

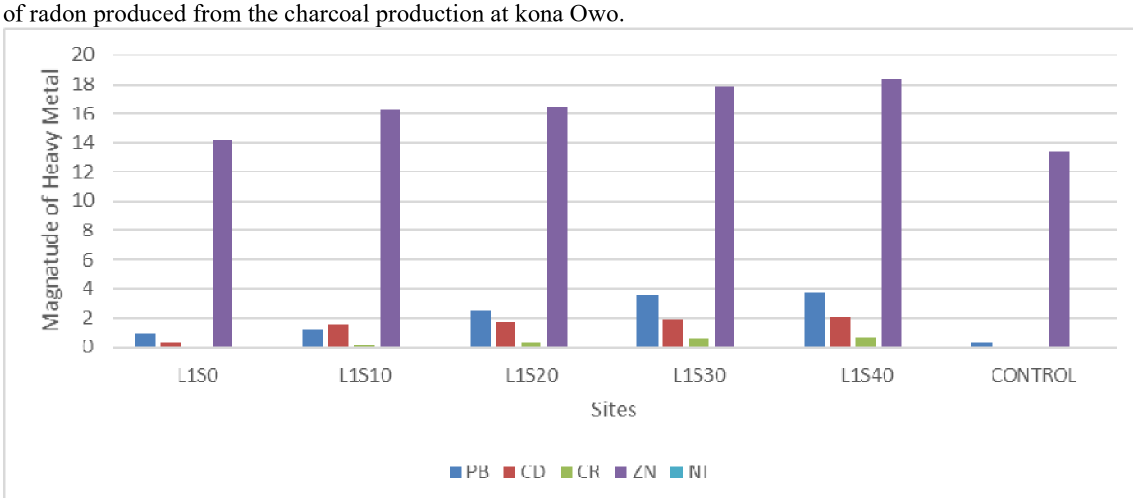


**Figure 1: Magnitude of heavy metals at Kona Owo.**

The graph below shows the magnitude of heavy metals that is present in the soil as a result of disintegration of radon produced from the charcoal production at Oje Owode.

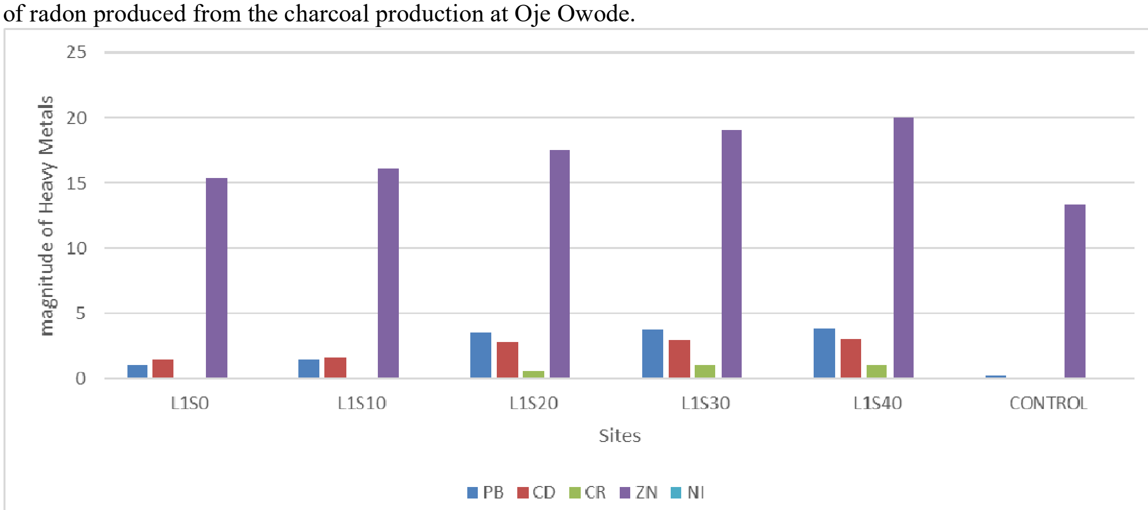


**Figure 2: Magnitude of heavy metals at Oje Owode**

 

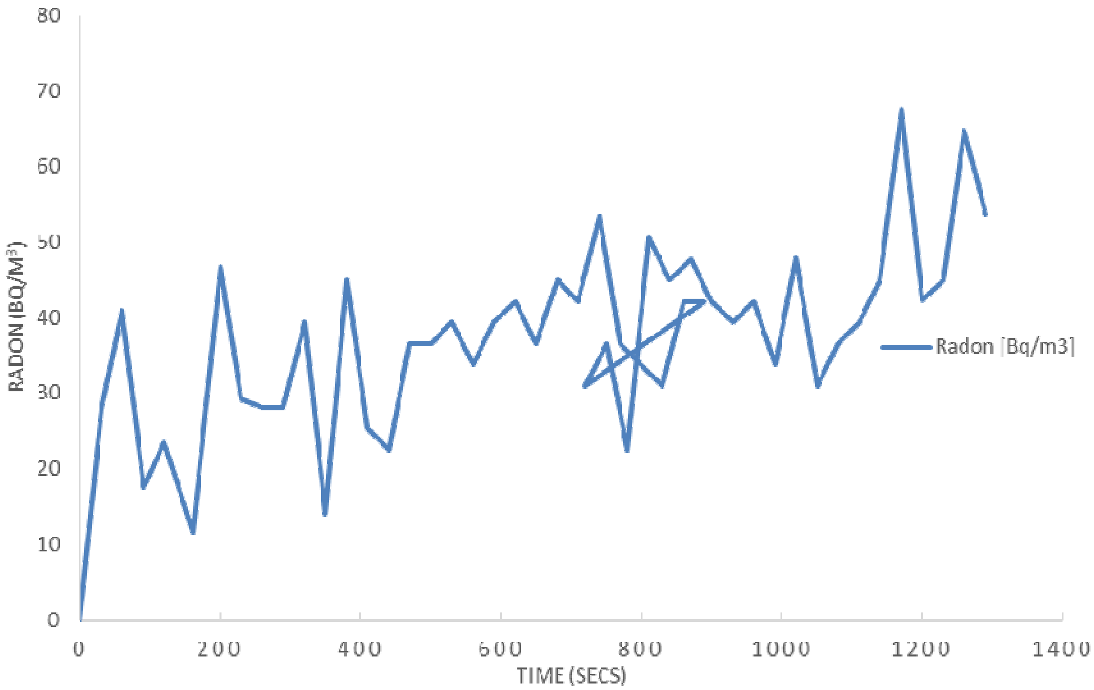


**Figure 3: Radon emission rate from *Vitellaria Paradoxa***