Rubber Bones

Introduction

How does drinking milk make bones stronger? Use this inquiry-based lab activity to test for the presence of calcium in chicken bones.

Concepts

- Bone structure
- Physiology
- Nutrition

Materials

Calcium carbonate, $CaCO_3$, (marble chips or limestone), 1.5 g
Sodium oxalate solution, $Na_2C_2O_4$, 1% solution, 2 mL
Vinegar, white, 6 mL
Water, distilled
Beaker, 50-mL
Beral pipets
Chicken bones, cooked (wishbone or leg bones)
Filter paper
Funnel
Graduated cylinder, 10-mL
Mortar and pestle
Stirring rod
Test tube, 16 × 100 mm

Safety Precautions

Sodium oxalate solution is slightly toxic by ingestion. Vinegar (dilute acetic acid) is a skin and eye irritant. Wear chemical splash goggles, chemical-resistant gloves, and a chemical-resistant apron. Wash hands with soap and water before leaving the laboratory.

Procedure

I. Qualitative Test for Calcium Ions

1. Grind calcium carbonate with a mortar and pestle. Weigh 1.5 g of powder into a 50-mL beaker.
2. Add 6 mL of vinegar and stir well. Carbon dioxide gas will be evolved. Allow any remaining solid to settle.
3. Filter the liquid above the solid into a test tube. The filtrate should be clear.
4. Add several drops of sodium oxalate solution to the test tube. Formation of a white precipitate (calcium oxalate) confirms the presence of calcium.

II. Inquiry Design

After students have performed the qualitative test for calcium, ask them to design an experiment to determine if the presence of calcium in cooked chicken bones makes bones strong. Discuss the need for positive and negative controls in the experiment.

III. Sample Experiment

Positive control
The qualitative test for calcium ions (Part I) may be used as a positive control for the experiment.

Negative Control
Cover cooked chicken bones with distilled or deionized water and allow to soak overnight. Add 2 mL of the resulting solution to a test tube and test calcium ions. Examine the hardness of the bones. Repeat test at regular intervals for one week.

Experimental Sample
Cover the cooked chicken bones with vinegar. Let soak overnight. Add 2 mL of the resulting solution to a test tube and test for calcium ions. Examine the hardness of the bones. Repeat test at regular intervals for one week.

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Disposal

Please consult your current *Flinn Scientific Catalog/Reference Manual* for general guidelines and specific procedures, and review all federal, state and local regulations that may apply, before proceeding. Vinegar and sodium oxalate may be disposed of according to Flinn Suggested Disposal Method #26b.

Connecting to the National Standards

This laboratory activity relates to the following National Science Education Standards (1996):

Unifying Concepts and Processes: Grades K–12
Evidence, models, and explanation
Constancy, change, and measurement
Content Standards: Grades 5–8
Content Standard A: Science as Inquiry
Content Standard B: Physical Science, properties and changes of properties in matter
Content Standard F: Science in Personal and Social Perspectives; personal health
Content Standards: Grades 9–12
Content Standard A: Science as Inquiry
Content Standard B: Physical Science, chemical reactions
Content Standard F: Science in Personal and Social Perspectives, personal and community health

Tip

- To prepare a 1% sodium oxalate solution from a solid, dissolve 1 g of sodium oxalate in 100 mL of distilled or deionized water. To prepare a 1% solution from 0.1 M sodium oxalate solution, mix 59 mL of 0.1 M sodium oxalate with 41 mL of distilled or deionized water.

Discussion

Using vinegar to remove calcium from bones is a popular experiment. However, some students think that the chicken bones are simply "degraded" by soaking them in acid. Prove to students that it really is calcium that is removed from the bone leaving a rubbery matrix behind. First students should learn how to test for calcium by running the positive control. Allow students to formulate a procedure which tests for the presence of calcium in chicken bones. This is a safe experiment to help students learn experimental design. Allow collaboration between teams. Guide students through a formal experimental report with data tables.

This experiment demonstrates the reaction of calcium carbonate ($CaCO_3$) with acetic acid or vinegar ($HC_2H_3O_2$) to form calcium acetate, a soluble salt. The calcium ion is free to react with the oxalate ion ($C_2O_4^{2-}$) to form a white precipitate of calcium oxalate (CaC_2O_4). This is one test for the presence of calcium ion. Calcium oxalate is insoluble in water and acetic acid.

$$CaCO_3(s) + 2HC_2H_3O_2(l) \rightarrow Ca^{2+}(aq) + 2C_2H_3O^{-}(aq) + CO_2(gas) + H_2O(l)$$

$$Ca^{2+}(aq) + C_2O_4^{2-}(aq) \rightarrow CaC_2O_4(s)$$

Calcium can be removed from bone and reacted with the oxalate ion in the same manner as the known calcium source.

The bones soaked in vinegar will become rubbery. The bones soaked in water will remain bone brittle. Removing enough calcium to yield "rubber bones" will take several days. Leg bones may take a week or more. Add fresh vinegar as needed to keep bones covered and use covers on the beakers to help prevent evaporation. The distilled water and vinegar used in the experiment should be tested for calcium ions as a part of the negative control aspect of student designs. *Note:* Tap water may give a positive test for calcium in some regions of the country. Encourage students to examine their chicken bones soaked and unsoaked under a dissecting microscope.

Chickens are fed materials that contain calcium carbonate. Chicken egg shells are also formed from calcium carbonate. In the heat of summer, chickens sometimes lay eggs with weak shells that break easily. One hypothesis for these weakened shells is that chickens don't perspire to cool off and they hyperventilate and exhale excess carbon dioxide. The calcium carbonate needed for eggshell production is thus diminished in supply and not as much calcium carbonate is produced to coat the egg—thus the weakened eggshell.

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Materials for *Rubber Bones* are available from Flinn Scientific, Inc.

Catalog No.	Description
C0347	Calcium Carbonate, 100 g
S0249	Sodium Oxalate, 0.1 M Solution, 500 mL

Consult your *Flinn Scientific Catalog/Reference Manual* for current prices.