***Testing for Radiation in Seaweed***

This document summarizes all MCSV seaweed radiation testing done between 2011 - 2019 by the lab of Professor Thomas Hess, University of Maine Department of Physics. First, we discuss how to interpret the results. A short description from Dr. Hess then explains the testing protocol. This is followed by eight tables summarizing results from 2011 to 2018. Harmful radiation is highlighted red in these tables.

***How to interpret radiation testing results***

Results are reported as Bq/kg. Bq is an abbreviation of becquerel, a measure of radioactivity named after Henri Becquerel, who worked with Pierre and Marie Curie to discover radioactivity. The Becquerel is a very small unit adapted to atomic scale. Activities given in becquerel units can therefore seem exceptionally high and possibly dangerous. For context, the human body itself emits radiation at an activity of about 8,000 Bq – a value which may seem high but is in reality very small.

When discussing radiation, it's important to distinguish between naturally occurring vs manmade sources. Every day we're exposed to low levels of naturally occurring radioactivity such as radon and elemental isotopes. Radon is formed as a transient product in the decay of primordial uranium-238, which is the most common uranium isotope found in nature. Other naturally occurring isotopes found in this decay chain include Pb-210 and Pb-214 (lead isotopes) and Bi-124 (a bismuth isotope). K-40 (potassium-40) is another commonly occurring radioactive isotope. Foods rich in potassium such as seaweed and bananas contain naturally high levels of K-40. Although the amount in a single banana is small in environmental and medical terms, the radioactivity from a truckload of bananas can cause a false alarm when passed through a Radiation Portal Monitor used to detect possible smuggling of nuclear material at U.S. ports. We've evolved the capacity to repair damage from this low-level radiation, but high-energy manmade radiation and uncommon isotopes can be harmful. Cs-134 and Cs-137 are harmful cesium isotopes that usually originate from nuclear fission; Cs-137 accounts for much of the radioactivity associated with spent nuclear fuel rods and contamination from the Chernobyl and Fukushima accidents. Iodine-131, which is harmful to the thyroid and other tissues, is also associated with nuclear contamination.

Our results show levels of both these natural and unnatural isotopes, which allows comparison of normal background radiation with manmade, harmful radiation. All of our seaweed testing results to date show only natural background radioactivity, with no evidence of fallout from Fukushima. A natural radioactive isotope of potassium (K-40), found in most if not all land and sea plants, as well as in seawater, accounts for nearly all of the radioactivity measured in our seaweeds. The presence of natural, harmless isotopes makes it impossible to 'measure' seaweed radioactivity with a Geiger counter.

***Description of testing protocols, from Professor C.T. Hess***

Samples of edible seaweeds were tested from 2011 to 2019 for assessment of radionuclide content, with particular attention given to looking for evidence of contamination from the 2011 nuclear event in Fukushima, Japan. The supplied assorted samples were processed using an HPGe (High-Purity Germanium) detector. Each of the radionuclide photo-peaks were then compared with both a certified radioactive source standard and Canberra's LabSOCS efficiency software. The samples were shown to contain radioisotopes common to the marine environment and to all terrestrial vegetation. In particular K-40, the naturally occurring radioisotope of potassium, accounted for nearly all of the activity of these samples. Other radioisotopes measured were Bi-214 and Pb-214; these naturally occurring isotopes are found in many varieties of plant material. Values given for shorter lived isotopes, Cs-134 and I-131 represent our efforts to identify possible activity even though no corresponding gamma emission lines are present for these isotopes. None of the tested samples showed evidence of recent contamination. The activities of the samples ranged from below the detection limit to 8203 Bq/kg and well within the range expected for seaweed. For comparison, bananas contain about 150 Bq/kg, spinach is about 250 Bq/kg and again this is almost entirely due to high potassium content and does not represent any risk or potential hazard.

| Sample-**Isotope** | **K-40 (Bq/kg) +/- 10%** | **Pb-214 (Bq/kg) +/- 18%** | **Bi-214 (Bq/kg) +/- 16%** | **Cs-137 (Bq/kg) +/- 25%** | **Cs-134 (Bq/kg) +/- 99%** | **I-131 (Bq/kg) +/- 99%** |
|---|---|---|---|---|---|---|
| Rockweed powder | 430 | 1.21 | 1.39 | 0.183 | <0.0135 | <0.100 |
| Kelp leaf | 3061 | 6.14 | 5.64 | 0.566 | <0.808 | <0.725 |
| Kelp powder | 1086 | 1.30 | 0.678 | <0.204 | <0.270 | <0.249 |
| Irish moss powder | 466 | 1.33 | 0.711 | <0.172 | <0.0317 | <0.0905 |
| Dulse flakes | 1521 | 0.43 | 0.362 | <0.114 | <0.0787 | <0.122 |

