Pfizer Education Initiative

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Iron in Cereal

Description:
A small magnet is used to remove particles of iron from iron fortified breakfast cereal. This demonstration can be used when discussing food digestion, human physiology, red blood cells, or nutrition.

Safety Wear safety goggles or glasses at all times in the laboratory. There are no hazards associated with materials in this experiment.

Standards:
Grade *K-4*

- Employ simple equipment and tools to gather data.
- Magnets attract and repel each other and certain kinds of other materials.
- Nutrition is essential to health. Students should understand how the body uses food and how various foods contribute to health. Recommendations for good nutrition include eating a variety of foods, eating less sugar and eating less fat.

Grade 5-8

- A substance has characteristic properties.
- Some chemical elements can be recovered (iron filings).

- Cells carry on the many functions needed to sustain life. This requires that they take in nutrients, which they use to provide energy for the work that cells do and to make the materials that a cell or an organism needs.

Grade 9-12

- Most cell functions involve chemical reactions. Food molecules taken into cells react to provide the chemical constituents needed to synthesize other molecules.
- Selection of foods and eating patterns determine nutritional balance.

From the National Science Education Standards

Materials:

- Total® brand cereal, or other high iron content breakfast cereal
- zip type bags
- Beaker
- Magnetic stir bars
- Stir plate
- Magnetic stir rod
- Magnetic wands

Procedure:
Experiment can either be a demonstration or hands-on.

Demonstration:

1. Add Total Cereal up to the 500-mL volume of a 2-liter beaker. Add water up to 800-mL mark of the beaker.
2. Place large magnetic stir bar and place beaker on magnetic stir/hot plate.
3. Stir for approximately 10 minutes or until the cereal turns into a slurry of smaller particles.
4. Using magnetic stir rod, retrieve the magnetic stir bar and observe your findings.

Hands on:

1. Measure ¾ cup or weight 30 grams (serving size) of Total Cereal and place into a zip-type baggie.
2. Add a small magnetic stir bar and 100-ml of water to the baggie of cereal.

Suggested Question: What is another way when we eat the cereal to break it into little pieces?

Target Response: Use teeth to chew food to smaller pieces.

3. Securely close the zip lock bag. Using your hands, mix the cereal into the water.

Suggested Question: What happens to the cereal when you mix it with the water?

Target Response: It will break down, get mushy.

Suggested Question: What happens to cereal in your mouth and stomach after you eat it?

Target Response: It breaks down, gets mushy.

Suggested Question: What is the process called when our bodies break down food?

Target Response: Digestion

Suggested Question: Why do our bodies need to break down food?

Target Response: For energy, nutrients

Suggested Question: What do you think will happen when this "digested" cereal is stirred with this magnet?

Target Response: Nothing, some students may predict iron to stick to the magnet.

5. Retreive magnetic stir bar from the mixture observe the stir bar.

Suggested Question: What happened when we stirred the cereal with the magnet? What did you see on the magnet?

Target Response: Black stuff

Suggested Question: What was the black stuff on the stir bar?

Target Response: Dirt, iron

Suggested Question: The black stuff on the magnetic stir bar is iron, and the Total cereal people put it there on purpose. Did you expect to get iron metal from breakfast cereal? Why would they do this?

Target Response: For nutrition

Are the cereal makers just kidding us by putting iron metal in our cereal? Given that iron metal will not dissolve in water, how is it going to be absorbed in our body? Won't it just be excreted like most other small iron objects would if we swallowed one? Why, or why not?

Present a large nail or spike and ask students if think we could get the same nutrition if we chewed on this?

See below explanation to lead discussion.

Explanation

The iron in the cereal is pure iron! It is the same iron found in nails and automobiles. It is mixed in the cereal batter along with many other additives. It is different than the iron found in iron pills. The iron in iron pills is ionic (e.g., $FeSO_4$) which is more easily broken down and used by the body. Cereal makers however cannot use ionic iron because it speeds up spoilage and the shelf life of the cereal would be shortened. Iron is often added to fortified cereals in the form of powdered iron (often listed as reduced iron in the ingredients). Powdered iron is easy to measure, has no stability problems, and does not affect the taste or color of the cereal in this form.

