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Research Article

# Radioactive Sediment-Induced Hypertension and Cancer Risk; Possible Modification by *Podophyllum Peltatum* Leaf Extract

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## Abstract

Effluents due to local and unprotective mining activities can elevate concentration of primordial radionuclides and thus pose serious health threat to population of people living in the mining environment. The effect of the mining activities in the studied areas so far has been an environmental concern. Stream water, well-water and water sediments were collected around local mining area of Ijero-Ekiti, Ijero local government area in Ekiti State Nigeria. The activity concentration of the radionuclides were measured with gamma ray spectroscopy (GRS). The results of activity concentration of radionuclides obtained as mean activity concentration of plutonium $^{242}$Pu, uranium $^{238}$U and thorium $^{232}$Th in water sediments from dug wells are 1208.8 ± 216.6, 58.7 ± 6.7 and 117.1 ± 94.9 Bq $l^{-1}$ respectively which are significantly ($P < 0.05$) higher than that obtained from dug well-water (262.2 ± 18.7, 16.5 ± 1.0 and 17.2 ± 1.8 Bq $l^{-1}$) and earth surface stream water (226.3 ± 18.5, 14.5 ± 1.9 and 14.8 ± 1.5 Bq $l^{-1}$) respectively in same location. The results from this study suggest that effluents from local mining activities may have elevated the activity of primordial radionuclides in the study area and this potends high cancer and hypertension risk for the entire populace. However, antioxidant and anticlastogenic properties exhibited by *Podophyllum peltatum* plant in this study could possibly justify the plant as dietary supplement to salvage the health risks in local mining areas.

**Keywords:** Radionuclides; Activity Concentration; Water Sediments; Antioxidant; *Podophyllum peltatum*

## Introduction

Radiations in natural environment normally emerge from radioactivity in environmental physical features like rocks, ground water, rivers [1]. Natural radionuclides which are inimical to health were also detected and reported to be hugely present in the earth crust [2]. The presence of these radionuclides in the rocks, soil, and water results in continous human exposure to both external and internal radiations [3]. Uranium and Thorium are naturally occuring constituents of meteorites from which the earth agglomerate several years ago and through this phenomenon, geological forces such as volcanism had tremendous influence on these earth crust constituents [4]. Humans are constantly exposed to natural background radiations which are the naturally occuring radioactive radicals [5]. Several studies over the past decades focused on the local mining areas and hypothesized that the mining soils are the major radionuclide source while ground water from the mining

soil exhibits low radioactivity and contributes to dilution of gross alpha and gamma particle levels. Research has also shown that the specific levels of radiation in terrestrial environment are related to the geological composition of each lithological area as well as the content of Thorium and Uranium in the rock from which the soil originate [6]. Uranium occurs as trace element in the earth's crust and mostly in concentration of (1.0-10 ppm) in granite and in sediment of granitic origin while Thorium is mostly present in concentration between (3.0-30 ppm) in crustal minerals [3]. Weathering however breaks up accumulation of Uranium minerals into discrete grains and particles which are then washed into the valley and lakes. This has caused widespread dispersal of Uranium into the environment and underground water contains a complex of highly corrosive mixture of ions, radicals some of which are capable of forming soluble uranium compounds [4]. Besides, erosion usually move uranium particles and mixture of organic materials such as gases, bones, debris which tend to reduce the acidity of the ground water into nearby streams and this phenomenon has deleterious effect on the people in such environment as it often constitutes large source of mining related water pollution [7]. On the contrary, numerous in vitro and *In vivo* studies reported polyphenolic compounds from medicinal plants such as *Podophyllum peltatum* (may apple) protect against oxidative stress [8]. Many of the metabolites from such plants exhibit potent antioxidant and anticlastogenic properties. This study is concerned with evaluation of health burden of radioactive sediments from effluent in local mining area and possible modification by *Podophyllum peltatum* leaves as dietary supplements against hypertension and cancer risks which are fundamental effects of radioactivity.

## Materials and Methods

### Location and sample collection

The sampling site for this study was at Ijero-Ekiti, Ijero Local Government Area of Ekiti-State, Nigeria. Water and water sediments were collected from three (3) water streams and three (3) dug wells around the local mining site in Ijero-Ekiti. 10 samples of water and water sediments were collected at distance 200m, 400m and 600m at different points from each of the three located water streams and three dug wells in the study area. The water samples were taken to the laboratory in well labeled plastic bottles while the water sediments were in polythene bags. The farmers and people living in the community drink the stream and well water daily for survival.

### Sample preparation

The water sediment samples were dried at $100^0$C till constant weight to eliminate traces of water in the sediments. The sediment samples were pulverized and sieved with 2mm mesh to obtain homogenous particle size. 200g each of the samples was transferred into uncontaminated empty cylindrical plastic container of uniform size and were sealed for 28 days. This was done to allow radon and its short lived progenies to reach secular radioactive equilibrium prior to gamma spectroscopy and the water samples were filtered with grade 3 qualitative filter paper having pore size of 6µm. In addition, *Podophyllum peltatum* leaves were obtained from different local government areas in Ekiti-State. Identification and authentication screening were conducted at Herbarium Centre, Department of Agricultural Technology, Federal Polytechnic Ado-Ekiti. Thereafter the leaves were air-dried for 30 days at room temperature and were ground to fine powder and used for this study.

