Testing for Presence of Radioactivity in Food Products Imported from Japan to Canada

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Abstract

Following the Fukushima Nuclear accident of March 11th of 2011, many people, particularly among the general public are still skeptical about the safety of foods imported from Japan. Furthermore, currently little radiation monitoring of food happens in Canada. The present study aims to test for the presence or absence of gamma radioactivity in various food products imported to Canada from Japan. Thirty commonly imported Japanese and thirty-two additional Canadian food products were purchased from supermarkets and convenience stores in Vancouver, British Columbia. All samples were tested for gamma radiation from cesium-134 and cesium-137 using a portable gamma spectrometer, the *EXPLORANIUM GR-135 Plus Identifier*. All food samples tested in this experiment were found free of any detectable gamma radioactivity.

Key words: Japanese, Food, Fukushima, Canada, cesium-134, cesium-137, gamma radiation

1. Introduction

Over three years after the Fukushima Daiichi Nuclear accident in 2011, Canadians remain concerned about radioactivity in food; particularly sea food products coming from Japan (Pynn, 2014). Immediately after the accident, the Canadian Food Inspection Agency (CFIA) implemented import control measures which banned foods and animal feed products from affected areas in Japan to enter Canada without official documentation proving their innocuity (BCCDC, 2014). The CFIA also started a testing program that monitored the radiation levels of food from Japan, domestic milk and domestic fish off the coast of British Columbia. However, because all food samples tested were negative for radioactivity, the import controls were lifted and the monitoring & sampling program was discontinued three months after the Fukushima incident (CFIA, 2011). According to Health Canada, the radiation levels that resulted from the Fukushima incident are far below the levels of concern to public health in Canada; yet, many in Canada are still skeptical about the integrity of foods with respect to radiation contamination (Health Canada, 2014). Public skepticism about radiation could be due to media bias, rumors, lack of information and lack of radiation monitoring programs. The objective of this research is to test for the presence/absence of radioactivity in various food products imported to Canada from Japan.

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2. The Great East Japan Earthquake

The Great East Japan Earthquake (Also known as 2011 Tōhoku earthquake or Higashi Nihon Daishinsai) occurred on March 11th, 2011 at 2:46 PM; its epicenter was located approximately 70 km east of the Oshika Peninsula of Tohoku district in Japan (Dobashi, 2011). With a magnitude 9.0 (Ritchter scale), it is considered to be one of the top five most powerful earthquakes in the world since 1900 (Dobashi, 2011). The violent earthquake motion triggered many disasters such as fires, explosions, accidents, building destructions and tsunami waves of up to 40.5 m (Chiu et al, 2013). According to the National Police Agency of Japan (2014), 15,889 people were killed, 2,601 were missing and 6,152 were injured.

2.1 Fukushima Daiichi Nuclear Power Plant Accident

Approximately one hour after the Great East Japan Earthquake, the tsunamis that were generated hit the Fukushima Dai-Ichi Nuclear Power Plant, resulting in the take down of several electrical generators and three nuclear reactors. The nuclear reactors eventually underwent a meltdown, followed by explosions and the release of radionuclides into the atmosphere. The three most significant radionuclides released in this incident were iodine-131 (^{131}I), cesium-134 (^{134}Cs) and cesium-137 (^{137}Cs) (Marzo, 2014). The National Institute for Safety Agency of Japan (NISA) estimated that the amounts of radioactivity released by the three crippled reactors were 160 PBq (1PBq = $1.0*10^{15}$ Becquerels) of ^{131}I and 15 PBq of ^{137}Cs. In addition, 520 ton of water containing 2800 TBq of ^{131}I, 940 TBq of ^{134}Cs and ^{137}Cs were released into the ocean within days of the meltdown (Hamada & Ogino, 2012).

On March 11, 2011 at 7:03 PM, followed by the Fukushima nuclear plant disaster, Japan's prime minister declared a state of emergency (Hamada & Ogino, 2012). Residents from nearby areas to the plant were evacuated, residents from surrounding areas were recommended to stay indoors and shipments of food products such as spinach and milk from areas close to the plant were banned as they were found to have radiation levels exceeding Japan's legal limits (Chiu et al, 2013).

