Bubbles in the Cabbage Juice

Objective

Students will conduct experiments with cabbage juice as an indicator to identify carbon in a variety of substances.

Background

Cabbage is a cole crop, related to broccoli, cauliflower, kale and Brussels sprouts. It is a cool weather vegetable that grows well in Oklahoma when planted very early in the spring or in the fall.

The cultivated cabbage is derived from a leafy plant called the wild mustard plant, native to the Mediterranean region. It is an excellent source of Vitamin C and contains large amounts of glutamine, an amino acid that has anti-inflammatory properties.

Red cabbage contains a pigment molecule called flavin (an anthocyanin). This water-soluble pigment is also found in apple skin, plums, and grapes. Very acidic solutions will turn anthocyanin a red color. Neutral solutions result in a purplish color. Basic solutions appear in greenish-yellow. Because of this it is possible to determine the pH of a solution based on the color it turns the anthocyanin pigments in red cabbage juice.

The color of the juice changes in response to changes in its hydrogen ion concentration. Acids will donate hydrogen ions in an aqueous solution and have a low pH. Bases accept hydrogen ions and have a high pH.

English Language Arts: Read and Discuss

1. Provide copies of the reading page included with this lesson, "Carbon, Agriculture and Global Climate Change.
   —Students will read as a group or individually.
   —Discuss the information as a class.
   —Students will determine the central idea of the reading and how it is conveyed through particular details.
   —Students will provide a summary of the text distinct from personal opinions or judgments.
   —Students will determine the author's purpose and explain how it is conveyed in the text.
2. Students will use online search engines to research one of the following topics: terrestrial carbon sequestration, no-till farming.
   —Students will gather relevant information from multiple print and digital sources, assess the credibility of each source and quote or paraphrase the data and conclusions of others while avoiding plagiarism and providing basic bibliographic information for sources.
   —Students will work in groups to discuss what they have learned from their research.

Oklahoma Academic Standards

GRADE 6
Speaking and Listening: R.1,2,3; W.1,2. Reading and Writing Process: R.1,2,3. Research: R.1,2,3; W.1,2,3 Physical Science: 1-4. Life Science: 2-1,3. Earth Science: 3-3

GRADE 7
Speaking and Listening: R.1,2,3; W.1,2. Reading and Writing Process: R.1,2,3. Research: R.1,2,3; W.1,2,3 Physical Science: 1-2

GRADE 8
Speaking and Listening: R.1,2,3; W.1,2. Reading and Writing Process: R.1,2,3. Research: R.1,2,3; W.1,2,3 Physical Science: 1-3,5,6. Life Science: 1-7. Earth Science: 2-1; 3-4

Science

ACTIVITY ONE

Advance Preparation

—Warn teachers in the surrounding classrooms that you will be conducting an experiment that smells bad.
—Bring distilled water to a boil.
—Chop the cabbage and add it to the boiling water.
—Remove the water from the heat and let it stand for about 30 minutes, stirring occasionally.
—Strain the liquid into a pitcher and let it cool.
—Label five clear short fat cups as follows:
control
yeast/sugar
baking soda/vinegar
club soda
breath
—Pour some of the cooled liquid into each of the cups.
—Set aside the remaining liquid to use in Activity 2.

Explain

—Read and discuss the background information about cabbage. Explain that cabbage is an indicator—a substance that indicates the presence, absence or concentration of a substance or the degree of reaction between two or more substances by means of a characteristic change. In addition, explain that carbon dioxide makes an acid when dissolved in water.

Procedure

—Remind students of potential hazards when mixing substances together. As always, practice safety procedures in all science activities.
—Divide students into four groups, and provide each group with one of the cards included with this lesson.
—Students will read the cards ahead of time to make sure they understand the procedure.
—Divide the cabbage juice evenly among the five labeled cups.
—Keep the "control" cup separate so all groups will be able to compare their results to it.
—Give each of the groups one of the labeled cups and the appropriate materials.

Summary

—After all groups have concluded their experiments, line up all four cups.
—Students will compare the four cups with the control cup and with each other.
—Students will summarize the investigation using the "Scientific Method Outline" included with this lesson.
—Students will answer the following questions in their summaries:

- Did one source of carbon dioxide cause more color change than the other sources?
- Which method would you use if you needed to make a large amount of

Resources Needed

1 purple cabbage

2 quarts distilled water
pitcher

clear, short, fat cups
funnel measuring cups and spoons

yeast

sugar

1 bottle of club soda

baking soda

2 empty 16-ounce soda bottles vinegar

balloons

soil samples from three different places with varying amounts of humus (organic content)

lab journal

carbon dioxide?
- How is carbon dioxide formed?

Extension

Since plums and grapes have the same water-soluble pigment as cabbage, students will repeat the above activity, using plums and/or grapes as an indicator.

ACTIVITY TWO

Explain

—Soils rich in humus (organic matter) tend to be more acidic than others.

—Decomposition and respiration of soil creatures makes carbon dioxide, which forms an acid when dissolved in water.

