

Natural Adhesives

Objective:

Investigate natural alternatives compared to synthetic-based adhesives.

Keywords:

- Adhesives
- Natural adhesives
- Mussels
- Gecko

21st Century Skills Represented:

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

National Science Education Standards:

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

feedstocks

Crop - flour from soybeans

processes

Chemical conversion - polymerization

uses

Adhesives

Background

What are glues and adhesives? Which properties make some better than others?

An adhesive, or glue, is a mixture in a liquid or semi-liquid state that bonds items together. Glues are generally made from organic or bio-based compounds, while adhesives are chemical-based.

The use of glue can be traced back to cave paintings from the time of the Neanderthals. Furniture making throughout the course of history has relied heavily on glues. In the 1930s with advances in the chemical and plastics industry, new adhesives or synthetic resin glues were developed. The new adhesives have specialized properties such as being waterproof, which make them valuable for many commercial uses including the aerospace industry.

Kymene is soy glue that is used in paper making and various wood products.

Glues are essential to our future. Increasing numbers of manufacturing processes are using various forms of glues and adhesives to replace stitching, stapling, and more expensive (and less effective) forms of fastening. Experiments with medical glues suggest that one-third of all wounds may be "stitched" with glues in the next few years. Glues have proven to be so versatile that scientists are constantly watching for new applications. Scientists are again looking to nature for new clues to help with engineering better adhesives.

Materials

Per group of 2-3 students (may want to provide extra supplies for additional tests):

- 1 cup soy flour
- 1/3 cup sugar
- 1 teaspoon vinegar
- 2 wooden craft sticks (large or jumbo)
- 1 clear plastic cup
- 1 wooden stir stick
- Measuring tools: cups and spoons
- Water

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Pre-Lab Preparation

1. Have students record their answers to the following questions:
 - a. What is an adhesive?
 - b. What are adhesives used for?
 - c. What is a natural adhesive?
2. Hold a class discussion on the questions and their answers.
3. Have students collaborate to conduct research on these questions:
 - a. How do mussels stick to varying surfaces under water?
 - b. Why are geckos able to climb varying surfaces?
 - c. How does an anteater's sticky tongue work?
 - d. Why do bugs stick to a spider's web?
4. Share the results of the research during a class discussion. How could we use these ideas from nature to make natural adhesives?

Lab Procedures

1. Divide the students into groups of 2 or 3.
2. Have each group gather two craft sticks, a wooden stirring stick, and a plastic cup.
3. Each group should place 1 cup soy flour into the plastic cup. Then add:
 - a. 1 ½ cup water
 - b. 1/3 cup sugar
 - c. 1 tsp. vinegar
4. Using the stir stick, mix the contents very thoroughly.
5. Each group should then use the stir stick to apply the mixture to the end of one craft stick.
6. They should then place the end of the other craft stick on top of the mixture to adhere them together.
7. Allow a few moments for the adhesive to dry.
8. Each group should then develop a series of tests to determine the strength of the adhesive.
9. Have groups mix differing ratios of ingredients and test the strength of those mixtures. Test at least four different ratios.
10. Students should record their procedures, results, and observations in their notebooks.

Post-Lab Discussion/Question

1. Provide students with a list of ingredients used in common synthetic adhesives.
2. Have the students record their answers to the following questions:
 - a. What recipe/ratio of ingredients worked the best?
 - b. What tests did you perform and what did they tell you about the soy adhesive?
 - c. What ingredients in common synthetic adhesives might be harmful to human health and the environment?
 - d. Do you think it is beneficial to make natural adhesives that do not contain the harmful chemicals synthetic adhesives have? Why?
3. Hold a class discussion on the questions and their answers.

Natural Adhesives

Expansion Ideas

- Have students test the strength of their soy adhesive against that of a synthetic adhesive.
- Have students test the effectiveness of using cornstarch and soy flour in making natural adhesives.

Evaluation of Learning

- Students were able to successfully make and use at least four different batches of soy adhesives.
- Students will turn in their procedures, results, observations, and answers to all questions.

Resources

- Videos
 - [Wood Glue Inspired by Mussels](#) from ScienceDaily
- Websites and Articles
 - [How Products Are Made: Glue](#)
 - [Kymene \(includes other references\)](#)
 - [Natural Adhesives & Glues](#)
 - [Homemade Natural Glue Recipe](#) by sustainableecho
 - [Adhesives in Everyday Life](#) by The Adhesive World
 - [Soy Inks and Adhesives: Cost Savings and Environmental Assurance](#) by United Soybean Board
 - [Soy flour](#) by Cargill
 - [Purdue students create new products from corn and soybeans](#) by Ag Answers

Contacts

- National Polymers, Chagrin Falls, OH: <http://www.nationalpolymer.com/>