3. Iodine-131, Cesium-134 & Cesium-137

The three most significant radionuclides released into the environment after the Fukushima incident were ^{131}I, ^{134}Cs and ^{137}Cs (Marzo, 2014). ^{131}I is the unstable and radioactive version of the metal iodine. Upon its decay, ^{131}I releases a beta particle and gamma radiation. Humans can be exposed to ^{131}I through ingestion of contaminated foods; upon ingestion, iodine is accumulated in the thyroid gland. High doses of radioactive iodine may induce thyroid cancer. Lower doses of radioactive iodine may lead to reduced thyroid gland activity and hormone production (US EPA, 2002). Iodine-131 is soluble in water so it can easily accumulate in marine organisms. However, its environmental impact is low due to its 8-day half-life (US EPA, 2002).

^{134}Cs and ^{137}Cs are common byproducts fissions or the splitting of uranium. ^{134}Cs has a half-life of 2 years and it emits gamma and beta radiation as it decays to xenom-134 or barium-134, which are non-radioactive byproducts. Cesium-137 decays to barium-137m which then decays to a stable form of barium. In the first decay beta particles are released and in the second decay, gamma radiation is emitted. Cesium-137 and barium-137m have a half-life of 30 years and 2.6 minutes respectively (EPA, 2002). Radioactive cesium behaves similarly in the human body.

Humans can be exposed to radioactive cesium through the ingestion and inhalation routes. Sources of radioactive cesium include atmospheric fallout, contaminated soil, water, foods and nuclear accidents. Once in the body, it is distributed in the body's soft tissues, with a slightly higher concentration in the muscles and slightly lower concentrations in bone and fat (US EPA, 2002). Radioactive cesiums have more significant health outcomes than radioactive iodine because of their longer half-lives. Based on epidemiological studies, exposure to radioactive Cesiums, particularly Cs-137 can lead to increased risk to malignant tumors and shortening of life. In a case study, in Brazil, Goiania in 1987, about 250 civilians were accidentally exposed to ^{137}Cs sources from stolen medical equipment (Toxnet, 2006). Exposures were oral and dermal. The civilians showed signs and symptoms of acute radiation syndrome (ARS), radiation burns, ocular injury, hematological effects and reduced sperm counts. Four of the exposed individuals died (Toxnet, 2006).

4.1 Ground Contamination

After the Fukushima Plant Disaster, large quantities of radionuclides, mainly ^{131}I, ^{137}Cs and ^{134}Cs, were released into the air (Hamada & Ogino, 2012). These radionuclides aerosolize into fine particles or become soluble gases, thus being able to form dry or wet deposits in any surface which is in contact with contaminated air. Dry and wet deposition is the mechanism by which air contamination is able to contaminate the land (IRSN, 2012). The implication of radionuclide deposition is that plant products can be contaminated by direct deposition on the plant surface or by absorbing radionuclides that were deposited and adsorbed in soil (Nakanishi et al, 2012). In a study by Nakanishi et al (2012), radioactive Cs was measured from wheat, rice, peach tree and soil, two months after the Fukushima incident. The study found that high levels of radioactive Cesiums were detected on the leaves, branch, trunk, rice grain and soil due to fallout deposition on plant surfaces. Cesium accumulation on milled rice (Cs deposits falls on the bran surface) was also found suggesting that contamination happened due to Cs absorption from water and soil as well.

Animal products can also be contaminated due to fallout deposition. Animals may consume contaminated plant products and water, leading to the possibility of livestock products such as meats, milk, eggs being contaminated (IRSN, 2012). One such example is contaminated milk that was found weeks after the Fukushima incident. Milk with ^{131}I concentrations five times higher than the Japanese guidelines was found on farms in the Fukushima Prefecture (Belson & Tabuchi, 2011). From March 2011 to February 2012, around 2000 milk product samples were analyzed in Japan; resulting in 23 samples exceeding Japanese guidelines (IRSN, 2012).

4.2 Contamination of the Marine Environment

Immediately after the Fukushima Nuclear Disaster, there has been major concern about the marine biota. At the time of the disaster, winds were blowing in the direction towards the sea, resulting in large amounts of radionuclides being released directly into the ocean (Batlle et al, 2014). The main radionuclides released into the ocean were ^{131}I and ^{137}Cs. However, due to ^{131}I's short half-life, 2 months after the Fukushima incident, it was no longer detectable (IRSN, 2012).