—Alkaline soils (less acidic) have low organic content. However, some soils will test high for acid even though they do not contain much organic matter.

Procedure

—Hand out the worksheet to each group of students.

—Students will follow the directions on the worksheet and write their results in their journal.

—Students will also copy and answer the questions from the worksheet into their journals.

Answers to Worksheet Questions

- If a soil tests acidic, does it have high or low organic content? (Usually high organic content, but not always. Sand may be acidic but contain low amounts of organic materials.)
- Why would the organic content of soil from a forest floor differ from that of a plowed field? (There generally is more organic matter in a forest than in a plowed field. A forest canopy will continually drop leaves, sticks, and other debris, whereas a plowed field has no canopy. However, some agricultural fields can be rich in added material, and some forests, such as those containing cedar trees, can be low in organic material.)
- Would all plants grow well in highly organic soil? (No. Desert plants grow best in low organic conditions.)

Extra Reading

Allaby, Michael, *Droughts (Weather Science),* Facts on File, 2011.

Bial, Raymond, *A Handful of Dirt*, Walker and Co., 2000.

Burnie, David. *Plant – Eyewitness Books*, Dorling Kindersley, 2003.

Chambers, Catherine, *Drought (Wild Weather)*, Heinemann, 2007.

Desonie, Dana, *Geosphere: The Land and Its Uses (Our Fragile Planet),* Chelsea House, 2008.

Gardner, Robert, *Super Science Projects About Earth's Soil and Water (Rockin' Earth Science Experiments)*, Enslow, 2007.

Gifford, Clive. *The Kingfisher Geography Encyclopedia*, Kingfisher, 2003.

Lindbo, David, *SOIL! Get the Inside Scoop*, American Society of Agronomy, 2008.

Nardi, James B., *The World Beneath Our Feet: A Guide to Life in the Soil,* Oxford, 2003.

Vocabulary

acidic—any compound that reacts with a base to form a salt

alkaline—any base, as soda or a mineral salt, which can neutralize an acid

anthocyanin—any of various soluble pigments producing blue to red coloring in flowers and plants

base—any of various com- pounds that react with an acid to form a salt, have a bitter taste, and turn red litmus paper blue

neutral—neither acid nor basic

pH—a number used in expressing acidity or alkalinity on a scale whose values run from 0 to 14 with 7 representing neutrality, numbers less than 7 increasing acidity, and numbers greater than 7 increasing alkalinity; also: the condition represented by such a number

pigment—a substance that gives color to other materials; especially a powder mixed with a liquid to give color

soluble—capable of being dissolved in a liquid

solution—a liquid in which something has been dissolved

Reading Page

Carbon, Agriculture and Climate Change

Carbon dioxide gas is a colorless, odorless gas that is part of our atmosphere. It is formed by respiration (breathing), combustion (burning), chemical reaction and decomposition (rotting).

Carbon is present in all organic matter. For thousands of years the carbon cycle on Earth was in balance. Plants took carbon gas from the air through photosynthesis and converted it to food, which animals could eat. Animals converted it back to carbon dioxide and released it back into the air through breathing or through waste materials, which decomposed. Plants that died without being eaten released carbon dioxide back into the air as they decayed.

Millions of years ago, some of the plants and animals fell into wet, swampy places where there was little oxygen in the soil. Since the normal decay process is not possible without oxygen, these plants and animals released very small amounts of carbon as carbon dioxide and methane gas. Over time these masses of matter became oil, coal and natural gas, which still contained most of the carbon from the original plants and animals. About 200 years ago, people discovered they could burn these materials to produce tremendous amounts of energy.

When people first started burning fossil fuels, they didn't realize they might be causing an imbalance in the carbon cycle. Although there are some scientists who disagree, the majority of climate scientists believe this imbalance is the cause of changes that are gradually taking place in our climate, causing the oceans to warm up and melt glaciers and producing droughts, extreme heat and storms, like tornados and hurricanes, that are more severe than usual.

Once they identified the problem, scientists began looking for solutions. One of the things they found was that during the 1980s an average 5.5 billion tons of carbon dioxide was released into the air through the burning of fossil fuels. During those same years, the amount of carbon dioxide in the air only increased by an average of 3.2 billion tons. By looking at these figures, scientists figured out that about 2.3 billion tons of carbon dioxide were taken up by plant photosynthesis. Scientists now are working on ways to use plants to take up even more of the extra carbon dioxide in our atmosphere. One simple way is to plant millions of trees.

Agricultural researchers found another possible solution in programs that were put in place for other reasons. Fifty years ago, the government established several programs designed to help slow the erosion of farmlands. Farmers were taught that their topsoil was not so likely to blow or wash away if they kept it covered with some kind of plants. Farmers began using such erosion control methods as no-till farming, which leaves stubble in place instead of plowing up a field after harvest. Researchers found that on land where these programs have been in place for long periods of time, large amounts of carbon from the atmosphere have been trapped in the soil and in the plants growing on top of them. Since carbon is necessary for plant growth, keeping carbon in the soil is also an added benefit for the farmer.