### Radioactivity measurement

A low-level gamma spectrometry system consisting of 76mm by 76mm NaI(TI) detector (Model No 802-series, Canberra Inc.) coupled with a Caberra series 10 and Multi-channel analyzer (Model No 1104) through preamplifier base were used for the measurement. The activity concentration of $^{214}$Bi determined from its 1.760 MeV gamma peak was chosen to provide an estimate of $^{238}$U in the sediments and water samples, while that of daughter radionuclide 208Tl determined from its 2.615 MeV gamma peak was chosen as an indicator of $^{232}$Th. $^{242}$Pu was determined by measuring 1.460 MeV gamma ray emitted during decay of $^{242}$Pu.

### Determination of chemical composition of *Podophyllum peltatum* leaves

### Phytochemical analysis

This was determined using method described by Odebiyi and Sofowora (1978).

### Nuclear magnetic resonance [NMR] of *Podophyllum peltatum*

Proton nuclear magnetic resonance of the oil extract of the plant was carried out after extraction with ethanol in a soxhlet apparatus and the solvent removed via rotary evaporator. The NMR spectra were recorded in CDCl3 on a bunker AVANCE DPX spectrometer operating at 300MHz for 'H' chemical shift [ð] are given in ppm relative to the internal standard tetramethyl saline {TMS, ð=0.00ppm}.

### Hydroxyl- radical [OH*] scavenging assay

The ability of the plant extract to scanvenge hydroxyl radicals was determined using method described by Halliwell and Gutteridge (1981).

### Nitric-oxide [NO*] radical scanvenging assay

The ability of the plant extract to scavenge nitric oxide radicals was determined using method described by Jagetia and Baliga [9].

## Results

| | No of Samples | Activity | Concentration | (Bq/L) | | |
|---|---|---|---|---|---|---|
| S/N | | $^{242}$Pu | $^{238}$U | $^{232}$Th | U/Th | Th/U |
| Stream 1 | 10 | 242.7 ± 7.7 | 15.8 ± 0.3 | 16.5 ± 0.5 | 0.96 | 0.93 |
| | | 230.7-251 | 16.3-2.3 | 16.3-17.0 | | |
| Stream 2 | 10 | 229.9 ± 63.1 | 15.4 ± 4.1 | 14.4 ± 0.5 | 1.07 | 0.94 |
| Stream 3 | 10 | 206.2 ± 7.7 | 12.3 ± 0.3 | 13.6 ± 4.0 | 0.90 | 1.02 |
| | | 202.4-212 | 11.8-12.5 | 12-14.7 | | |

**Table 1:** Mean and range of activity concentrations of 242Pu, 238U and 232Th in water samples from streams around a local mining area at Ijero-Ekiti.

| | No of Samples | Activity | Concentration | (Bq/L) | | |
|---|---|---|---|---|---|---|
| S/N | | $^{242}$Pu | $^{238}$U | $^{232}$Th | U/Th | Th/U |
| Dug well 1 | 10 | 283.2 ± 72.7 | 17.4 ± 5.8 | 18.7 ± 5.0 | 1.04 | 1.08 |
| | | 281.3-285 | 15.5-18.8 | 18.3-19.6 | | |
| Dug well 2 | 10 | 255.9 ± 56.4 | 16.7 ± 4.8 | 17.8 ± 6.6 | 0.94 | 1.07 |
| | | | | | | |
| Dug well 3 | 10 | 247.5 ± 56.7 | 15.5 ± 5.2 | 15.2 ± 3.7 | 1.11 | 1.00 |
| | | 210-295 | 14.3-16.4 | 13.3-16.9 | | |

**Table 2:** Mean and range of activity concentrations of 242P, 238U and 232Th in dug well water samples around a local mining area at Ijero-Ekiti.

| | No of Samples | Activity | Concentration | (Bq/L) |
|---|---|---|---|---|
| S/N | | $^{242}$Pu | $^{238}$U | $^{232}$Th |
| Dug well 1 | 10 | 1958.1 ± 5.2 | 112.0 ± 2.4 | 157.3 ± 2.0 |
| | | 1950.2-1965.3 | 107.6-115.5 | 154.9-160.3 |
| Dug well 2 | 10 | 1385.1 ± 8.4 | 48.7 ± 1.8 | 178.5 ± 39.7 |
| | | 1380.5-1389.9 | 47.6-49.8 | 177.7-179.9 |
| Dug well 3 | 10 | 283.18 ± 72.66 | 15.54 ± 5.22 | 15.22 ± 3.73 |
| | | 281.33-284.55 | 14.30-16.42 | 13.31-16.91 |

**Table 3:** Mean and range of activity concentrations of 242Pu, 238U and 232Th in water sediment samples from dug well around a local mining area at Ijero-Ekiti.