In a study by Wada et al (2013), 6462 specimens within 169 marine species were collected off the coast of Fukushima from April 2011 until October 2012 and analyzed for ^{131}I, ^{134}Cs and ^{137}Cs. In 2011, 63 specimens exceeded the Japanese regulatory limit (100 Bq/kg) for ^{134}Cs and ^{137}Cs; and in 2012, 41 specimens exceeded the limit. The researchers found that radionuclides concentrations decreased significantly with time but differed amongst taxa and habitats; coastal benthic fishes having the most gradual radiation decreases and the most frequent concentration above limit detections (Wada et al, 2013). In another study by Tateda et al (2012), ^{137}Cs concentrations of invertebrates, benthic fish and predator fish from the southern Fukushima area were monitored immediately after the 2011 incident. It was found that ^{137}Cs concentrations reached its maximum (Algae= 880 Bq/kg, benthic fish= 3200 Bq/kg, predator fish=1600 Bg/kg) during the months of late April, May and late July of 2011; concentrations after July began to steadily decrease (Tateda et al, 2012). Although cesium contamination has decreased significantly around Japan's sea, monitoring of the marine species fished in the area is still recommended (IRSN, 2012).

In Canada, the Canadian Albacore Tuna Association has been monitoring radiation in sea food that may come from the Pacific of Japan (BC Wild Albacore Tuna, 2013). Monitoring began in 2010 (before that Fukushima Plant disaster) and continues until the present. Testing is done for the main radionuclides ^{131}I, ^{134}Cs and ^{137}Cs that were released in the Fukushima incident. Up to date, no sample had detectable levels of the three radionuclides (detection limit = 0.002 Bq/g) (BC Wild Albacore Tuna, 2013). Additionally, in a recent study by Luan and her colleagues (2013), 52 samples within 10 species of fish and 3 species of shellfish from markets in the Greater Vancouver Regional District were tested for the presence of radionuclides ^{134}Cs and ^{137}Cs. The study showed that none of the samples contained the radioactive cesium isotopes (Detection limit = 0.01 µSv/hr near the surface of the meter, corresponding to approximately 1 Bq) (Luan, Sidhu, & Zitouni, 2013).

5. Canadian Guidelines

In order to control radioactively contaminated commercial foods and water in situations of nuclear emergency, Health Canada has set guidelines for three food groups (BCCDC, 2014). Refer to Table 1 for action levels of ^{131}I, ^{137}Cs and ^{134}Cs. The Canadian Guidelines were developed with recommendations from the Food and Agriculture Organization (FAO)/World Health Organization (WHO) Codex Alimentarius Comission; its purpose is to protect the public from radiation-induced cancer and genetic disorders in the offspring as a result of consuming radioactively contaminated food/water (BCCDC, 2014).

Table 1: Recommended Action Levels for Three Food Groups in Canada

Radionuclide	Action Levels (Bq per kg)		
	Fresh Liquid Milk	Public Drinking Water	Other Commercial Foods and Beverages
^{131}I	100	100	1000
^{137}Cs	300	100	1000
^{134}Cs	300	100	1000

6. Role of Public Health Inspectors

This research project aims to inform Public Health Inspectors (PHI) about the facts regarding contaminated foods from Japan due to the Fukushima nuclear plant disaster. The PHI's role is to protect and promote public health. By arming Canadian PHIs with the knowledge of the conditions of Japanese foods, they will be able to more effectively educate the public by presenting all of the up-to date facts on the matter so that the public can make a well-informed decision on whether or not to purchase foods imported from Japan.

7. Purpose

After the Fukushima nuclear plant meltdown on March 2011, Canadians are still concerned about food products coming from Japan. Little radiation monitoring in foods happens in BC because testing for radiation is expensive and Health Canada has determined that radioactivity levels in foods in Canada are below the national guidelines. The purpose of this research project is to test for the presence/absence of total radiation in various food products imported to Canada from Japan. The result of this study will determine whether food products from Japan contain radionuclide traces so that Canadian consumers can be aware of it when purchasing such products in the Canadian market.

