

Isolating the Elemental Iron in Cereal

Overview

In this activity, students will learn that the mineral iron, added to iron-enriched cereal, is often present in the form of tiny iron metal filings. While this form of iron is not metabolically useful, the acidic solution present in the consumer's stomach is able to dissolve the iron filings, making the iron physiologically useful.

Thinking About the Experiment in Advance

1. Only three commonly found metals are magnetic. They are iron, cobalt, and nickel.
2. Iron is a critical component of hemoglobin, the protein that transports oxygen from our lungs to the tissues and organs in our body. We use the oxygen to provide energy from the foods we eat. People suffering from anemia are deficient in iron and often lack the energy required to carry out daily tasks. According to the National Institutes of Health, the average daily iron intake from foods and supplements is 13.7–15.1 mg/day for children 2–11 years old, 16.3 mg/day for children and teens 12–19 years old, 19.3–20.5 mg/day in men and 17.0–18.9 mg/day for women older than 19 (<https://ods.od.nih.gov/factsheets/Iron-HealthProfessional/#:~:text=The%20average%20daily%20iron%20intake,in%20women%20older%20than%2019.>)
3. To be properly nourished, our diets must include the vitamins and minerals required for good health. Consuming larger amounts of iron is dangerous, so it is important not to consume too much. This is often accomplished by eating a well-balanced diet, including fruits and vegetables.
4. Iron exists in several forms, including its elemental, metallic form, and in combination with other elements in various compounds. We can identify the form of the iron by its name. The elemental, uncombined form, is often referred to as reduced iron or mineral iron. The combined forms usually contain the terms 'ferrous' or 'ferric' in their names. Ferrous iron is the biologically useful form of the element.
5. Because intake of small amounts of iron is so important for our good health, cereal manufacturers often add it to their products. To increase the shelf-life of the cereal, the iron is added in its uncombined, or elemental form, as fine, metallic filings, or powder. Although we cannot use that form of iron to carry oxygen, the acid in our stomachs dissolves the filings or powder, converting it into the ferrous form which is very useful.

Materials

1. Dry breakfast cereal (bran flakes, etc.) with high iron content
2. One-cup measuring device
3. Plastic bag with zip-lock closure, quart-size or larger, or blender or mortar and pestle
4. Rolling pin (to crush the cereal if you use the zip-lock bag)
5. Thin-walled transparent plastic cup that holds two cups of liquid or more
6. Spoon or another stirring device
7. Water
8. Strong magnet
9. Waxed paper, small piece

Procedure

1. Measure one cup of dry cereal. Pour the cereal into the plastic zip-lock bag, mortar, or blender container.
2. If cereal is in the zip-lock bag, use the rolling pin to crush the cereal into very fine crumbs. Alternatively, grind the cereal into very fine crumbs using the pestle in the mortar, or the blender.
3. Transfer the cereal crumbs into the plastic cup, which should be filled about one-quarter or less full.
4. Add water to the cup, until the cup is about three quarters full.
5. Use the spoon to stir the mixture for 10 or 15 minutes, letting the cereal soften in the water. The cereal will absorb much of the water so you may need to continue adding water until you have a very liquid mixture that stirs easily.
6. Once the cereal has softened, hold the magnet tightly along the outside wall of the cup at a level near the top of the water-cereal mixture.
7. With the magnet tightly in place, stir the softened cereal-water mixture for several minutes. Carefully watch the area inside the cup at the point where the magnet is touching the cup's outer wall.
8. When you see a small black band of fine powder accumulate along the inside wall, stop stirring but do not remove the magnet from its position along the outside cup wall.
9. Carefully tip the cup and its contents so that the liquid level is lower than that of the magnet, leaving the black deposit out of the water-cereal mixture. The black material is the iron filings. Carefully tip the cup back to its upright position and record your observations of the iron filings in a notebook or other recording device. If there is enough iron, transfer it to a small piece of waxed paper so you can observe it more carefully. Record those observations.
10. Transfer the cereal-water mixture into a container for appropriate disposal. Dispose of waxed paper and plastic bag. Wash and dry the plastic cup and spoon.

Thinking About What You Observed

1. Why did the amount of iron you isolated from the cereal seem so small? Would it have been safe to consume a serving of cereal if it had contained a much larger amount of iron?
2. Examine the nutrition label on the cereal you tested. Does it list the amount of iron present in one serving? If you were to eat one serving of the cereal, would it provide you with the daily allowance based on the data reported by the National Institutes of Health referenced in this experiment?
3. Read the smaller print at the bottom of the nutrition label to determine the form in which the iron is present in the cereal. Which does it say: 'reduced iron', mineral iron, or ferrous iron? Check the labels of other food items in your kitchen (for example, pasta products or baking mixes) to see whether they contain any iron. If they do, in what form is it present?
4. Do an internet search to determine the form in which iron is included in vitamin supplements. Would you expect to be able to isolate iron from those supplements using a magnet? Why, or why not?