Activity of radioactive foods

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1 Hypothesis

A common salt substitute is to use KCl rather than NaCl. The gamma ray emission from ^{40}K should be visible from a sample of KCl from the grocery store, and emission intensity should be proportional to the mass present.

2 Introduction and procedure

The idea is simple: figure out where ^{40}K gamma rays should show up, and measure them. If you find them, for a fixed detection time and measurement geometry, vary the amount of KCl present. Intensity should be proportional to the mass present; you will need a scale.

You should be familiar with the UCS-30 gamma ray spectrometer by now from PH255. If not, one of your group members probably is. An abbreviated startup procedure is given below.

2.1 Startup

1. Turn on the power to the Spectech UCS30
2. run the program "USX USB" from the shortcut on the desktop
3. place the ^{60}Co source on top of the table, and place the lead cylinder around it
4. place the cylindrical NaI detector inside the lead cylinder
5. Turn the high voltage on and set to 650 V.
6. Expose the detector to the ^{60}Co source. Set the gain in UCS30, by adjusting the coarse gain and fine gain, such that two peaks (the 1173 and 1333 keV photopeaks) are visible in the collected spectrum on the right hand (high energy) side. If these peaks are too far to the left, you will have insufficient dynamic range for your measurements.

2.2 Running the experiment

1. Once you have set the detector to a reasonable gain, giving you sufficient dynamic range to detector the gamma radiation of all sources, perform an energy calibration. This is done by accumulating gamma ray spectra with a sufficient number of sources. Press the green diamond to start collecting data and the red octagon to stop, and use the "X" to clear the spectrum. Before clearing a spectrum to take the next measurement, save the data to the computer's hard disk (to be transferred to your thumb drive) as a Comma Separated File so you can get back to the data and analyze it in Excel on your own computer. Collect data for at least 5 minutes for each source. To analyze your

data highlight the characteristic peaks that become visible. These correspond to the full absorption of the radiation emitted in the decay of the excited nuclear states. When you hold the pointer over the highlighted areas the computer will display the number of accounts within the highlighted area, the average ADC count (sometimes called *peak centroid*, and the FWHM (Full Width at Half Maximum) value. FWHM is another measure for the standard deviation, σ, of a Gaussian. They relate to each other as $FWHM = 2 \cdot \sqrt{2 \cdot \ln(2)} \approx 2.36 \cdot \sigma$. Further record the counting time of each source measurement. Record all these data in an Excel spread sheet. You will use Excel for your data analysis.

Using Excel plot the measured gamma ray peak centroid (in ADC counts) versus their tabulated energy values. You will have to look up the known energies of the gamma lines on the web. The instructor can help you figure out how. Tip: the US national labs are wonderful sources of online data. The data points you collected should more or less line up on a straight line. The slope of this line gives you the energy calibration. If you are adventurous try to describe the data with a parabola. Does this give a better fit to the experimental data? The tabulated data and the energy calibration plot with fit need to be part of your written report.

In your Excel spread sheet convert the FWHM values into σ. Plot σ as a function of their corresponding peak centroids. Is there a trend? Can you fit the data with some appropriate mathematical function? Explain your data and choice of fit function in your report.

2. Put the unknown source on the detector and collect data for 5 minutes. Using your newly found energy calibration identify the radio nuclide(s) contained in this radiation source. Your report needs to explain how you identified the unknown material.

3 Task

Verify the hypothesis above![i]

[i] It is not clear if spilling No-Salt™is also bad luck, but let's not take any chances. That being said, don't throw it over your shoulder if you do; keep the lab clean.