8. Methods

Food samples were purchased from supermarkets and convenience stores in Vancouver – BC, Canada. 30 imported Japanese food products were purchased from Fujiya and Kim's Mart. 32 food products commonly found in Canadian stores were purchased from Superstore and Costco. All food products were prepared to be analyzed with the *GR-135* Plus. Each food product was removed from its package, and a one serving size portion, according to package label, was placed in a plate or a cup. After all of the 60 samples were prepared, each sample was measured with the *GR-135 Plus* for the presence/absence of gamma radiation from ^{134}Cs and ^{137}Cs specifically. Analysis was done by lifting the *GR-135 Plus* from its docking station, setting it to "survey mode" and approaching the machine as close as possible to each food sample. When in close proximity to the food sample, the "identify" function was used in order to attempt to detect any radionuclides present. If the machine detected any amount of gamma radiation from ^{134}Cs and ^{137}Cs radionuclides, the sample was considered to have gamma radiation contamination present. If no gamma radiation was detected from the sample, it was considered "absent" of gamma radiation contamination.

9. Results

All 62 samples of the imported Japanese food products and food products commonly available in Canadian stores were analyzed with the *GR-135 Plus* for the presence or absence of gamma radiation from ^{134}Cs and ^{137}Cs. Analysis with the "identify" function resulted in the *GR-135* Plus displaying "background" for all samples tested. This indicates that radiation from ^{134}Cs, ^{137}Cs or other radionuclides were not present in any of the samples during the time of the experiment. Refer to tables 2 and 3 below, for a summary of the results.

Table 2: Food Products Imported from Japan

Sample #	Product name	**Product Description**	**Gamma radiation (Present or Absent)**
1	Tennenkoubo Pan Chocolate	Baked wheat cake - chocolate flavor	Absent
2	Maronn Annpai	Chestnut cake	Absent
3	Mayonnaise	Mayonnaise (Half-calories)	Absent
4	Iri Goma (Shiro)	Rosted Sesame Seeds (White)	Absent
5	Iri Goma (Kuro)	Roasted Sesame Seeds (Black)	Absent
6	Ryokuto Harusame	Japanese Vermicelli dry noodles	Absent
7	Yamaimo Soba	Buck Wheat Noodle	Absent
8	Aonori	Dried sea weed powder	Absent
9	Tororo Connbu	Algue	Absent
10	Beni Ebi	Dry shrimp	Absent
11	Tennkasu	Fried Wheat Flour	Absent
12	Niwatori no Shiodare Itame no Moto	Gochiuma - Salt Sauce	Absent
13	Wakame	Soy Bean Paste	Absent
14	Otona no Furikake (Beni Shake)	Topping for rice	Absent
15	Chuka Zannmai	Instant Noodles (Soy Sauce)	Absent
16	Bamu Roru	White Cake roll	Absent
17	Crème Stew	Stew Mix	Absent
18	Yaki Sushi Nori	Roasted Sea Weed	Absent
19	Sannma Kabayaki	Canned Baked Seasoned Saury	Absent
20	Yude Azuki	Canned Red Bean	Absent
21	Ajisuke Ika	Canned Squid in Soy Sauce	Absent
22	Torokeru Kare	Curry Medium	Absent
23	Shoyu	Soy Sauce	Absent
24	Goma Abura	Sesame Oil	Absent
25	Kurosu Iri Mozuku	Seasoned Sea weed	Absent
26	Aka Miso	Soybean paste (Red)	Absent
27	Aokappa Tsukemono	Pickled Cocumber	Absent
28	Ika Kimuchi	Squid marinated in Kimchi paste	Absent
29	Kyushu Ichibann Natto	Fermented Soy Beans	Absent
30	Gennmai-Cha	Green tea Bag	Absent

Table 3: Food Products Commonly Available in Canadian Stores

Sample #	Product name	**Product Description**	**Gamma radiation (Present or Absent)**
1	2% Partially Skimmed Milk	Skim milk – 2%	Absent
2	100% Whole Grain Canadian Oats - Quick Oats	Oatmeal	Absent
3	Wild Pacific Pink Salmon	Canned wild salmon	Absent
4	Green Tea	Green tea bag	Absent
5	White bread	Sliced bread - white	Absent
6	Coffee Crisp	Coffee chocolate bar	Absent
7	Rosemary Roasted Chicken with Potatoes	Garlic, paprika and rosemary spices	Absent
8	Spaghettini	100% whole grains pasta	Absent
9	Paste made from Tomatoes - Herbs & Spices	Canned tomato paste	Absent
10	Chunky Chicken Noodle Soup	Canned chicken noodle soup	Absent
11	Red Kidney Beans	Canned kidney beans	Absent
12	Raspberry Jam	Raspberry jam	Absent
13	Fruit Plus Veggies & Fibre	Veggies and fruits juice	Absent
14	Pure Olive Oil	Olive oil	Absent
15	Mayonnaise 1/2 Fat	Mayonnaise – ½ fat	Absent
16	Tofu Dessert Peach and Mango	Tofu – mango and peach flavored	Absent

