Journal of Radiation and Nuclear Applications
An International Journal

http://dx.doi.org/10.18576/jrna/070102

Identification of Medical and Industrial Used Radionuclides in Dumpsites across Lafia Town, Nasarawa State, Nigeria

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Revised: 3 Sep. 2021, Revised: 27 Oct. 2021, Accepted: 19 Nov. 2021.
Published online: 1 Jan 2022.

Abstract: This research intends to unveil the presence of radionuclides in dumpsites across Lafia Town of Nasarawa state using thermos-scientific interceptor (IdentiFINDER). The presence, types and trust level of radionuclides was found using stratified random sampling technique. The grid of the study area was defined within the range of 50 x 25 meter. In each data point, the type of radionuclides and their respective trust level were obtained. From the observation and results, it was seen that 103Pd was found in 39% of the total points with trust level of 50-67%, 109Cd was found in 19% of the total points with trust level of 50-72%, 241Am was found in 9% of the total points with trust level of 61%, 125I was found in 20% of the total points with trust level of 54-86%, 131I was found in 3% of the total points with trust level of 55-71%, 75Se was found in 6% of the total points with trust level of 60% and 57Co was found in 4% of the total points with trust level of 71%. Based on the high trust level of these radionuclides, they can be harness and apply appropriately in medicine and industry.

Keywords: Radioisotopes; Industrial; Medical; IdentiFINDER; thermos-scientific Interceptor; Radiation.

1 Introduction

Radioisotopes are elements having the same atomic number but different atomic weights. For example, ^{I3I}I, ^{I25}I, ^{123}I are all isotopes of the same element [1]. Their chemical and biological behaviors are expected to be identical [2]. The slight differences in the weights, that they have, is due to differences in the number of particles that they hold inside the nucleus. Some isotopes are perturbed by this kind of change in the nuclear structure [3]. They become unstable, and emit radiation till they reach stable state. These are called radioisotopes [4]. Importance of radioisotopes in medicine is because of their two characteristics: their biological behavior is identical to their stable counterparts, and because they are radioactive their emissions can be detected by a suitable instrument [5]. Studying the levels of radionuclide distribution in the environments provides essential radiological information [6]. Natural radioactivity originates from extraterrestrial sources as well as from radioactive elements in the earth crust [7]. About 340 nuclides have been found in nature, and more than 60 of these are radioactive [8]. All elements having an atomic number greater than 80 possess radioactive isotopes, and all isotopes of elements heavier than number 83 are radioactive [9]. The natural radio activities of the earth are categorized into primordial, secondary and Cosmo genic radionuclides [10]. The primordial nuclides which now exist are those that have half-life at least comparable to the age of the universe. Radionuclides with half-life greater than 1010 years have decayed very little up to the present time [11]. All isotopes of iodine will behave in the same way and will concentrate in the thyroid gland [12]. There is no way of detecting the stable, natural iodine in the thyroid gland, but the presence of radioactive iodine can be detected externally in vivo by a detector [13]. Thus, the radioactive iodine becomes a tracer, a sort of a spy, which mimics the behavior of natural iodine and relays information to a detector [14]. The radioactive tracers are popular because of the ease with which they can be detected in vivo and the fact that the measurement of their presence in the body can be in quantitative terms. The measurement can be very accurate and sensitive [15]. The radioisotopes are physical entities and their radiations and measurements are characterized by

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laws of physics. Hence, the knowledge of nuclear physics is needed for practicing Nuclear Medicine [16]. It is no more or no less than learning the morphological and biochemical characteristics of microorganisms. Doctors are used to learn as much as possible about the tools of their trade. Nuclear Medicine is usually defined as a "clinical specialty devoted to diagnostic, therapeutic and research applications of internally administered radionuclides.". Diagnostic implies both in vivo and in vitro uses [17]. In modern times, there is hardly any medical research, where a radioactive tracer is not used in some form or other [18]. Normally basic medical research is not considered as nuclear medicine, but clinical research applications of radioisotopes are considered as an integral part of this specialty [19]. Same thing holds true for nuclear physics in relation to the practice of nuclear medicine. The approach in this work is also to give few salient facts, which one needs to know, in actual day-to-day practice of nuclear medicine [20]. When we detect radioactivity, there is some component of it, which is arising from the background radiation. Most of these comes from naturally occurring radioactivity in the soil. Procedures designed to answer these questions with the use of radioisotopes form the basis of Nuclear Medicine [21]. Radiation discovered more than a century ago has found many vital applications in medical and industrial spheres. Radiotracer technology has become an integrated part of multi-disciplinary investigation in oil fields for oil reservoir evaluation [22].

