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MONITORING OF RADIONUCLIDE CONTAMINATION IN FOOD SAMPLES IN MALAYSIA DUE TO DAIICHI REACTOR ACCIDENT IN FUKUSHIMA, JAPAN

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ABSTRACT

On March 11, 2011, a serious accident occurred in Daiichi nuclear reactor plant, Fukushima, Japan which caused radioactive materials been released into the atmosphere in the form of aerosols and dust particles. Sea water around the plant was also found contaminated with high radioactivity readings. These radioactive materials could be transported by the winds and ocean current across international borders and cannot be controlled by human. Thus, a continuous monitoring activity of radionuclide content in the air and sea water needs to be conducted by the authorities. In addition to radioactivity monitoring, Malaysia should also control the entry of contaminated food in order to prevent radionuclide ingestion by human. The radionuclide ^{131}I, ^{134}Cs and ^{137}Cs were used as a measure of pollution levels and counted with gamma spectrometry using standard analysis method suggested by AOAC International. In this paper, details description of the role of Radiochemical and Environment Group, Nuclear Malaysia who's responsible in analyzing the radioactivity in the food samples due to Fukushima Daiichi, Japan accident was included. The radioactivity limit adopted and analysis results from this monitoring were discussed.

Keywords: Accidents, food, contamination, monitoring, nuclear reactor, radioactivity

INTRODUCTION

Consequent from the Fukushima Daiichi accident on March 11, 2011, Atomic Energy Licensing Board (AELB) had monitored environmental radiation levels through the Radiological Environmental Monitoring System (ERMS) to detect any release of radioactive in Malaysia. Since October 31, 2011, radioactive contaminant recorded by ERMS was at the background level with the data range from 0.031 to 0.223 µSv/hr (AELB, 2011). Under the Atomic Energy Licensing Regulations, the public dose limit is 1 mSv per annum, or 0.50 µSv / hr.

This monitoring showed that the radioactive fallout from Fukushima, Japan did not reach Malaysia. However, there are possibility that the radioactive materials find their way to Malaysia, which is through the consumption of contaminated food imported from Japan and neighboring countries that were affected by fallout from the Fukushima Daiichi nuclear reactor.

Radioactivity present in foodstuffs had become a public concern in Malaysia since the Chernobyl nuclear plant accident of April 1986. At that time, the Government had specific control of the entry of food items imported from Europe to this country so that local population health can be guaranteed (Amin, 1988). Consequence from Fukushima Daiichi Mark I reactor accident, the public awareness to radioactivity level in foodstuffs again been awakened. Because of the hazards to the environment from reactor accidents, there was much concern on imported foodstuffs from Japan through all over entry points (ports and airports) of Malaysia. For monitoring purposes, the Ministry of Health as the authority on quality control of foodstuffs in this country in collaboration with the Malaysian Nuclear Agency had conducted food monitoring programmed to check on radioactive levels in imported foods.

Control the Entry of Food Items

The most significant and abundant activity in foods following the nuclear power reactor accident were radioisotopes of iodine and cesium. Iodine-131 (^{131}I) has a half-life of only 8 days but nevertheless, once entering the food chain it is of great concern in the first days following most nuclear accidents involving operating reactors. On the other hand, the longer-lived radionuclide of Cesium-134 (^{134}Cs) and Cesium-137(^{137}Cs) were predominating. Cesium activity is important because of its long-lived isotopes that are persistently retained in the top surface of soil. ^{137}Cs (half-life 30 years is readily detectable in human and foodstuffs during and since weapons testing. A second cesium isotope, ^{134}Cs (half-life 2.3 years), has also played a prominent role in activity from nuclear accident.

Contaminated food chain resulting from the fallout can affect humans whether directly or not. It causes a health hazard to the population through the direct irradiation and internal contamination after consumption of contaminated foodstuffs (Franic´ et al., 2008).

The Ministry of Health, Labor and Welfare, Japan had conducted food monitoring procedure for 47,241 samples (dairy products, vegetables, meat, eggs, fishery products and others), taken from March 19, 2011 to November 1, 2011 for 23 districts in Japan. 850 (1.80%) from the 47,241 food samples taken had showed a positive reading level that exceeding provisional regulation limits. Results showed that from 850 contaminated food samples, 54.71% came from Fukushima, 14.82% from Saitama, 8.35% from Ibaraki and the rest came from other districts. From 850 contaminated food samples, 2.71% consist of milks, 40.00% vegetables, 19.42% from eggs and meast, 15.06% from fishery products and 22.71% from raw, refined and unrefined tea leaf products (MHLW, 2011).

