

How Radioactive Is Your Banana?

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Bananas are a good dietary source of potassium. However, 0.0117% of natural potassium is the radioactive isotope ^{40}K , which decays by beta particle emission with a half-life of 1.26×10^9 years (1). This raises the question: how radioactive are bananas? This question is not as flippant as it might sound—at least one publication has advocated using a banana as a source of radioactivity in a laboratory exercise (2).

Answering this question is an interesting exercise in proportions and kinetics. First, we need to know that a large banana has a potassium content of about 600 mg (3). If 0.0117% of this is ^{40}K , then our large banana will have

$$(0.600 \text{ g}) \times (0.000117) = 7.02 \times 10^{-5} \text{ g}$$

of ^{40}K present.

Let us determine the activity of 1 mole of ^{40}K . A half-life of 1.26×10^9 years is equivalent to $t_{1/2}$ of 3.97×10^{16} s. This, in turn, can be converted to a rate constant using the expression:

$$k = \frac{\ln 2}{t_{1/2}}$$

This gives us a value of $1.75 \times 10^{-17} \text{ s}^{-1}$ for k . Using the first-order rate expression

$$\frac{\Delta N}{N} = -kt$$

and a time t of 1 s, we can determine the activity of one mole, 6.022×10^{23} atoms, of ^{40}K per second:

$$\frac{\Delta N}{6.022 \times 10^{23}} = -(1.75 \times 10^{-17} \text{ s}^{-1})(1 \text{ s})$$

$$\Delta N = -1.05 \times 10^7$$

That is, in one mole (40.0 g) of ^{40}K , about 10.5 million atoms are decaying per second. Finally, to answer our banana-related question, we set up the following proportion:

$$\frac{1.05 \times 10^7}{40.0 \text{ g}} = \frac{x}{7.02 \times 10^{-5} \text{ g}}$$

Solving to get our final answer:

$$x = 18.4$$

A large banana has an activity of about 18.4 Bq (becquerel, equal to one disintegration or nuclear transformation per second), or 0.511 nCi (nanocuries). As a comparison, the americium in a typical smoke detector has an activity of 0.9 μCi , or the equivalent of about 1800 bananas.

Perhaps the banana can become a standard for very-low-level radioactivity...

Literature Cited

1. Lide, D. R. *CRC Handbook of Chemistry and Physics*, 82nd ed.; CRC Press: Boca Raton, FL, 2001.
2. Hoeling, B.; Reed, D.; Siegel, P. B. *Am. J. Phys.* **1999**, *67*, 440.
3. Complete Guide to Bananas. <http://www.banana.com/nutrition.html> (accessed Jun 2004).