**Table 1** Radiation testing results for sea vegetables harvested May-October 2011. Reported 10/15/12

| Sample-**Isotope** | **K-40 (Bq/kg) +/- 10%** | **Pb-214 (Bq/kg) +/- 18%** | **Bi-214 (Bq/kg) +/- 16%** | **Cs-137 (Bq/kg) +/- 25%** | **Cs-134 (Bq/kg) +/- 99%** | **I-131 (Bq/kg) +/- 99%** |
|---|---|---|---|---|---|---|
| Bladderwrack | 1068 | 2.04 | 1.54 | 0.256 | <MDA* | <MDA* |
| Alaria | 1685 | 0.898 | 0.616 | 0.117 | <0.172 | <0.126 |
| Kelp powder | 3920 | 0.688 | 0.771 | 0.384 | <0.066 | <MDA |

**Table 2** Radiation testing results for sea vegetables harvested May-October 2012. Reported 3/21/2013

* <MDA below Minimum Detectable Activity. The channels associated with these isotopes did not register enough activity to produce a valid measurement. Values may be read as zero.

| Sample-**Isotope** | **K-40 (Bq/kg) +/- 10%** | **Pb-214 (Bq/kg) +/- 18%** | **Bi-214 (Bq/kg) +/- 16%** | **Cs-137* (Bq/kg) +/- 25%** | **Cs-134 (Bq/kg) +/- 99%** | **I-131 (Bq/kg) +/- 99%** |
|---|---|---|---|---|---|---|
| Alaria leaf | 924 | 2.547 | 2.138 | 1.025 | NR** | NR** |
| Laver leaf | 709 | 1.311 | 3.532 | 0.019 | NR | NR |
| Sea lettuce leaf | 876 | N/A | 4.04 | 0.22 | NR | NR |
| Kelp powder | 1011 | 2.269 | 3.964 | 0.832 | NR | NR |
| Rockweed granules | 1984 | 1.496 | 0.201 | 0.025 | NR | NR |
| Toasted nori sheets | 956 | 1.041 | 4.834 | 1.718 | NR | NR |

**Table 3** Radiation testing results for sea vegetables harvested May-October 2013. Reported 3/10/2014

*Though Cs-137 is not a naturally occurring photo-peak (unlike each of the others), its observed photo-peak was low enough to be contributed as a result of the trace (safe) amounts of Cs-137 in the environment from weapons testing decades ago.

**NR Not Reported, below MDA.

| Sample - **Isotope** | **K-40 (Bq/kg) +/-8.1%** | **Pb-214 (Bq/kg) +/-32%** | **Bi-214 (Bq/kg) +/-34%** | **Cs-137 (Bq/kg) +/-10.2%** | **Cs-134 (Bq/kg) +/-41%** | **I-131 (Bq/kg) +/-40%** |
|---|---|---|---|---|---|---|
| Rockweed granules | 773 | 2.34 | 0.376 | 0.708 | 0.818 | 0.0324 |
| Kelp Powder | 1001 | 0.212 | 0.213 | 0.321 | 0.717 | 0.002 |
| Dulse Granules | 978 | 2.13 | 0.021 | 0.213 | 0.912 | 0.003 |
| Irish Moss Powder | 908 | 1.89 | 0.087 | 0.211 | 1.01 | 0.001 |
| Kelp Leaf | 1022 | 0.892 | 0.343 | 2.13 | 0.982 | 0.034 |
| Rockweed Powder | 982 | 2.13 | 0.003 | 0.754 | 0.982 | 0.098 |
| Sushi Nori Toasted | 882 | 1.01 | 0.072 | 1.11 | 1.09 | 0.006 |