It is worth to mention that meat and milk had recognized as sensitive indicators for presence of fission products in the environment (Franic´ et al., 2008). In addition, milk can be served as an early indicator or health risk to the public because largely consumed by infants and children who are considered the critical group of the population (Amin, 1988). Airborne radioactivity can be deposited directly onto the ground or washed out by rain. Thus, both vegetation and soil can be contaminated. Deposited materials attached to leaves and possibly transferred throughout the plant by naturally uptake and enter the food chain. Leafy vegetables are the other foodstuff which could pose a health risk at the early stage after a reactor accident, since they are consumed very soon after being harvested. Based on these considerations, foodstuffs such as milk and milk products, eggs and meats, vegetables and fruits, and fishes and seafood were listed as priority food to be checked for each consignment.

For Malaysia, the type and number of imported food items which need to be controlled due to Fukushima Daiichi nuclear accident is set by the Ministry of Health (MOH). Food samples were taken by the Ministry of Health Officer came from various entry points in Malaysia including airports, sea ports and land borders. Each consignment of food arrived to this country will be prevented from distribution until the results of the food analysis were issued from the Radiochemistry and Environment Laboratory of Nuclear Malaysia. Analysis of the samples normally takes a day and most results were reported to MOH within the same day as sample received. Results obtained from this analysis will be compared with the CODEX Alimentarious Limit so that Ministry of Health will determine whether the imported food can be accepted or returned to the exporting country.

MATERIALS AND METHODS

Sample Preparation

Food samples received from MOH were analyzed directly by using Gamma-ray Spectrometry without doing any further chemical process. Liquid sample was directly transferred into the container without chemical treatment. Solid sample were sliced for edible portion before further homogenization in a food processor. Samples were then transferred into standard counting containers and weighed before counted using gamma-ray spectrometry counting system.

Sample Counting

Measurements were performed at the Radiochemistry and Environmental Laboratory, Malaysian Nuclear Agency by using co-axial HPGe Gamma-ray Spectrometry system. Samples were counted using standard analysis method suggested by Association of Analytical Communities (AOAC). A 350 ml Marinelli Beaker was used to store the sample to be measured and positioned on the detector's end cap. To monitor the environmental radiation, room background was periodically measured once a week. A multi radionuclide solution consists of ^{210}Pb (46.54 keV), ^{241}Am (59.54 keV), ^{109}Cd (88.04 keV), ^{57}Co (122.07 keV), ^{123m}Te (159.00 keV), ^{51}Cr (320.07 keV), ^{113}Sn (391.71 keV), ^{85}Sr (513.99 keV), ^{137}Cs (661.62 keV), ^{88}Y (898.02 keV, 1836.01 keV) and ^{60}Co (1173.23 keV, 1332.51 keV) were used for calibration in the respective sample container size. The total uncertainties for efficiency calibration are less than 2.5%. The performance of the detection system were monitored regularly using sealed point source of ^{241}Am (59.54 keV) and ^{60}Co (1332.51 keV). IAEA Soil-6 was then used for the quality assurance of sample analysis. Counting periods for the food samples were taken for 7200 seconds. Peak was marked and calculated manually according to respectively energy of radionuclide after background subtraction. I-131 was identified through its photopeak energy line at 364.48 keV, ^{134}Cs average activity using energy line at 604.70 keV and 795.85 keV and ^{137}Cs at 661.66 keV. Activity value was calculated base on the fresh weight of the sample and corrected for density. Due to the low count rate, the associated uncertainties for the measurement at 2 sigma is between 10 – 20 %. The minimum detectable activity (MDA) for radionuclides was quantified at 1 Bq/kg per fresh weight after considering the size and the counting time of the sample.

RESULTS AND DISCUSSIONS

Gamma-ray spectra of 587 samples of imported food were obtained using a HPGe gamma-ray detector. The product that originated in a region likely affected by the radioactive released from the Fukushima nuclear plant accident had shown that the activities of ^{131}I (Fig.1), ^{134}Cs (Fig.2) and ^{137}Cs (Fig.3) were not exceeded the guideline levels as summarized in the Table 1.

