Natural Rubber: Harvest, Manufacture & Test

Objective:

Explore and investigate an alternative source of rubber.

Keywords:

- Rubber
- Synthetic
- Natural polymer
- Latex

21st Century Skills Represented:

- Environmental Literacy
- Critical Thinking & Problem Solving
- Communication & Collaboration

National Science Education Standards:

- Earth & Space Science: Earth & Human Activity
- Physical Science: Matter & its Interactions
- Engineering, Technology & Applications of Science: Links Among Engineering, Technology, Science & Society

feedstocks	processes	uses
Crop – Russian dandelions & guayule	Mechanical – extraction/separation Chemical conversion - polymerization	Rubber

Background

The only commercial natural rubber source in the world is the Brazilian Rubber Tree. Extracting the rubber from the trees is a process that is still very primitive. Most of the extracted materials are still collected in buckets, and even coconuts.

Natural rubber is essential for the U.S. economy and national security because it provides performance characteristics not available from synthetic, petroleum-derived rubber. North America consumes 2.7 billion pounds of natural rubber, of which 80% is used in tires. Trucking, construction and aviation tires require a high percentage of natural rubber to meet performance characteristics making natural rubber critical to the nation's trucking and construction industries as well as the U.S. strategic defenses. Aircraft tires require nearly 100% natural rubber to meet heat tolerance and required adhesion specifications.

The clear solution to this market need is a new rubber industry which will provide high quality, domestically grown rubber. Up until five years ago, natural rubber supplies have been adequate. However, due to increased consumption worldwide, natural rubber prices have increased five-fold since 2001. It is forecasted that demand will exceed supply in 2020 by approximately 15%.

What can be done to domesticate and commercialize sources of natural rubber and to identify and develop processes, uses, and markets for co-products? What are the properties and characteristics of natural rubber that make it such a valuable commodity for so many industries? Explore the exciting research and commercialization that is developing around the Russian dandelion.

Materials

Per group of 2-3 students:

- Various sizes and types of rubber bouncy balls
- Enough dandelions to retrieve ½ teaspoon of sap
- ¼ cup water
- Beaker to hold at least 1 cup of liquid
- Vinegar
- Plastic straw
- Bunsen burner and forceps
- Styrofoam cup
- Ice to fill styrofoam cup to ¾ level

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Pre-Lab Preparation

1. Break students into small groups. Provide each group with differing types and sizes of rubber bouncy balls.
2. Have each group bounce the balls and determine the highest bouncers.
3. When finished with their testing, each group should answer the following questions:
   a. Why did some balls bounce higher than others?
   b. What physical characteristics do the higher bouncers have in common (i.e. big, rough, dense, etc.)?
   c. What characteristics of rubber do you think make it bouncy?
4. As a class discuss the group's answers.
5. As a class discuss the following ideas:
   a. What is a polymer?
   b. What are some examples of polymers?
   c. What are the differences between man-made/synthetic polymers and natural polymers?

Lab Procedures

1. Harvest the dandelion sap by squeezing the stem until you have ½ teaspoon. Place sap into beaker.
2. Add ¼ cup of water to the beaker and stir the mixture with a straw.
3. Slowly add vinegar until the sap attaches itself to the straw.
4. Remove the sap from the straw and squeeze into a ball. This will expel the excess water.
5. Bounce the ball and record your observations.
6. Hold the ball with the forceps and heat it over the Bunsen burner for a few seconds.
7. Bounce the ball and record your observations (i.e. was it higher or lower than before).
8. Fill a Styrofoam cup ¾ full of ice and place the ball on top of the ice.
9. Place a second Styrofoam cup on top of the first to contain the ice and shake vigorously for a few minutes.
10. Bounce the ball and record your observations (i.e. was it higher or lower than before).

Post-Lab Discussion/Question

1. Have students graph the relative heights of the different rubber balls (i.e. synthetic, natural made at room temperature, natural heated, and natural chilled).
2. Students should then answer the following questions:
   a. How did the bounciness of the naturally made ball compare at the differing temperatures (i.e. room temperature, hot, and cold)? Why do you think there was a difference?
   b. How did the bounciness of the synthetic ball compare to that of the naturally made ball? Why do you think there was a difference?
   c. How did the characteristics of the synthetic ball compare to the naturally made ball?
   d. What are the benefits of using the natural rubber over the synthetic rubber? What are the disadvantages?
3. As a class discuss the following ideas and questions:
   a. Current research that will use the sap of Russian dandelion roots to make rubber.
   b. Why is there interest in finding natural rubber sources?
   c. What is the potential for market development?

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Expansion Ideas

- Change the amount of vinegar to test the strength of the rubber balls.
- Use sticky sap from other plants, such as milkweed.

Evaluation of Learning

- Graphs of bouncing balls.
- Develop comparison tests for rubbers made from other natural polymers.

Resources

- Videos
  - Dandelion Rubber from YouTube by The Ohio State University-OARDC
  - In Your House, In Your Car: OARDC Boosts Development of New Bioproducts from YouTube by The Ohio State University-OARDC
  - Dandelions in Tomorrow's Automobiles from YouTube by OBIC

- Websites and Articles
  - Background on polymers and more lesson plans on rubber by the Akron Global Polymer Academy at the University of Akron
  - Program of Excellence in Natural Rubber Alternatives (PENRA) by The Ohio State University-OARDC
  - Dandelion Rubber Could Replace Rare Sources by Eric Bland, Discovery News

Contacts

- Ohio Agricultural Research and Development Center at The Ohio State University, Wooster, OH: http://oardc.osu.edu/
- Akron Global Polymer Academy, Akron, OH: http://agpa.uakron.edu/

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