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ELEMENTAL AND RADIOACTIVITY LEVELS IN SOILS AROUND TRANSFORMERS IN AKUNGBA-AKOKO, NIGERIA

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ABSTRACT
This work was carried-out in order to determine the level of some elements and the activity concentration of some radionuclides in soils around transformers in Akungba town. 9 Soil samples were taken beside transformers and 1 from a location with no transformer. Locations were determined with global positioning system. All samples were taken from a depth 5 cm below the topsoil. All the soil samples were analysed with Gamma ray spectrometry (with NaI thallium activated detector) for radioactivity level, while 3 of the soil samples were analysed with Energy Dispersive X- ray Fluorescence Spectrometry for elemental analysis. Out of the mean activity concentrations of ^{238}U, ^{232}Th and ^{40}K, only ^{40}K was higher than United Nations Scientific Committee on Effects of Atomic Radiation permissible limit. In elemental analysis, Iron was higher than United States Environmental Protection Agency Residential Soil Screening level (USEPA) in all the locations investigated; Manganese and Copper were both higher than USEPA in soil S5; and Manganese in S9 and Copper in S6 were higher than their USEPA standard. Residents in these areas, mostly children, who play on these soils and ingest them, are susceptible to hazardous health effects of ^{40}K and these elements with high concentration.

INTRODUCTION
All elements in nature can be classified as metals or non-metals based on a criteria like physical properties. (Oketayo *et al*., 2011). From physical properties, metals are generally a large group of substances that are opaque, form alloys, conduct heat and electricity, and are malleable. More than 80 of the 125 known elements fit this definition (Oketayo *et al*., 2011).

Metals were further classified based on heaviness. Heavy metals are elements with specific gravity greater than 4g / cm^3 (Davies, 1978; Duffus, 1980). Some metals are also termed Radioactive: these are metals with unstable nuclei.

Heavy metals reach the soil surface most times through anthropogenic activities. Example, spilled on soil metal-contaminated transformer oil and metal mining, while radioactive elements are relatively distributed based on the geological formation of the soil (Al-Jundia *et al*., 2003; Orabi *et al*., 2006).

Transformer oils gets metal-contaminated via wear and tear of transformer parts, and enters the environment through poor handling of damaged electrical equipment, leakages, spillage during retro filling (Bentum *et al*., 2012).

Once metals become part of biogeochemical cycle, they may accumulate in the various cycle-media and ultimately transfer into man through oral intake, skin and inhalation.

Akungba Akoko is a part of Akoko southwest in Ondo State Nigeria, where soil surface are underlie by Precambrian Basement Complex rocks. Thus making the place not immune from the exposure of primordial sources of radiation. Again, most electricity transformers are located around residential areas, the metal-contaminated transformer oil can get in contact with surrounding soil; and gets into human. There is therefore a dire need to determine the elemental and radioactivity levels in soils around transformers in the study area, to authenticate the safety of the residents from hazardous effects of these elements.

MATERIALS AND METHODS

Site Description

The sampling sites were within Akungba town. The sites were identified with Geographical Positioning System.

Sample Collection

Soil samples (each of about 700 g) were taken around transformers (at a depth of 5 cm) in nine locations and in one with no transformer. The soils were dug with clean knife and were packed with gloved-hand into polythene bags. The samples were labeled properly for easy identification.

Elemental and Radioactivity Level Determination

Energy dispersive X-ray fluorescence (EDXRF) spectrometry was used to determine elemental concentration. The sun-dried soil samples were at first ground with pestle and mortar to fine powder.

The ground soil was pelletized with hydraulic press operating at 8 to10 kgf. The cylindrical-shaped soil pellets were transferred into the sample chamber of the EDXRF spectrometer. The operation of the EDXRF was discussed somewhere else (Adejumo *et al*., 2014).