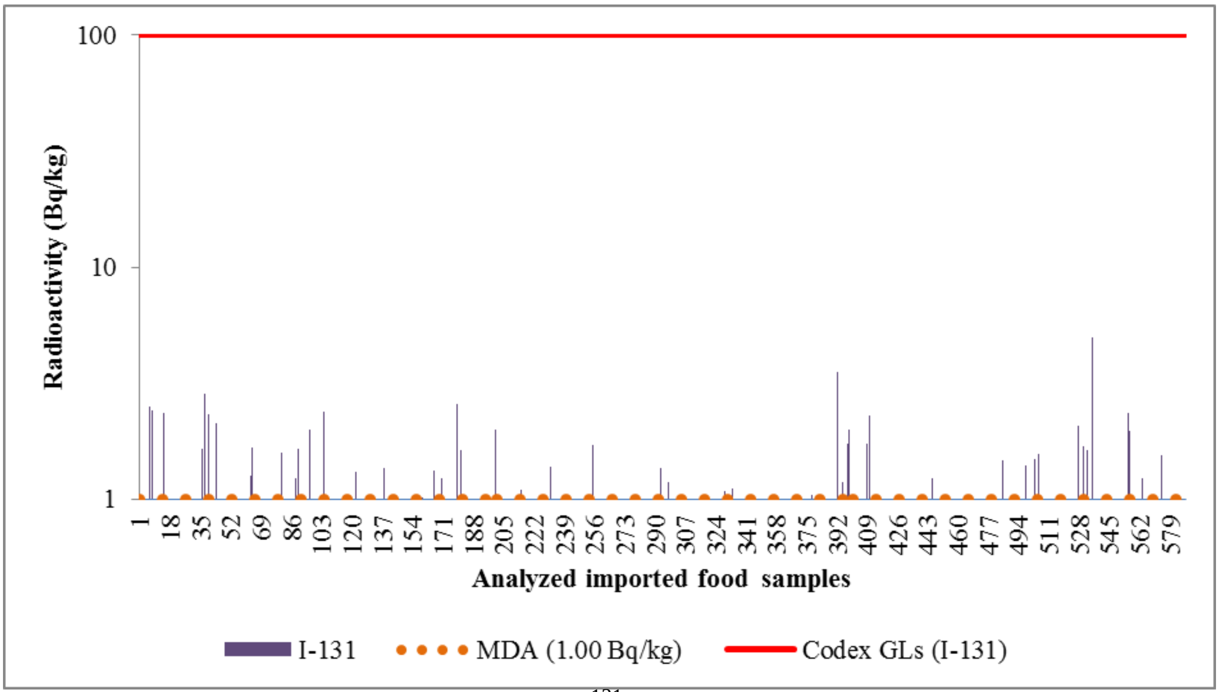

Figure 1: Radioactivity of ^{131}I in imported food samples

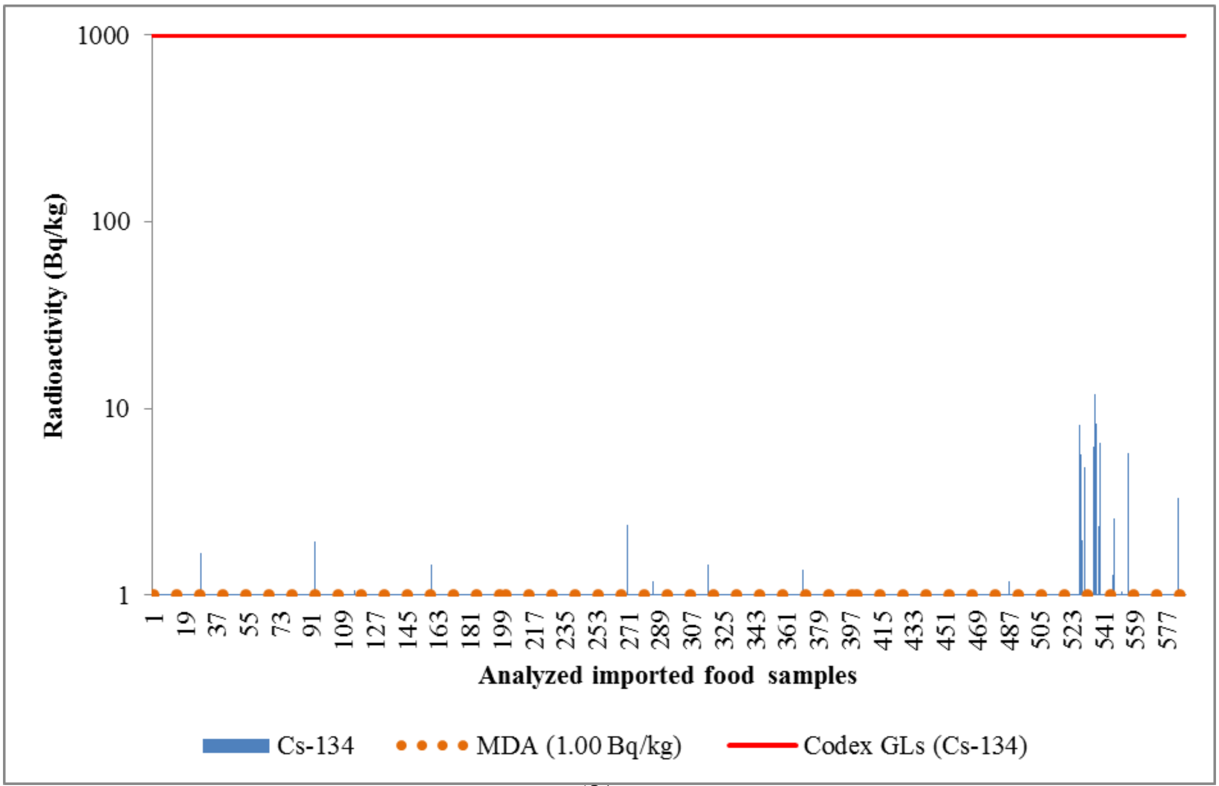

