Science in Your Shopping Cart

Grade Level: 4-8

Lesson Overview

Have you ever wondered about the science behind items in your shopping cart? Scientists continually research new products and improvements to current products. In this lesson, students will take a look at some of the research being done. Utilizing the scientific method, they will experiment with absorbency of products. Students will also learn about exciting careers in science and technology.

Student Objectives

1. Identify contributions made by scientists at the Agricultural Research Service in common items found in your shopping cart.
2. Experiment with known and unknown items to determine their absorbency.
3. Explore careers in science and technology.

Materials

- ✓ Science in Your Shopping Cart booklet https://naitc-api.usu.edu/media/uploads/2014/06/18/shopcart.pdf
- ✓ internet access
- ✓ 6 plastic trays
- ✓ masking tape
- ✓ 6 pipettes
- ✓ 6 graduated cylinders
- ✓ water
- ✓ sugar
- ✓ artificial sweetener
- ✓ 4 - ¼ teaspoon measuring spoons
- ✓ Polyacrylate (can purchase from gardening centers, plant nurseries, science supply companies - look for “Soil Moist” or “Crystal Soil”)
- ✓ Super Slurper (may be available from your IL Agricultural Literacy Coordinator http://www.agintheclassroom.org/AGLitCoord/Coordinator%20Directory_website.pdf) Note this activity can be done without Super Slurper if not available.
- ✓ salt shaker
- ✓ worksheets & information sheets (included in the lesson)
    - Scientific & Technological Changes to Agricultural Products Summary
    - USDA –-ARS - National Center for Agricultural Utilization Research
    - How Absorbent Are They? Small Group Experiment Directions
    - How Absorbent Are They? student worksheet and data sheet
    - Super Slurper
    - Who am I?

Vocabulary

- **absorbent** – the ability to take in a substance.
- **polymer** – a chemical compound or mixture of compounds that is formed by combination of smaller molecules and consists basically of repeating structural units.
- **saturated** – to soak or fill with something to the point where no more can be absorbed or dissolved.

Background Information

There really is a lot of science in your shopping cart. Scientists are continually researching ideas for new products, new methods, and improvements to current items. Have you ever had seedless watermelon or grapes? Scientific research improved both of those items. Agricultural research provides us with a high quality, safe food supply.

Procedure

1. As an interest approach, bring in a variety of items found in the Science in Your Shopping Cart booklet and ask students to determine what they have in common.
2. Introduce students to the USDA's Agricultural Research Service. The following are some suggestions for how to do so depending on the amount of time and resources available.
    a. Divide students into pairs or small groups to explore and discuss research done by the Agricultural Research Service. Each student should choose an area of research and develop a 3-minute presentation for the class on their topic. (Working in pairs or small groups may help students generate ideas of how to present their topic.)

    Students may gather information from the Science in Your Shopping Cart booklet (https://naitc-api.usu.edu/media/uploads/2014/06/18/shopcart.pdf), the USDA Agricultural Research Service Science website (https://www.ars.usda.gov/) or the Scenes of Science video (https://www.youtube.com/watch?v=MvbDPrOnBn4).

    The goal of each presentation should be to share the information about the topic in a manner that will help the audience remember it. Encourage students to be creative, use visuals (pictures, posters, flyers, etc.), and be dramatic. It is up to you how long you wish to let them research and create their mini-presentation. Then have each student present their topic. After all the presentations are done, you may wish to quiz them to see how much they remember.

    b. If time is short, you can use the idea listed above with a few modifications. Copy one different page for each student from the Science in Your Shopping Cart book. Then, give them to the students. Tell them they have

5-10 minutes to read their topic and decide how to present it to the class in one minute. The goal of the presentation is the same as above. Then have students give their brief presentations. After all the presentations are done, you may wish to quiz them briefly to see how much they remember. The "Scientific & Technological Changes to Agricultural Products Summary" information sheet provides a quick summary for you.

c. Share with the students the USDA – ARS - National Center for Agricultural Utilization Research Information Sheet in this lesson.

d. Show students some or all of the Scenes of Science DVD.

e. Use the High-Tech Food lesson and Science in Your Shopping Cart power point available at http://www.agclassroom.org/scienceinshopping.htm.