For activity concentration of soil samples, gamma ray spectrometry technique with NaI(Tl) scintillation detector was used. The sun-dried soil samples were sieved with 2 mm mesh screen. Then, 500g of each soil samples were poured into beakers - previously washed with diluted hydrogen tetraoxosulphate (VI) acid (H_2SO_4) and dried to avoid contamination. They were later sealed for about four weeks to allow the parent radionuclides achieve secular equilibrium with their respective daughter nuclides.

The Detector setting, calibration of spectrometer, counting of samples and calculation of activity concentration in samples were done as reported somewhere else (Famuti, 2013).

RESULTS AND DISCUSSION

Table 1.0: Concentration of Elements in Soil Samples

Elements (ppm)	Study Soil (S5) (N07^{0}28'29.6" E005^{0}44'12.6")	Study Soil (S6) (N07^{0}28'45.2" E005^{0}44'01.8")	Control Soil (S9) (N07^{0}28'22.3" E005^{0}43'54.05")	USEPA, 2016
Fe	151823 ± 468	156039± 531	126355 ± 483	5500
K	41654 ± 693	43567 ± 799	64566± 483	NI
Ti	14452± 254	9627 ± 234	18433 ± 329	NI
Cu	377± 254	403 ± 26	21 ± 1	310
Mn	2528± 58	1645 ± 46	2412 ± 57	1900

NI: Not Indicated

According to table 1.0 Potassium concentration was higher in S9 than in S5 and S6; Manganese concentration in S5 and S9 was higher than in USEPA; and Titanium concentration was high in S5 and S9. The above listed metals concentration were higher than values obtained by Adejumo *et al*., 2014 in soil (0-15cm depth) in another part of the area (Ondo State southwest, Nigeria) where this present study was carried out. What could be suggested for the wide margin in concentrations of these metals and that of Adejumo *et al*., (2014), is geological formation of the soils. The Geology of the soil was thought-of as the major source of the concentrations of these metals because the control soil concentration (which is geological area with study sites) was having values almost the same or above the study sites concentration.

Concentrations of Iron and Copper in the study samples (S5 and S6) were higher than in control sample (S9) and USEPA. This suggests that Iron and Copper concentration were from anthropogenic activity and geological formation of the soil. These sources were suggested because the study samples and the control sample are in same

geological area, so, the only reason for the disparity in concentrations of these metals, (in study sites and control) would be contribution coming from anthropogenic activity such as metal-contaminated transformer oil.
Aderonke *et al*., 2011 obtained Iron concentration of (111400± 19.4 mg/kg) at Itagunmodi in Nigeria. This is not suprising because the soil is derived from amphibolites and related basic rocks

Table 2: Comparison of the range of activity concentrations of ^{238}U, ^{232}Th and ^{40}K in this study with those from other countries and World's Average

Country	Activity concentration (Bq/kg)			Reference
	^{238}U	^{232}Th	^{40}K	
Saudi Arabia	14.5	11.2	225	Alaamer.,(2008)
Canada (Saskatchewan)	19	8	480	Kiss *et al*., (1988)
South India	35	29.8	117.5	Narayang *et al*., (2001)
Republic of Ireland	60	26	350	MacAulay and Morgan (1988)
World's average	35	30	400	UNSCEAR, 2000
Akungba-Akoko	22.84	10.23	401.79	This study

From table 2, only concentration of pottasium-40 was higher than world's average, other radionuclides were below the world's average. Potassium 40, a primordial radionuclide, would have emanated alone from the geological formation of the area.

CONCLUSIONS

The elemental and radioactivity levels of some metals in soils around transformer in Akungba-Akoko have been determined. Pottasium, titanium concentration and Manganese high concentration in study sites were suggested to have emanated from geological formation of the soil. Iron and copper high concentrations in study sites were suggested to come from geological formation of the soil and anthropogenic activity like metal-contaminated transformer oil.

Potassium-40, which was the only radionuclide with the concentration higher than world's average, was suggested to have emanated from geological of the study area.

Residents in these areas, mostly children, who play on these soils and ingest them, are susceptible to hazardous health effects of ^{40}K and these elements with high concentration.

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