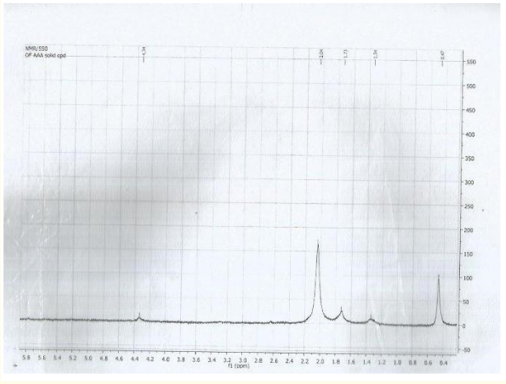

**Figure 1:** Nuclear Magnetic Resonance of Extracted Oil of Podophyllum peltatum Plant.

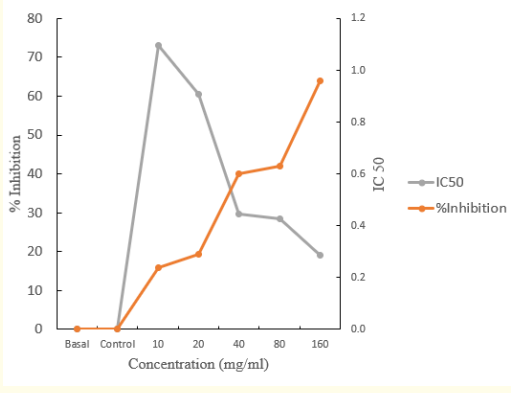


**Figure 2:** Nitric Oxide Scavenging Ability of Podophyllum peltatum Leaf Extract.

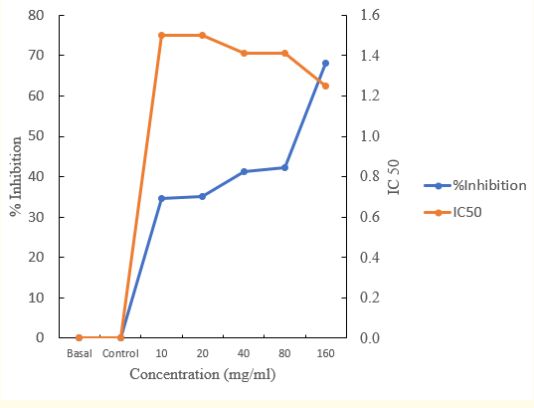


**Figure 3:** Hydroxyl radical Scavenging Ability of Podophyllum peltatum Leaf Extract.

## Discussion

Radiations are generally recognized as potent physical mutagens and carcinogens which have very high propensity to mutate and induce cancer in the living cells. However, the results of radioactivity measurement on activity concentration of the primordial radionuclides in water samples and water sediment samples from the stream water, well-water and sediments from dug wells around a local mining site in Ijero-Ekiti under this study is of great concern. The sediment samples in the dug wells exhibit higher activity concentration of $^{242}$Pu, $^{238}$U and $^{232}$Th. The depth factor may have contributed to the elevated activity concentration of the radionuclides compared to the stream water which runs on the surface. Besides the mean activity concentrations of the sediment samples obtained in this study are higher than the values reported by [10,11] and [12] in the assessment of borehole water. However, the high mean values of radionuclides observed in this study might be attributed to myriad of effluents due to the mining activities in the study area. This development potends danger and health risk for the populace in the study area. The radioactive nuclides could penetrate and mutate the cellular cytochemical composition of the inhabitants, thus inducing proliferation of abnormal mutated cancer cells which could later manifest as cancer such as leukemia, hepatocarcinoma, myomas, burkitt lymphoma e.t.c. On the contrary, research findings on folk medicine conducted on *Podophyllum peltatum* plant leaves demonstrated promising protective potential against hypertension and cancer risks. The phytochemical and mineral analyses conducted on this plant sample revealed appreciable concentration of saponin, flavonoids and phenolics compounds which are potent antioxidant and free radical scavengers [13]. Besides, saponin (15mg/100g) and (0.467) sodium to potassium [Na/K] ratio which are required for proper functioning of nervous system and as well play important physiological role in regulating blood pressure were obtained from Tapinanthus globuferus leaf extract. It has since been recommended that Na/K ratio less than 0.60 will prevent high blood pressure [14]. In addition, the extracted oil from the plant analyzed via the nuclear magnetic resonance (NMR) in Figure 1 above reveals appreciable amount of organosulphur and phenolics compounds which suggest that the plant would be suitable anticarcinogen and antioxidant supplement against cancer, hypertension as well as other oxidative stress related diseases. The plant extract also demonstrated antioxidative potential against hydroxyl and nitric oxide radicals where its inhibitory and antioxidative potentials increased with increase concentration. This could be attributed to its inherent tocopherol and phenolic constituents which are capable of donating electrons to hydrogen atoms to neutralize peroxyl and other damaging free radicals thus, protecting

biological membrane system [15-17]. However, the results of this study justify the high level of exposure to health risk by people living around local mining areas and as well suggest *Podophyllum peltatum* plant as possible dietary supplement against hypertension and cancer risk.

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