3. Introduce the group experiments. "Many times we see advertised paper towels that are said to be super absorbent. What does absorbent mean? If I pick up a wet paper towel that has started to drip the water it contains, I would describe the towel as saturated. What does saturated mean? The definition of saturated is to soak or fill with something to the point where no more can be absorbed or dissolved. In simple terms for this activity, it cannot hold any more water. Today we are going to experiment with some substances that you may or may not recognize. You are going to determine how absorbent they are. As you do the investigation, remember that we will only add water until the substance becomes saturated. As soon as water puddles around and runs out of the substance, it is saturated – it cannot hold any more water.

   Divide students into 6 groups. Give each group the Small Group Experiment Directions – How Absorbent Are They? page. Then pass out to each student How Absorbent Are They? information pages and data sheets.

   Assist students in completing the "How Absorbent Are They?" experiments.

   a. Pass out the trays and explain how they should be labeled. Using masking tape and a pen to label the sections of the tray substance 1, substance 2, substance 3, and substance 4. Do not tell the students what each substance is until they have completed their trials.

   b. Have the students complete the first part of the worksheet (problem, hypothesis, etc.).

   c. The teacher should place a scant ¼ teaspoon of substance 1 (sugar) on each group's tray.

   d. Give students time to follow the procedure outlined on the small group directions page as they fill out the data sheet.

e. After they have completed the first part of the investigation, place a scant ¼ teaspoon of substance 2 (artificial sweetener) on each group's tray. Repeat step "d."

f. Next, place a scant ¼ teaspoon of substance 3 (Super Slurper) on each group's tray. Be sure you do this with a dry spoon as water will damage the entire contents of the container. Repeat step "d."

g. Then, place a scant ¼ teaspoon of substance four (polyacrylate) on each group's tray. Be sure you do this with a dry spoon as water will damage the entire contents of the container. Repeat step "d."

h. After all have experimented, tell the students what each substance was and write it on How Absorbent Are They data sheet. Explain that substances 3 & 4 are polymers bound together by their chemical composition.

i. Either the teacher or the students should then lightly sprinkle salt on each substance and observe what takes place. The salt begins to break down the chemical bonds of the Super Slurper and polyacrylate which makes it appear to melt.

j. Students should complete the rest of How Absorbent Are They? student worksheet using the scientific method.

k. Finally, share with the students the Super Slurper student information sheet.

Note: This activity was adapted from Maryland Ag in the Classroom.

4. Explore careers in science and technology. Here are some resources that may be useful:
   a. Living Science Careers poster set https://www.agriculture.purdue.edu/USDA/careers/index.html

   b. Agricultural careers https://www.ilaged.org/ag-career-websites

Extension Activities

1. Plan an exhibit to display somewhere in the school (such as the library or another common meeting area) to highlight products from the food and fiber system. Describe the role of research in each product. The first activity in this lesson may help with this project.
2. Name three of research's most important contributions to science and society.
3. List the major agricultural commodities (such as corn, soybeans, wheat, etc.) in Illinois. How has research improved them over the years?

4. Name several agricultural issues that affect the environment. How are agricultural scientists addressing these issues? How would you deal with them?

Additional Resources

- USDA-ARS-National Center for Agricultural Utilization Research in Peoria https://www.ars.usda.gov/midwest-area/peoria-il/national-center-for-agricultural-utilization-research/
- Science in Your Shopping Cart resources including lesson, power point, video, online book and more http://www.agclassroom.org/scienceinshopping.htm
- Scenes of Science DVD https://www.youtube.com/watch?v=MvbDPrOnBn4

Standards

Illinois Science Standard

MS.LS1.5. Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms.

Illinois English Language Arts Standard

ELA.RST.1: Cite specific textual evidence to support analysis of science and technical texts.

The **M**ultidisciplinary **AG**ricultural **I**ntegrated **C**urriculum (mAGic) was created in 2004 under the leadership of the Illinois State Board of Education (ISBE) and the Facilitating Coordination in Agricultural Education Project (FCAE). Funding was made available through the FCAE grant budget from the agricultural education line item of the ISBE budget. This revision, as printed, was developed in January 2021.