Bubbles in the Cabbage Juice

GROUP 1: YEAST/SUGAR

Materials: jar with cabbage juice
funnel
16-ounce soda bottle
balloon
1 packet of yeast
1 teaspoon sugar
1/2 cup warm water
straw

1. Blow up a balloon and let the air out.
2. Use the funnel to put the yeast, sugar and warm water into the soda bottle, and let it sit for about 10 minutes.
3. Put a balloon over the mouth of the bottle and gently shake the contents.
4. Let the bottle and balloon sit until the balloon is inflated.
5. Twist the balloon closed.
6. Insert a straw in the balloon opening to release some of the gas from the balloon into the cup of cabbage juice in the cup.
7. In a journal, record materials used, steps completed and results.
8. Compare with the "control" cup to justify your results.

GROUP 2: BAKING SODA/VINEGAR

Materials: jar with cabbage juice
funnel
16-ounce soda bottle
balloon
1 tablespoon baking soda
2 tablespoons vinegar
straw

1. Blow up a balloon and let the air out.
2. Use a funnel to place the baking soda in the bottle.
3. Use a funnel to place vinegar in the balloon.
4. Attach the balloon to the mouth of the balloon, and allow the vinegar to flow into the bottle with the baking soda.
5. When the balloon inflates, twist the opening, and remove it from the bottle..
6. Insert a straw in the balloon opening to release some of the gas from the balloon into the cup of cabbage juice in the cup.
7. In a journal, record materials used, steps completed and results.
8. Compare the "control" cup to justify your results.

GROUP 3: CLUB SODA

Materials: jar with cabbage juice
bottle of club soda
balloon
straw

1. Blow up a balloon and let the air out.
2. Open the bottle of club soda, and quickly put the balloon on the bottle mouth.
3. Let the balloon stay on the bottle until it inflates.
4. Twist the balloon closed.
5. Take the balloon off the bottle.
6. Insert a straw in the balloon opening to release some of the gas from the balloon into the cup of cabbage juice in the cup.
7. In a journal, record materials used, steps completed and results.

GROUP 4: BREATH

Materials: jar with cabbage juice
balloon
straw

1. Blow up a balloon and let the air out.
2. Blow up the balloon again and twist the opening.
3. Release some of the gas from the balloon into the cup of cabbage juice in the cup.
4. In a journal, record materials used, steps completed and results.
5. Compare with the "control" cup to justify your results.

Name____________________________________

Activity 2 Worksheet

MATERIALS PER TEAM

1 12-oz cup of cabbage juice
5 baby food-sized jars
1⁄4 cup vinegar
6 teaspoons baking soda
3 soil samples from 3 different locations log or journal

INSTRUCTIONS

1. Place a different soil sample in each of the three jars. Fill each about one-fourth full with soil.
2. Fill each jar halfway with cabbage water.
3. The redder the water gets, the more acid the soil is. This usually means the soil is high in organic content.
4. The more blue the water, the more alkaline the soil. This usually means the soil is low is organic content.
5. Fill the two remaining jars halfway with cabbage water.
6. Add 1⁄4 cup of vinegar to one. The liquid should turn red indicating extreme acid conditions.
7. Add 6 teaspoons baking soda to the other jar. The liquid should turn blue indicating extreme alkaline conditions.
8. Use these last two jars to compare the acidity and alkalinity of the 3 soil jars.
9. Line up the jars from blue to purple to red.
10. Record your procedures and results from this investigation in a lab book or journal.
11. Copy the questions from the worksheet and answer them in the journal.

QUESTIONS

- If a soil tests acidic, does it have high or low organic content?

- Which would have more organic content—soil from a forest floor or soil from a plowed field?

- Would all plants grow well in highly organic soil?

Oklahoma Ag in the Classroom is a program of the Oklahoma Cooperative Extension Service, the Oklahoma Department of Agriculture, Food and Forestry and the Oklahoma State Department of Education.

Name___________________________________

Scientific Study Format

Title of Experiment or Study:

I. Stating the Problem:

What do you want to learn or find out?

II. Forming the Hypothesis:

What is known about the subject or problem, and what is a prediction for what will happen?

III. Experimenting: (Set up procedures)

This should include: materials used; dates of the experimental study; variables, both dependent and independent (constant and experimental); how and what was done to set up the experiment; fair testing procedures.

IV. Observations:

Includes the records, graphs, data collected during the study.

V. Interpreting the Data:

Does the data support/defend the hypothesis?

VI. Drawing Conclusions:

Justify the data collected with concluding statements about what has been learned. Discuss any problems or concerns. Use other studies to support the conclusion. Give alternative ideas for testing the hypothesis.

Oklahoma Ag in the Classroom is a program of the Oklahoma Cooperative Extension Service, the Oklahoma Department of Agriculture, Food and Forestry and the Oklahoma State Department of Education.