Figure 2: Radioactivity of ^{134}Cs in imported food samples

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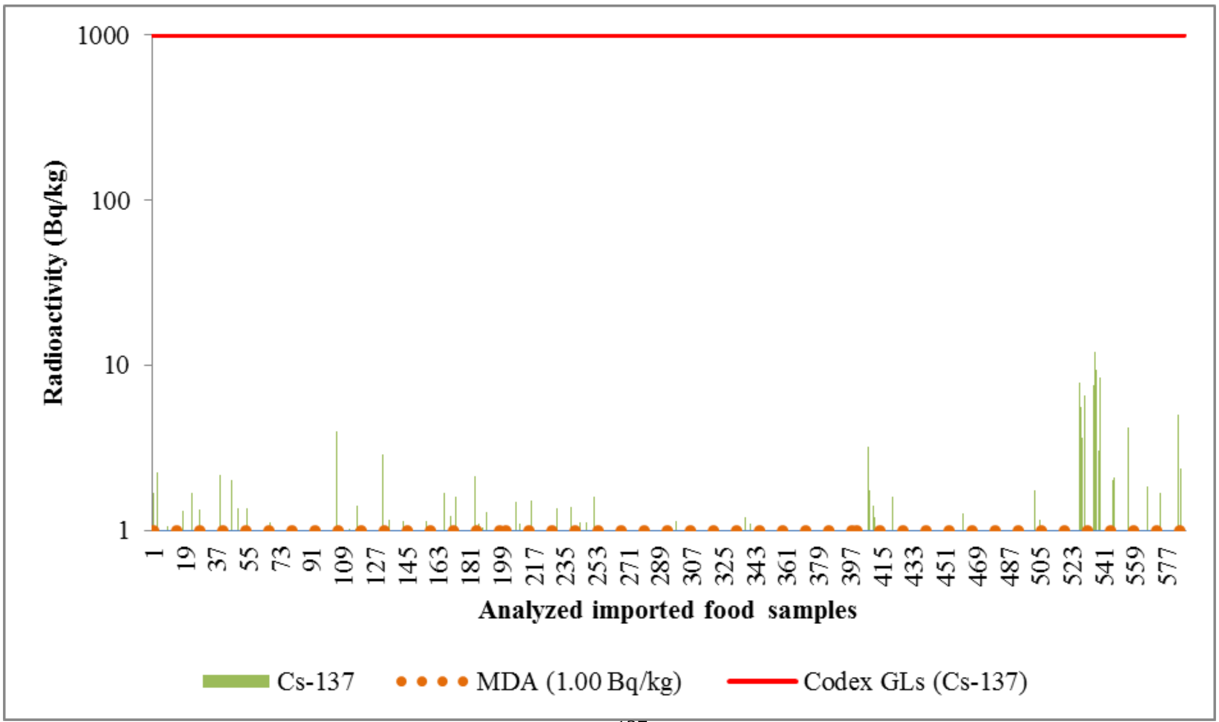