17	Mandarin Ponkkan	Mandarin orange	Absent
18	Craft Baked Bread	Sliced bread - oat & nut with honey	Absent
19	Banana	Banana	Absent
20	Smoked Oysters	Canned smoked oysters	Absent
21	Canada No.1 Maple Syrup	Maple syrup	Absent
22	Solid Light Tuna in Water	Canned tuna	Absent
23	Bowl Noodle Soup	Spicy kimchi instant noodles	Absent
24	Original Pancake & Waffle Mix	Pancake mix	Absent
25	100 % Coffee	Instant coffee	Absent
26	Activia Yogurt - Strawberry	Strawberry yogurt	Absent
27	Organic Chia seeds	Chia seeds	Absent
28	Seasoned Chicken	Roasted chicken - whole	Absent
29	Broccoli	Broccoli	Absent
30	Top Sirloin Grilling Steak (Triple A)	Mechanically tenderized steak	Absent
31	Organic Baby Spinach	Baby spinach	Absent
32	Large Eggs (Grade A)	Eggs with omega-3	Absent

10. Discussion

The findings in this study suggest that foods imported from Japan to Canadian stores are likely not contaminated with ^{134}Cs, ^{137}Cs or other radionuclides that were released from the Fukushima incident four years ago. There may be several reasons to why ^{134}Cs and ^{137}Cs contamination from the Fukushima incident were not found in the food products from Japan. The most likely reason would be that radionuclides that were released into the environment have been diluted to the point below detection levels (Zitouni, 2014). Due to wind patterns during the Fukushima incident, large quantities of radionuclides were released over the Pacific Ocean. Radiation levels in the Pacific Ocean close to the plant may have peaked immediately after the incident; however due to its enormous volume and water currents, it is very likely that the radionuclide concentration have been vastly diluted. In a study by Germany's Geomar Helmholtz Centre for Ocean Research (Behrens, 2012), global ocean circulation models were constructed to estimate the long term dispersion of ^{137}Cs from the local waters off the Fukushima plant. The model predicted that two years after the incident, ^{137}Cs levels would fall to 10 becquerel per cubic meter; and within four years, ^{137}Cs levels would fall to 1-2 becquerel per cubic meter which is about twice the levels prior to the incident (Behrens, 2012). Consequently, on a risk assessment study performed three months after the Fukushima incident, the researchers measured radionuclide levels of squid samples and seawater from the ocean waters located at the east of Japan (Yu et al, 2015). ^{137}Cs concentration in sea water was found to range from 1 to 826 mBq/L and ^{137}Cs concentration was found to be on average 1.65 Bq/kg (Yu et al, 2015). The study concluded that the emissions from the Fukushima plant did not have significant adverse effects on the marine biota at the population level (Yu et al, 2015).

Another reason that could explain the absence of radionuclides in Japanese food products is the natural decay of radionuclides such as I-131 and Cs-134 in addition to dilutions in the air, water and soil. This explains why ^{131}I was not expected to be detected in this study. It has a short half-life of eight days (US EPA, 2002), thus it is very unlikely that at present times, it would still be found in the environment or in foods. ^{134}Cs and ^{137}Cs on the other hand, have a longer half-life (US EPA, 2002). Therefore, if gamma radiation was found in the Japanese food products in the present study, ^{134}Cs and ^{137}Cs would be the major suspects. Land can be contaminated through dry and wet deposition of radioactive material. Immediately after the Fukushima incident, food products exposed to the air could have been highly contaminated through deposition. However, years after the incident, food products such as crops are contaminated by growing in contaminated soil or if irrigated with contaminated water. Livestock are contaminated if fed with contaminated crop products. The absence of radiation in Japanese food products suggest that natural degradation of radionuclides may have contributed to the levels below detection limits currently found.

