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Preliminary investigation of naturally occurring radionuclides in some traditional medicinal plants used in Nigeria

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ABSTRACT

The preliminary investigation of the activity concentration of Naturally Occurring Radioactive Materials (NORMs) in seven different medicinal plants; *Anacardium occidentale*, *Azadirachta indica*, *Daniella oliveri*, *Moringa oleifera*, *Psidium guajava*, *Terminalia catappa* and *Vitellaria paradoxa* by means of gamma spectroscopic analysis using a NaI(Tl) detector shows that the activity concentration of ⁴⁰K in the medicinal plants ranges from 74.59 ± 2.19 Bq/Kg to 324.18 ± 8.69 Bq/Kg with an average of 171.72 ± 6.09 Bq/Kg. The highest activity concentration of ⁴⁰K was recorded for *A. indica* while *A. occidentale* had the lowest activity concentration. ²²⁶Ra activity concentration varies from 10.79 ± 4.24 Bq/Kg to 42.47 ± 2.76 Bq/Kg with an average of 25.02 ± 3.18 Bq/Kg. The lowest activity was recorded for *P. guajava* while the highest activity was recorded for *V. paradoxa*. For the activity concentration of ²³²Th, it ranges from 27.76 ± 1.02 Bq/Kg to 41.05 ± 1.05 Bq/Kg, with an average of 35.09 ± 0.71 Bq/Kg. The lowest activity was recorded for *V. paradoxa* while the highest activity was recorded for *T. catappa*. The average annual committed effective doses due to ingestion of ²²⁶Ra, ²³²Th and ⁴⁰K in the plants ranges from 0.00426 ± 0.00050 mSv/yr to 0.00686 ± 0.00044 mSv/yr with an average of 0.00538 ± 0.00035 mSv/yr, the highest value was recorded for *A. occidentale* while *P. guajava* has the lowest, the results determined for all the plants are far below the worldwide average annual committed effective dose of 0.3 mSv/yr for an individual provided in UNSCEAR 2000 report indicating that the associated radiological health risk resulting from the intake of radionuclides in the medicinal plants is insignificant. Consequently, the medicinal plants of this study are considered safe in terms of the radiological health hazards.

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1. Introduction

Emphasis on plant research has increased in recent times, and a large body of evidence has been collected to show the substantial potential of medicinal plants used in different traditional systems all over the world. About 70–80% of the world population, particularly in the developing countries rely on non-conventional medicine in their primary healthcare (Chan, 2003; Desideri, Meli, & Roselli, 2010). Natural radionuclides are found in every constituent of the environment; air, water, soil, food and in humans (WNA, 2014).

According to the International Food Safety Authorities Network (INFOSAN, 2011), plants used as food commonly have ^{40}K , ^{232}Th and ^{238}U and their progenies. It is expected that similarities would be found in plants used for medicinal purposes since plants are the primary pathway of natural radionuclides entering into the human body through the food chain. In a variety of concentrations, Naturally Occurring Radioactive Materials (NORMs) have always been present in every part of the earth and in the tissue of all living beings. Natural radionuclides such as ^{238}U , ^{232}Th and ^{40}K can be found almost everywhere; in soil, public water supplies, oil and atmosphere thereby subjecting human beings to reasonable exposure (Ali, 2008; Varier, 2009).

The role of NORMs in animal and plant metabolism has long been established, but their effect and influence on administration of medicinal plants had received relatively little attention without due regard to possible side effects because they have been perceived to be in smaller quantities meanwhile mankind has continually use traditional herbal medicine from medicinal plants for the treatment of various diseases and ailments (Odugbemi, 2006, Odugbemi & Akinsulire, 2008; Okoli, Aigbe, Ohaju-Obodo, & Mensah, 2007; Oladipo, Njinga, Baba, & Muhammad, 2012).