In medicine, ^{57}Co is used as marker to estimate organ size also used as a tracer to diagnose pernicious anemia, ^{75}Se is a radiotracer used in brain studies scintigraphy scanning study of the production of digestive enzymes, ^{103}Pd is used in brachytherapy for early prostate cancer, ^{109}Cd is used in cancer detection and pediatric imaging, ^{125}I is used in cancer brachytherapy (prostate and brain) filtration rate of kidneys, can also be used as a major diagnostic tool used in clinical tests and to diagnose thyroid disorders [23]. Also used in biomedical research and ^{241}Am is used in osteoporosis detection and heart imaging [24]. While in industry, ^{57}Co is used to locate pipeline blockages [25], ^{241}Am is used in many smoke detectors for homes and businesses, to measure levels of toxic lead in dried paint samples, to ensure uniform thickness in rolling processes like steel and paper production and to help determine where oil wells should be drilled [26], ^{109}Cd is used to analyze metal alloys for checking stock and scrap sorting [27], ^{75}Se is used in protein studies in life science research [28] and ^{235}U is used a fuel for nuclear power plants and naval nuclear propulsion systems and used to produce fluorescent glassware, a variety of colored glazes and wall tiles [29].Studies of the same kind have been conducted in different parts of Nigeria to assess the radionuclide distribution and their respective trust level but there had never been evidence of research to assess the radionuclide distribution and their respective trust level in Lafia dumpsites. Therefore, this research unveils the presence of the above stated radionuclides in soil from some dumpsites as well as their trust level (which indicates their availability in the study area) in Lafia Town, using thermos-scientific interceptor (identiFINDER) obtained from Nigerian Nuclear Regulatory Authority (NNRA).

2 Materials and Methods

2.1 Materials

The materials that were used in the field for the Identification of Medical and Industrial Used Radionuclides in Mining Sites AcrossLafia Town can be shown in Table 1.

Table 1: Materials, their Specifications and uses.

Materials	Specifications	Uses
Thermo Scientific Interceptor	(ii) A High-efficiency Cadmium Zinc Telluride (CZT) finder Detector, with dimension 122mm x 68mm x 30mm, resolution of 7mm x 7mm x 3.5mm (0.3in x 0.3in x 0.15in) CZT identification detector, with ^{3}He Neutron detection at 8atm., 13-mm diameter x 66m (0.5in dia x 2.6in) at 1.2 cps/nv. It has dose rate of High performance, 1024-channel DSP-based MCA with energy compensation dose rate algorithm on finder detectors and operating temperature range of -20^{0}C to +50^{0}C (-4^{0}F to +122^{0}F) at up to 95%RH at 95^{0}F with energy range of 25KeV to 3MeV and sensitivity of 1.5cps/µR/h, 1.2cps/nv.	This is used to detect the radionuclides as well as their trust level
Map of Mararraba-Udege	Google map	This provide names and directions of the area.
Measuring Tape	Steel type	This is for measuring grid size.
Global Positioning System (GPS)	15m horizontal (50 ft)	Used to take coordinates of sample points.

2.2 Method

2.2.1 The Study Area

This research work centered on Lafia Town of Nasarawa State. The coordinates of the study area are tabulated in Table 2. Map of the study area is presented in Figure 1.

Table 2: Sample Points and their Locations.

Sample Point	Sample Coordinates	
	North	**East**
Lafia Modern Market	$8^0$29'31.359	$8^0$31'44.403
Opposite Governor Isah House	$8^0$29'08.491	$8^0$31'52.682
Timber Shade Lafia	$8^0$29'51.372	$8^0$30'49.266
Science School Lafia	$8^0$30'11.385	$8^0$30'45.369

Fig. 1: Map Showing Sample Location in Lafia Town.

