Food irradiation is a sensitive subject for many people. The practice involves exposing the food to ionizing radiation in order to kill harmful bacteria (such as salmonella) that cause sickness. The food is essentially unchanged and does not lose any nutritive value. Parasites and insect pests are easily destroyed by this process, while bacteria take longer to kill. Viruses are not affected by the radiation treatment. But don’t worry - the food is not radioactive and you will not glow in the dark if you eat it.

**Nuclear Decay Processes**

Radioactive decay involves the emission of a particle and/or energy as one atom changes into another. In most instances, the atom changes its identity to become a new element. There are four different types of emissions that occur.

**Alpha Emission**

**Alpha ($\alpha$)** decay involves the release of helium ions from the nucleus of an atom. This ion consists of two protons and two neutrons and has a $\pm 2$ charge. Release of an $\alpha$-particle produces a new atom that has an atomic number two less than the original atom and an atomic weight that is four less. A typical alpha decay reaction is the conversion of uranium-238 to thorium:

\[
\text{\textit{\text{^{238}\text{U}}} \rightarrow \text{\textit{\text{^{234}\text{Th}}} + \text{\text{^4_2 \alpha}}}^+}
\]

We see a decrease of two in the atomic number (uranium to thorium) and a decrease of four in the atomic weight (238 to 234). Usually the emission is not written with atomic number and weight indicated since it is a common particle whose properties should be memorized. Quite often the alpha emission is accompanied by gamma ($\gamma$) radiation, a form of energy release. Many of the largest elements in the periodic table are alpha-emitters.

![Figure 24.2.1: Emission of an alpha particle from the nucleus.](image)

**Beta Emission**

**Beta ($\beta$)** decay is a more complicated process. Unlike the $\alpha$-emission, which simply expels a particle, the $\beta$-emission involves the transformation of a neutron in the nucleus to a proton and an electron.
The electron is then ejected from the nucleus. In the process, the atomic number increases by one while the atomic weight stays the same. As is the case with $\alpha$-emissions, $\beta$-emissions are often accompanied by $\gamma$-radiation.

A typical beta decay process involves carbon-14, often used in radioactive dating techniques. The reaction forms nitrogen-14 and an electron:

$$\ce{^{14}_6C} \rightarrow \ce{^{14}_7N} + \ce{^0_{-1}e}$$

Again, the beta emission is usually simply indicated by the Greek letter $\beta$; memorization of the process is necessary in order to follow nuclear calculations in which the Greek letter $\beta$ appears without further notation.

**Positron Emission**

A positron is a positive electron (a form of antimatter). This rare type of emission occurs when a proton is converted to a neutron and a positron in the nucleus, with ejection of the positron. The atomic number will decrease by one while the atomic weight does not change. A positron is often designated by $\beta^+$. Carbon-11 emits a positron to become boron-11:

$$\ce{^{11}_6C} \rightarrow \ce{^{11}_5B} + \ce{^0_{+1} \beta}$$

**Electron Capture**

An alternate way for a nuclide to increase its neutron to proton ratio is by a phenomenon called electron capture. In electron capture, an electron from an inner orbital is captured by the nucleus of the atom and combined with a proton to form a neutron. For example, silver-106 undergoes electron capture to become palladium-106.

$$\ce{^{106}_{47}Ag} + \ce{^0_{-1}e} \rightarrow \ce{^{106}_{46}Pd}$$

Note that the overall result of electron capture is identical to positron emission. The atomic number decreases by one while the mass number remains the same.
Gamma Emission

Gamma \( \gamma \) radiation is simply energy. It may be released by itself or more commonly in association with other radiation events. There is no change of atomic number of atomic weight in a simple \( \gamma \)-emission. Often, an isotope may produce \( \gamma \)-radiation as a result of a transition in a metastable isotope. This type of isotope may just "settle", with a shifting of particles in the nucleus. The composition of the atom is not altered, but the nucleus could be considered more "comfortable" after the shift. This shift increases the stability of the isotope from the energetically unstable (or "metastable") isotope to a more stable form of the nucleus.

Summary

- Radioactive decay processes are described.

Contributors

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