In Nigeria today, the use of herbal medicines for therapeutic purposes has increased drastically due to the fact that medicinal plants are cheap, readily available and widely distributed. Apart from the high cost of procuring available allopathic medicines for treating even common health disorders, other reasons for this shift are inaccessibility of health institutions in the rural or remote locations in the country and growing awareness of adverse reaction to some allopathic drugs. Besides, Nigeria being in the tropics, has forest that are full of cheap, easily available and sustainable medicinal plants which can be used and have always been used for the treatment of various diseases (Oni, Isola, Oni, & Sowole, 2011).

The therapeutic effect of these medicinal plants for the treatment of various diseases are based on the organic constituent (such as essential oil, vitamins, glycosides, etc.) present in them (Desideri, Meli, & Roselli, 2009; Lordford, Emmanuel, Cyril, & Alfred, 2013), although, certain inorganic elements (example Al, Br, Ca, Cl, Mn, Mg, etc.) have been considered as essential in the formation of active constituent which are responsible for the curative properties of the medicinal plants (Serfor-Armah et al., 2003). It has been established (Rajurkar & Pardesh, 1996) that there exists a relationship between chelating agents (removal of metals) and some chemotherapeutic agents. The effect of herbs is

related to their trace elements and their absorption into the blood (Rajurkar & Pardesh, 1996).

During the process of photosynthesis both the stable inorganic elements and the unstable ones (radioactive element) find their way into these plants. Natural radionuclides are transferred and cycles through natural processes and between the various environmental compartment by entering into the ecosystem and food chain through direct or indirect contamination of natural radionuclides (Adewumi, 2011; Elujoba, Odeleye, & Ogunyemi, 2005). It is possible for plants to absorb radionuclides during nutrient absorption through their roots and transport such nutrients via their phloem to their active portions. The rate of natural radionuclides uptake is highly dependent on the activity concentration in the soil. The root uptake depends on soil properties such as pH, mineralogical composition, organic matter content and nutrient status as well as metabolic and physiological characteristics of the plant species (IAEA, 2006). Plants uptake of radionuclides is one of many vectors for the migration of natural radionuclides into humans from the environment via the food chain. The study of the natural radionuclides levels of medicinal plants in the environment are of interest within plant evolution and thus provide information in the monitoring of environmental radioactivity (Lordford et al., 2013). However, the study of NORMs in plants is not only important because of the risk associated with it but also from the fact that some of them can be used as biochemical tracer in human food chain (Al-Kharouf, Al-Hamameh, & Dababneh, 2008; CNSC, 2013).

The role of natural radionuclides in plant and animal metabolism has been established and available in literature. However the effect and influence of these natural radionuclides on administration of medicinal plants had received little attention (Durugbo, Oyeteran, & Oyejide, 2012). The possible side effects due to the intake of these medicinal plants or herbal plants are not considered in the group of edible plants that have been studied in the past by nutritionist. Notwithstanding, many edible plants used as spices or fruits such as ginger, onion, papaw and mango etc., have medicinal properties and the ingestion of NORMs through the use of plants had not been recognized or considered significant in terms of quantity (Harb, 2009; Lordford et al., 2013; UTEHS, 2014). Epidemiological studies have not demonstrated adverse health effects in individuals exposed to small doses (<0.1 Sv) delivered in a period of many years with the exception of radiogenic health effects (primarily cancer) which is evident in epidermiological studies for only doses exceeding 0.05–0.1 Sv delivered at high dose rates (HPS, 2004; Morah, 2007).

The linear non-threshold (LNT) model indicates levels of risk to all levels of radiation (ICRP, 2005). Some scientists considered that since humans evolved and survived through this evolutionised environment which consists of some levels of radiation, some low levels of radiation are beneficial to the human (Cutler, 2004). However, medicinal plants are usually administered in raw forms or in formulations such as solutions, tablets or capsules. Undeniably, the activity concentrations of NORMs in herbal formulations are quite lower than in raw plants due to the preparation processes which inevitably remove some of the

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