Lastly, radiation may not have been detected in the present study because none of the Japanese food products tested was produced in the Fukushima prefecture region. According to the Japanese Ministry of Health - Labour and Welfare (JMHLW), the whole country's food supply did not get equally affected by the Fukushima incident's fallout (Kendall, 2012). In fact, Fukushima and surrounding prefectures had the most food samples exceeding national guidelines for ^{134}Cs, ^{137}Cs or ^{131}I. From March 2011 to March 2012, Fukushima had 718 unsatisfactory food samples which are 3.33% of the samples tested. Prefectures far away from Fukushima such as Kyoto and Aomori had no food sample exceeding national guidelines (Kendall, 2012). These findings indicate that fallout from the Fukushima incident did not cover a significantly large area. Furthermore, extrapolating the findings by JMHLW, it is very unlikely that any significant radionuclide contamination from Fukushima travelled as far as to other countries. The present study's finding that radiation was not detected in food products commonly available Canada also supports the assumption that no significant radioactive contamination from Fukushima reached far away countries such as Canada. Moreover, according to the United Nations, the Fukushima incident in Japan did not affect radiation levels in other countries; which still to date, have background levels far below background levels that most people experience daily (World Health Organization, 2011).

It is important to note that even if ^{134}Cs and ^{137}Cs contamination were found in Japanese food products, it would not be immediately considered detrimental to the health (personal communication with Dr. Zitouni, 2014). In such event, further in-depth analysis of the samples in a gamma spectrometry laboratory would be required. Furthermore, internal doses due to gamma radiation would have to be calculated to determine the actual potential harm to humans (Zitouni, 2014).

The findings in the present study also have the purpose to inform Public Health Inspectors (PHI) regarding the risks of consuming foods contaminated with radiation from the Fukushima incident. In the field of risk communication, risk, in this case, probability of adverse health effects from consumption of food contaminated with radiation, is "Hazard + Outrage" (Sandman, 2000). Hazard would be the actual health outcome such as increased cancer rate; and outrage would be anything negative perceived by the public regarding its risks. According to the findings in the present study and the literature, "hazard" is extremely low as no radiation was found in food samples from Japan; or if radiation traces were found, they were so low that it did not pose a long term health risk. However, due to media bias, rumors, lack of education and lack of radiation monitoring programs in Canada, the public's perception of food contaminated with radiation is extremely negative; in other words, outrage is very high. Consequently, although hazard is very low, because outrage is high, "risk" from eating food contaminated with radiation is considered to be naturally high. In order to reduce the risk perceived by the public, outrage has to be reduced. The most effective way to accomplish this is by educating the public about the actual hazards associated to consumption of food products from Japan.

It has been four years since the Fukushima incident and Canadians are still concerned about food products from Japan. This research hopes to provide Canadian PHIs with the knowledge of the conditions of Japanese foods, so that they are able to more effectively educate the public. By presenting all of the up-to date facts on the matter, the public would be able to make a well-informed decision on whether or not to purchase food imported from Japan.

11. Recommendations

Future studies that would enhance the findings of this research could test for the presence of radiation in produce products such as fruits and vegetables from Japan. Another study could be done with a wider variety and sample number of food products from Japan (including products imported from Fukushima and surrounding prefectures).. Lastly, a study where radiation levels in Japanese food products are quantified rather than tested for presence/absence could be performed by means of large NaI-Tl or HpGe detectors connected to advanced spectrum analyzers.

12. Limitations

Due to budget constraints, only 30 Japanese food products and 32 common food products in Canadian stores were tested. Additionally, the choice of food samples was based on affordability and availability. A wider variety of food products from both food groups would make a better representation of food products from Japan and other countries when testing for the presence of radiation. Moreover, no food product tested was directly produced in the Fukushima prefecture in Japan. It would be interesting to test for radiation in products from Fukushima and closely surrounding prefectures as these areas were likely more affected by the radioactive fallout following the Fukushima incident.

13. Conclusion

Four years after the Fukushima nuclear power plant disaster, many Canadians remain concerned about elevated radiation levels in food coming from Japan. The present study demonstrates that food products imported from Japan does not contain radiation traces from cesium-134 and cesium-137 released to the Fukushima incident back in 2011. Possible reasons for the absence of radiation in food could be due to dilution coupled with the natural degradation of radionuclides in the environment or the fact that only Fukushima and surrounding prefectures were affected by the nuclear plant’s radioactive fallout. The findings in this research can be of benefit to Public Health Inspectors when educating the concerned public regarding radiation contamination in food; so that the public can make well-informed decisions when purchasing food products imported from Japan.

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15. Competing interest

The authors declare that they have no competing interests.

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