

# SHORT HALF LIFE RADIONUCLIDE IN SOILS AND FLORA NEAR INDUSTRIAL AREA IN KLANG, SELANGOR, MALAYSIA

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## ABSTRACT

*Heavy industries as well as densely populated areas are contributing to anthropogenic activities, which in turn if not managed well, could impact the environment and health of the populations. The objective of this study is to determine the key contaminants into the environment of Klang District due to anthropogenic activities. Samples were collected on nine different locations in Klang Districts including soil samples as well as flora samples which are edible crops that are usually harvested for cooking or human consumption and decorative tree leaves. The samples were analyzed using Neutron Activation Analysis techniques.*

## ABSTRAK

*Industri berat serta kawasan berpenduduk padat menyumbang kepada aktiviti antropogenik, yang jika tidak diurus dengan baik, boleh memberi kesan kepada alam sekitar dan kesihatan penduduk. Objektif kajian ini adalah untuk menentukan bahan cemar utama ke dalam persekitaran Daerah Klang akibat aktiviti antropogenik. Sampel dikumpul di sembilan lokasi berbeza di Daerah Klang termasuk sampel tanah serta sampel flora yang merupakan tanaman boleh dimakan yang biasanya dituai untuk memasak atau makanan manusia dan daun pokok hiasan. Sampel dianalisis menggunakan teknik Analisis Pengaktifan Neutron.*

**Keywords:** anthropogenic, neutron activation analysis, edible crops

## INTRODUCTION

Environmental pollution due to heavy industrial activities is the main concern of the Malaysian Government. Taking into consideration the incident that happened at Kim-Kim River in 2019 have opened the eyes of Malaysians to take them seriously and proactive in protecting the environment they lived in [1]. In recent years, due to the increase in high demands on manufacturing to cover the consumer needs, it also increases the pollution caused by mining and processing plants to the manufacturing factory which later ends up as disposal waste to nature [2]. Anthropogenic activities from agricultural, industrial, and municipal dump activities are one of the major influences on soil pollution [3]. The level of contamination may extend hazardous effects to aquatic life, and human health, especially to human consumers of crops, by bioaccumulation through the food chain. Several

studies had been done in different states to determine the concentration of heavy metals contamination near the industrial areas but there is a lack of the study on major elements. The increase in the accumulation of K and Ca may potentially be caused by the usage of fertilizers on the ground for cultivation [4]. Due to the heavy industrial area in Klang Districts, there is a possibility that the Ca be contributed from petroleum industries [5]. Port Klang, situated in Selangor near to the heart of Malaysia, Kuala Lumpur, one of the biggest international trade ports in Malaysia which ranks as the 12th busiest container port in the world [6]. Klang District is one of the capital states of Selangor. The district is considered one of the rapid urbanization developments. Klang Valley which comprises the larger extension of other districts is the most densely populated, urbanised, and industrialised region of Malaysia [7]. Figure 1 shows the whole Klang District, on the centre coastal side there are Port Klang with heavy industries surrounding the area. Port Klang is divided into three different ports, which are Northport (red), Southport (green) and Westport (blue) which are administered by the Port Klang Authority. Due to the establishment of Port Klang Authority, the ports have been privatised since the early 1990s [8]. Northport (Malaysia) Bhd also owns and operates Southport as a regional conventional transshipment hub. As the Klang Industrial Area thrives with different kinds of industries including petrochemical, chemical, food, metal, automation, steel and other industries, the anthropogenic activities are very high surrounding the districts which could impose health hazards to the populations [9][10][11].



Figure 1: Klang District

Short half-life radionuclides are radionuclides that have short half-life which could range from minutes to hours where half-life is the interval time for half of the radioactivity of the radionuclide to decay [12]. The current conventional analytical techniques use for environmental analysis include atomic absorption spectrometry (AAS), inductively coupled plasma mass spectrometry (ICP-MS), X-ray fluorescence (XRF), and instrumental neutron activation analysis (INAA) [13]. The problem of using the AAS and ICP-MS in the routine analysis is the requirement for complete digestion of solid samples [14]. The procedure is both time and reagent consuming which does not include possible analyte loss from poor digestion, cross contamination, etc. The advantage of XRF and INAA is the possibility to analyze solid samples without the need to undergo chemical processes. Only pre-treatment of the samples to ensure the homogeneity of the samples are required to obtain accurate results.

However, XRF has difficulties compared to INAA due to limited sensitivity towards some elements and poor accuracy and precision [15]. Compared to all the methods, INAA proves to be better in terms of sample preparation and higher sensitivity to determine traceable values of different matrices samples [16]. This study is focused on the short half-life elements that could be found in the area near to the industrial as well as residential areas in Klang using Neutron Activation Analysis in the laboratory of Agensi Nuklear Malaysia.