2.2.2 Method Data Collection

A stratified random sampling technique was adapted. The grid of the study area was defined in a range of 50×25 meters grid. In each data point, the type of radionuclides and their respective trust level are obtained. The procedure was made following the recommendations of technical documents of some Regulatory Agencies such as IAEA and NNRA which cover all aspects of the uranium mining industry, from exploration to exploitation, decommissioning and the application of techniques in other non-uranium resource areas. The measurements were done using a portable gamma spectrometer (i.e. thermos-scientific interceptor), which carries out qualitative and quantitative analysis of gamma radiation using a Cadmium Zinc Telluride (CZT) detector.

3 Results and Discussion

3.1 Results

The data collected from different dumpsites such as radionuclides with their respective trust level are presented in Table 3.

Table 3: Radionuclides and Trust Level from the Study Area.

PointCode	Radionuclide I	Trust Level (%)	Radionuclide II	Trust Level (%)
LMM 1	Med-I-131	71	Med-Pd-103	57
LMM 2	Med-Pd-103	58	Ind-Cd-109	60
LMM 3	Med-I-131	67	Med-I-125	82
OGIH 1	Med-I-125	79	Med-Pd-103	66
OGIH 2	Med-Se-75	60	Ind-Co-57	74
OGIH 3	Med-I-125	54	Ind-Cd-109	72
TSL 1	Med-Pd-103	67	Ind-Pd-103	50
TSL2	Ind-Am-241	61	Ind-I-131	55
TSL 3	Med-I-125	72	Med-Pd-103	51
SSL 1	Med-I-125	61	Med-Pd-103	65
SSL 2	Med-I-125	66	Med-Pd-103	71
SSL 3	Med-I-125	86	Med-Pd-103	82

SSL = Science School Lafia; TSL = Timber Shade Lafia; OGIH = Opposite Govonor Isa House; LMM = Lafia Modern Market.

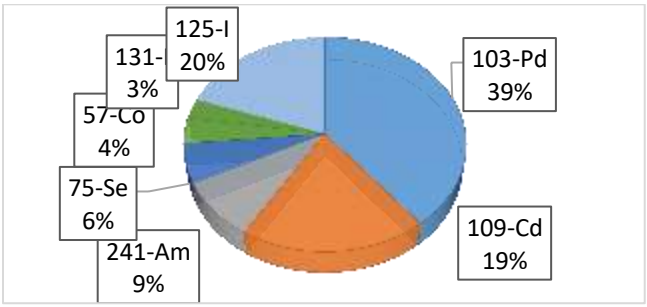

Fig. 4.1 Radionuclides and Percentage per Total Area under Study.

3.2 Discussion

The results of the Identification of Medical and Industrial Used Radionuclides in Dumpsites across Lafia Town using Thermo-Scientific Interceptor CTZ Radionuclide IdentiFINDER Detector was presented in Table 3. The analysis was done using a chart as presented in Figure 2. Seven radionuclides were found to be distributed across the twelve point under study. These radionuclides are Palladium-103, Iodine-125, Iodine-131, Cadmium-109, Americium-241, Selenium-75 and Cobalt-57. From the findings presented, it is possible to see that ^{103}Pd was found in 39% of the total points with trust level of 50-67%, ^{109}Cd was found in 19% of the total points with trust level of 50-72%, ^{241}Am was found in 9% of the total points with trust level of 61%, ^{125}I was found in 20% of the total points with trust level of 54-86%, ^{131}I was found in 3% of the total points with trust level of 55-71%, ^{75}Se was found in 6% of the total points with trust level of 60% and ^{57}Co was found in 4% of the total points with trust level of 71%. Therefore, the trust level of the device indicate that the radionuclides used for both medical and industrial purpose found in the study area are most likely present.

4 Conclusions

The findings of this work shows that, the trust level of the radionuclides for both Medical and Industrial uses found in most of the areas under investigation are high. This high trust level indicate that these radionuclides are embedded

in those areas can be harness and put to appropriate use in their area of usage as stated in Table 3 since they are highly demanded in our various hospitals and industries. It is therefore recommended that, the government should look for a way of sponsoring researchers to enable them engage in researches on the possible ways to extract these radionuclides for use in our various hospitals and industries instead of importing them from foreign countries.

Acknowledgement

Praise is to our creator, Lord of the worlds, the Eternal Guardian of the heavens and earths, Disposer of all created beings. Whom through His blessings upon us, we were able to successfully complete this research work.

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