**Table 4** Radiation testing results for sea vegetables harvested May-October 2014. Reported 3/01/2015

| Sample - **Isotope** | **K-40 (Bq/kg) +/-7.3%** | **Pb-214 (Bq/kg) +/-26%** | **Bi-214 (Bq/kg) +/-29%** | **Cs-137 (Bq/kg) +/-11.9%** | **Cs-134 (Bq/kg) +/-31%** | **I-131 (Bq/kg) +/-43%** |
|---|---|---|---|---|---|---|
| Rockweed Granules | 1765 | 1.331 | 0.043 | 1.26 | 1.982 | 0.037 |
| Kelp Powder | 1433 | 0.012 | 0.097 | 0.744 | 1.013 | ND |
| Dulse Flakes | 335 | 1.542 | 0.099 | 0.021 | 1.001 | ND |
| Rockweed Powder | 1235 | 3.234 | 0.012 | 0.332 | 0.984 | ND |
| Sushi Nori Toasted | 547 | 0.013 | 0.078 | 0.076 | 0.015 | 0.019 |
| Alaria Granules | 1279 | 1.785 | 0.015 | 0.249 | 0.054 | 0.098 |
| Sea Lettuce Powder | 1023 | 0.023 | 0.022 | 1.891 | 0.895 | 0.034 |

**Table 5** Radiation testing results for sea vegetables harvested May-October 2015 Reported 06/23/16
*ND Not Detected above method detection limit

| Sample - **Isotope** | **K-40 (Bq/kg) +/-6.1%** | **Pb-214 (Bq/kg) +/-22.1%** | **Bi-214 (Bq/kg) +/-22.8%** | **Cs-137 (Bq/kg) +/-24%** | **Cs-134 (Bq/kg) +/-51%** | **I-131 (Bq/kg) -** |
|---|---|---|---|---|---|---|
| Alaria Powder | 3216 | 2.120 | ND | 2.975 | 1.021 | ND* |
| Bladderwrack Powder | 2907 | 0.865 | 0.101 | 2.811 | 1.975 | ND |
| Rockweed Granules | 2145 | 2.431 | 0.101 | 2.764 | ND | ND |
| Rockweed Powder | 1987 | 2.123 | ND | 4.312 | 2.129 | ND |
| Sushi Nori Toasted | 1298 | 0.009 | 0.121 | 0.160 | 1.652 | ND |
| Kelp Powder | 2146 | 2.276 | ND | 3.219 | ND | ND |
| Sea Lettuce Flakes | 2004 | 0.147 | ND | 2.771 | 7.641 | ND |

**Table 6** Radiation testing results for sea vegetables harvested May-October 2016. Reported 05/19/17
*ND Not Detected above method detection limit

| Sample - **Isotope** | **K-40 (Bq/kg) +/-7.6%** | **Pb-214 (Bq/kg) +/-5.9%** | **Bi-214 (Bq/kg) +/-15.54%** | **Cs-137 (Bq/kg) -** | **Cs-134 (Bq/kg) +/-44.2%** | **I-131 (Bq/kg) -** |
|---|---|---|---|---|---|---|
| Bladderwrack, Coarse | 301 | 7.11 | 4.72 | ND* | ND* | ND* |
| Kelp Powder | 8203 | 4.78 | 2.30 | ND | 0.43 | ND |
| Kelp Whole Leaf | 726 | 5.97 | 6.05 | ND | 0.94 | ND |
| Rockweed Powder | 210 | ND | 3.28 | ND | ND | ND |
| Sea Lettuce Leaf | 40 | 3.17 | 3.11 | ND | 1.67 | ND |
| Toasted Nori Sheets | 332 | 4.59 | ND | ND | ND | ND |

**Table 7** Radiation testing results for sea vegetables harvested May-October 2017. Reported 05/13/18
*ND Not Detected above method detection limit

| Sample - **Isotope** | **K-40 (Bq/kg) +/-1.2%** | **Pb-214 (Bq/kg) +/-11.4%** | **Bi-214 (Bq/kg) +/-27.7%** | **Cs-137 (Bq/kg) +/-24%** | **Cs-134 (Bq/kg) +/-51%** | **I-131 (Bq/kg) -** |
|---|---|---|---|---|---|---|
| Toasted nori sheets | 827 | 9.92 | 0.79 | ND | ND | ND |
| Dulse leaf | 2316 | ND | ND | ND | ND | ND |
| Fucus powder | 1033 | ND | ND | ND | ND | ND |
| Alaria leaf | 3164 | ND | ND | ND | ND | ND |

**Table 8** Radiation testing results for sea vegetables harvested May-October 2018. Reported 06/20/19
*ND Not Detected above method detection limit