Figure 3: Radioactivity of ^{137}Cs in imported food samples

Table 1: Quantity of radioactivity analysis in food samples received from 18 March 2011 to 30 December 2011

Month	**Number of food samples**	
	Sample analysed	**Positive at levels exceeding guideline levels**
March	74	0
April	174	0
May	216	0
Jun	45	0
July	6	0
August	11	0
September	18	0
October	12	0
November	13	0
December	18	0
Total	**587**	**0**

Products received for analysis at the Radiochemistry and Environment Laboratory came in several groups of foods. Among of them were raw and processed fishery products (fresh fish, fish fillet, fresh shrimp, squid and etc.), vegetables (tomatoes, cucumber, mushroom and etc), cereal and cereal products (wheat flour, soy bean paste, noodle, bun and etc) and others products (tea, snack, sponge cake, and medical herbs). This entire product originally came from Fukuoka, Tokyo, Chiba, Osaka, Kyushu in Japan as well as other country near to Japan that affected by the nuclear accident including China, Korea and Taiwan.

Fortunately that Malaysia does not import fresh milk and meat product from Japan. Thus, the population risk from the intake of ^{131}I in milk and meat is reduced to a negligible level. Imports of fresh leafy vegetables, meat, herbs, fish and seafood are of such small quantities that the risk from these sources is also negligible. Thus, the population risk from these foods is insignificant.

Guideline levels (GLs) for radionuclide in foods were issued by Codex Alimentarius, under the name of CAC/GL 5-2006, ‘‘Codex guideline levels for radionuclide in foods contaminated following a nuclear or radiological emergency for use in international trade”. The guideline levels are based on ‘‘an intervention exemption level of 1 mSv in a year” (Varga, 2008). MOH adopted the Codex Guideline Levels (GLs) for radionuclide levels in internationally traded food following a nuclear or radiological emergency, where the amount of ^{134}Cs and ^{137}Cs must be less than 1000 Bq/kg, while ^{131}I must be less than 100 Bq/kg fresh weight for all type of foods. Normally the Codex GLs are applicable to the period of 1 year after the incident.

No radionuclide contamination was reported for food imported from Japan as a result of proactive control measure taken by Malaysia. All foods imported from Japan have to be accompanied with declarations of the Competent Authorities in certifying that the food is harvested and/or processed before the nuclear accident, or certified that the food originates from a prefecture other than Fukushima, Gunma, Ibaraki, Tochigi, Miyagi, Yamagata, Niigata, Kanagawa, Saitama, Tokyo and Chiba.

Food originating from Fukushima, Gunma, Ibaraki, Tochigi, Miyagi, Yamagata, Niigata, Kanagawa, Saitama, Tokyo and Chiba must been sampled and tested to determine the level of radionuclide ^{131}I, ^{134}Cs and ^{137}Cs, and in compliance with the Codex standard as in the Certificate of Analysis provided.

Thus, any food from Japan without the declaration from the Competent Authority in Japan as required will be subject to Hold, Test and Release (HTR) at the entry point in Malaysia. Under this HTR procedure, samples will be taken from each type of food by Ministry of Health (MOH) enforcement officers at the entry point to be analyzed for ^{131}I, ^{134}Cs and ^{137}Cs at Malaysian Nuclear Agency laboratory. Any food consignment from Japan which does not comply with the requirements will be rejected and will not be allowed to enter Malaysia. In addition to this requirement, MOH will carry out random monitoring at Examination Level 3 of the Food Safety Information System of Malaysia (FoSIM) on food imported from Japan. Some surveillance was also conducted by MOH on food sample in Sabah.

CONCLUSIONS

As a result, we can conclude that food products imported from Japan, and other affected countries (China, Korea and Taiwan) do not show any trace of ^{131}I, ^{134}Cs and ^{137}Cs contamination. It is very important to undertake environmental monitoring to detect the possible presence of radioactive contaminants in food products and other environments. Due to latest case of Fukushima Daiichi accident, the monitoring of imported food must be continuously practiced in Malaysia.

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