The particles of iron are very tiny and the chewing process dislodges them from the flakes. Upon swallowing the cereal, the very tiny pieces of iron react quickly with the acid and other chemicals in the digestive tract, changing it to a form that is more readily absorbed by the body. However it takes several days for the iron to be dissolved by the

mild acid found in our stomachs. Unfortunately, because the iron only remains in our stomachs a short time, little of this iron metal is dissolved, and most of it is probably excreted.

In a letter from General Mills, regarding the iron in Total cereal, they stated that the absorption iron is not completely understood and that sufficient iron is added to the cereal to insure that the required daily amount of iron is processed by the body. What this tells us is that the company advertises that their product contains the recommended iron allowance but that our bodies are probably not absorbing the full amount that is recommended.

Added Nutritional Information

Iron is the most abundant metallic element in the human body as well as an essential nutrient. The required daily dose of iron is only 18 mg per day; therefore, it is called a micronutrient. A deficiency of iron is called anemia and it causes fatigue and decreased resistance to infection. Cereal is often supplemented with iron. Metallic iron cannot be absorbed by the body; however, iron that's in the oxidized form of Fe^{3+} is easily absorbed. The addition of iron filings to food is a common method of iron enrichment. The metal filings are not bioavailable until they reach the stomach where they are oxidized to Fe^{3+}. The human body requires iron for many functions. Most importantly, iron is used in the production of hemoglobin molecules in red blood cells. It is the iron in the hemoglobin that attracts oxygen molecules, allowing the blood cells to carry oxygen to body cells. Red blood cells are constantly being replaced. Therefore, there is a constant need for a new supply of iron in the diet. That is why iron is often mentioned as a healthful additive to certain foods and vitamin pills.

Other suggested activities

1. Have a student look at the side of the cereal box to get the serving size and the percentage of the United States recommended daily allowance (U.S. RDA) of iron for each person. Ask if they think if we are really getting our full 100% daily allowance of iron in this form.
2. Direct the students to collect the amount of iron indicated in the "recommended daily allowance" column. If you do not have a milligram balance, student can make a rough determination by an indirect method. Allow them to develop their own plan. Wash the iron collected and dry it on absorbent paper. Use the cereal box to determine the number of servings included in the box. Divide the iron into that many equal piles.
3. Have cereals containing various amounts of iron available for use. Follow the procedure in using two different types of cereal. Compare the amounts of iron claimed to be present in one serving of each cereal. Based on your findings, determine the validity of the claims of the cereal manufacturers. Record the group results on the board. Students' conclusions should correspond to the amount of iron obtained and the claims of the manufacturers of the cereal. Use iron fortified

breakfast cereal such as Total, Special K, etc..., instant breakfast cereal packets such as Instant Cream of Wheat or instant oatmeal.

4. Wearing labcoat, gloves, and safety glasses or goggles, add some filings to a test tube. Add 1-mL of 0.1 M hydrochloric acid (HCl) and cap tube. Let the mixture stand overnight. If iron dissolves, the solution will be a light green in color is the iron is in the form of iron(II) chloride and yellow if it is iron(III) chloride. What do you observe?
5. Have students call or write a letter to the Consumer Departments of the cereal companies for additional information.
6. Talk about blood cells using microscope and available slides.

Disposal

Clean magnetic stir bar, wand, beaker. All other materials in this experiment can be disposed of in the trash.

REFERENCES

Robert Becker, *An Incredible Evening of Chemistry: 20 Demonstrations Guaranteed to Knock Your Socks Off*, Flinn Scientific, Inc., 1993, pages 13-14 and Mickey Sarquis and Jerry Sarquis, **Fun with Chemistry: A Guidebook of K-12 Activities**, Volume 1, Institute for Chemical Education, University of Wisconsin - Madison, 1991, pages 49-52

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