## METHODOLOGY

Nine sample locations were predetermined near the industrial and residential area in Klang District as shown in Figure 2. The sampling locations are mostly on empty fields with no trees around to get a better understanding of the possibility of airborne particulates deposited onto the ground.



Figure 2: Sampling Location in Klang District

0-10 cm surface soil was collected using the auger and some edible crops were harvested which were later inserted inside polyethylene bags. Samples were transported to a laboratory in the Malaysian Nuclear Agency for further analysis.



Figure 3: Sampling of the soils sample

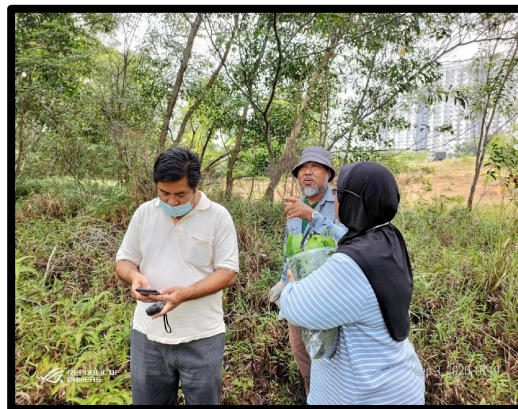


Figure 4: Sampling of the flora sample

The collected samples were cleaned and dried using an oven at 65°C until dried before ground into powder using a ball mill. Samples were then sieved using 0.2 mm sieve and were weighted approximately 0.10 g for a soil sample, while 0.50 g for flora samples. Each sample was prepared in duplicate to better analytical results. For each batch of irradiation, certified reference materials were co irradiated to get viable results.

The samples were irradiated using the Pneumatic Transfer System of Triga Mark II Puspatti Research Reactor operated at 750 kW with thermal neutron flux of about  $2.0 \times 10^{12} \text{ n.cm}^{-2}.\text{s}^{-1}$ . Each polyethylene vial was inserted into each rabbit tube. The rabbit tube was then inserted into the PTS chamber before setting it off to the reactor. The travel time from the chamber to the PTS port in the reactor is 3 seconds. Each sample was irradiated for 30 seconds and was cooled down for 10 minutes behind lead brick inside the fume hood. Samples were then counted using the ORTEC HPGGe detector of a high-resolution gamma spectrometry system for 5 minutes using GammaVision software. The detector has a relative efficiency of 20% with a resolution of 2.0 keV at 1332 keV. The ADC system connected to the PC analyzed the output signal from the detector. The samples were then recounted on the next day after the irradiation to get values for Na, Mn, K. Quantification of major, minor and trace elemental concentrations were analyzed using an in-house relative method's calculation.

## RESULTS & DISCUSSION

### *Quality Assessment*

Certified reference material namely San Joaquin Soil 2709a, Lake Sediment IAEA-SL-1 and Tomato Leaves 1573a were used as quality control material for each batch of samples. By analyzing the CRM, the accuracy of the analytical technique could be evaluated.

Table 1: Analytical Results of Certified Reference Materials (in mg/kg)

Elements	Measurement Value	Certified or Recommended Value	% Error
San Joaquin soil NIST SRM 2709A			
Dy	2.86	3.00	-4.61
Ti	3397	3360	1.11
V	106	110	-3.69
Al	71432	73700	-3.08
Cl	-	-	-
Ca	22085	19100	15.63
Mg	15376	14600	5.32
Na	11949	12200	2.06
K	20921	21100	0.85
Mn	435	529	17.70

#### Lake Sediment IAEA-SL-1

Dy	7.86	7.50	4.84
Ti	5113	5170	-1.10

V	177	170	3.83
Al	-	-	-
Cl	-	-	-
Ca	-	-	-
Mg	-	-	-
Na	1590	1700	6.48
K	13134	14500	9.42
Mn	3103	3460	10.32

Tomato Leaves NIST SRM1573a

Dy	-	-	-
Ti	-	-	-
V	0.95	0.84	13.25
Al	547	598	-8.46
Cl	5478	6600	-17.00
Ca	44240	50500	-12.40
Mg	11146	12000	-7.11
Na	141	136	-3.52
K	23634	27000	12.47
Mn	284	246	-15.55

Analytical Results of CRMs are tabulated in Table 1. Results obtained shows good precision and within the acceptable value with the certified materials. The relative errors varied from 0 to 17.7% which were within 20%, this indicates the percentage error of SRM is  $\pm 20\%$  are considered acceptable for analysis results.

***Elemental Concentration in Soil and Flora Samples***

The mean, maximum and minimum values observed for 10 elements in the soil samples are presented in Table 2 while the flora samples in Table 3, respectively. The flora samples showed a relatively high concentration of major elements such as Cl, Ca, Mg and K, while on soil samples it is rich in Ti, Al, Ca, Mg, Na, K and Mn. As shown in Table 3, there are some elements that have Min value lower than the detection limits of the detector.

Table 2: Elemental concentration in soil sample

Elements	Soil Sample (n = 9)			
	Average	SD	Min	Max
Dy (mg/kg)	2.13	0.91	0.94	3.94
Ti (%)	0.38	0.15	0.10	0.59
V (mg/kg)	56.2	24.7	7.2	82.2
Al (%)	7.02	4.39	1.29	17.08
Cl (mg/kg)	84.0	88.0	< 0.1	240.9
Ca (%)	0.23	0.34	< 1.00E-04	0.94

Mg (%)	0.38	0.26	0.11	0.77
Na (%)	0.14	0.12	0.02	0.40
K (%)	1.03	0.61	0.08	1.99
Mn (%)	0.20	0.55	< 2.00E-07	1.67

The Al is the highest element found in the soils collected where the lowest is 1.29% to the highest of 17.08% as tabulated in Table 2. It is most possible that the Al was deposited on the soil from the dry disposition of airborne particulate around the industrial area [17]. The results are comparable to the study of soils in Manjung, Perak where the concentration of the elements is higher near to the industrial areas and lower when away from the industries [18]. If compared to the value of composition of the upper continental crust, the elemental concentration in the soil samples is considerably lower except for the Mn value. In this study, the Mn value is average 0.19% from lower than detection limit up to 1.67% which is higher than the recommended value of 0.04%. The excess of the Mn in soils could be contributed to the acidity of the soils ( $\text{pH} = < 5.5$ ), as well as low in organic matter and temporarily waterlogged which is acidic sandy soil [19]. Of all ten soil samples, there is only one soil location that has the highest value of Mn. It is sandy soil between two heavy industrial areas in Klang. Therefore, the value of Mn could be contributed due to the soil factors as well as anthropogenic activities in the area.

Table 3: Elemental concentration in flora sample

Elements	Tapioca Leaves (n =4)				Lemongrass (n = 2)				Acacia (n = 4)			
	Average	SD	Min	Max	Average	SD	Min	Max	Average	SD	Min	Max
Dy (mg/kg)	0.02	0.03	< 0.001	0.06	0.06	0.04	0.03	0.09	< 0.001	-	-	-
Ti (mg/kg)	18.4	36.8	< 0.2	73.7	67.2	5.1	63.6	70.8	32.6	23.2	< 0.2	54.1
V (mg/kg)	0.26	0.16	0.07	0.40	0.19	0.26	< 0.02	0.37	0.18	0.35	< 0.02	0.71
Al (mg/kg)	184	128	60	313	229	185	98	360	125	124	53	310
Cl (%)	0.06	0.05	0.02	0.13	1.02	0.72	0.51	1.52	0.94	0.25	0.74	1.29
Ca (%)	0.88	0.22	0.75	1.21	0.41	0.01	0.40	0.41	0.75	0.21	0.56	1.03
Mg (%)	0.32	0.03	0.28	0.35	0.21	0.03	0.19	0.23	0.14	0.02	0.11	0.16
Na (mg/kg)	43.4	38.7	20.0	101.2	35.9	28.8	15.6	56.3	2810	1950	700	4690
K (%)	1.35	0.34	1.04	1.77	1.51	0.36	1.25	1.76	1.04	0.20	0.75	1.19
Mn (mg/kg)	2.21	1.01	0.93	3.29	39.1	4.7	35.7	42.4	208	25	194	246

Table 3 shows the elemental concentration between three different kinds of plant species. Tapioca leaves where people usually cook as dishes, lemongrass is also usually cooked in dishes for its aromatic and flavour enhancement, and acacia tree where people usually plant for ornamental purposes. From Table 3, there are significant differences between the elements present on the leaves. The K is the highest element presented in the samples which are commonly essential nutrients for plant growth. Comparing the three kinds of samples, lemongrass has higher deposition as well as higher Dy, Ti, Al and Cl while acacia has a high concentration of Na and Mn. In a study done by Gleb A. Zaitsev (et al) in 2020 on pine trees, it is found that the manganese mobility rises in a polluted environment from the emission by steel industries [20]. From the composition concentration of acacia in this study, we could see that the acacia tree was able to deposit quite significant elements on its leaves which is why it is usually planted in industrial or mining areas [21]. Tapioca has a quite high deposition of Al, Ca, Mg, Na and K but very low of Cl and Mn if compared to the other species. From the study of Hafizhan Zailani (et. al, 2020), other than the use of tapioca as dishes, it could also be used as a natural coagulant in leachate treatment [22]. The tapioca leaves could also be used as well for future research as a natural coagulant.

## CONCLUSIONS

The concentration levels of ten elements were quantified in soil and flora samples of Klang Districts. Several elements show significant contributions to differentiating three species of flora samples. Meanwhile, some elements have a value lower than the detection limits of the detector. However, it is recommended further research studies be conducted involving more samples from different regions or locations to confirm the present findings.

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