These mAGic lessons are designed to bring agriculture to life in your classroom. They address the Illinois Learning Standards in math, science, English language arts and social studies.

Illinois mAGic project update writers/reviewers: Rhodora Collins – Dekalb County; Suzi Myers – Kane County; Connie Niemann – Montgomery County; Debbie Ruff – Livingston County; Jennifer Waters – Sangamon County; Dawn Weinberg – Hancock County; and Carrie Winkelmann – Menard County.

Scientific & Technological Changes to Agricultural Products Summary

Agricultural Product	Actual scientific changes applied to the development product	Harvesting Technology
Apples	sweeter, crunchier, crisp, enzyme coating to deter browning	robotic pickers
Carrots	more vitamin A, new/old colors, enzyme to enhance color	
Tomatoes	colors, more beta-carotene, longer shelf life for processing	thicker-skinned fruit (plant breeding), mechanical harvesting machine that sees color
Peaches	new cold tolerant varieties	
Pears	pest resistance	
Watermelon	disease resistant, improved sweet taste	
Berries	extend the growing season, flavor, thornless varieties	
Peanuts	lower the fat, but maintain flavor	
Cayenne Pepper	increase the heat by 20%	
Bread/Wheat	changes in gluten, protein; ability to make sour dough anywhere with the identified bacteria; insect resistance	GPS/GIS technology, combine harvesting
Oranges/Citrus	higher yielding trees, increased disease resistance, better color, longer shelf life, freezing technology	picking machine, sensors for ripe fruit
Cheese	low-fat cheeses	
Milk	Lactose-free milk bacteria that produces an enzyme that breaks down milk sugar	
Grapes	seedless varieties, disease resistance, packaging technology	mechanized grape moving and picking
Potatoes	disease resistance, low-fat frying potato	
Rice	doubled the shelf life, rice flour to make bread and reduce oil absorption	GPS/GIS technology, combine harvesting
Poultry	turkeys bred to have more meat, disease resistance	
Beef	disease prevention, breeding programs for tender, low-fat, flavorful meat	
Oats	reduce cholesterol research	
Corn	enhance “corn flavor” in tortillas, corn starch, fat replacer,	
Soybeans	used as a substitute product in lipstick, plastics, flooring, paints, ink, cleaners, etc.	
Diapers	cornstarch-based moisture absorber, Super Slurper	
Cotton	cotton picking machine	
Sugar Beets	lifter harvester	
Walnuts	stronger trees developed through plant breeding	tree shaker
Olives	better canning methods	tree shaker
Lettuce	lettuce harvester for boxing, precision packing	

Note: This chart is used by permission from the “High-Tech Food” lesson developed by Utah Agriculture in the Classroom program.

USDA – ARS - National Center for Agricultural Utilization Research Information Sheet

Surplus crops and a chronic farm depression were the economic realities of the agricultural industry in 1938. In response, Congress authorized the USDA to build and staff four regional research laboratories for the purpose of finding new uses and markets for farm commodities.

Peoria, Illinois was selected as the site for the Northern Regional Laboratory (NRL), with a focus on corn, wheat and agricultural waste products. Operations began December 16, 1940.

In 1990, the Peoria lab's official name was changed to the National Center for Agricultural Utilization Research (NCAUR), reflecting a successful research history generating far more than regional impact and the direction of research yet to be done.

The NCAUR Mission

- Invent new uses of agricultural commodities for industrial and food products
- Develop new technology to improve environmental quality
- Provide technical support to Federal regulatory and action agencies

NCAUR exists to discover, develop and transfer new technology. From its beginning, they have worked directly with industry to achieve results of global significance, starting with the method for the mass production of penicillin. This commitment to commercializing new technology continues today. NCAUR scientists work collaboratively with universities, private industries and other government agencies to develop new technologies.

Today, they are the largest of the four regional centers and the most successful in transferring technology from the laboratory to the marketplaces. More than 150 patents have been awarded to NCAUR scientists since 1980. Following are a few of the results that are more easily recognized for their global and enduring impact.

- **Penicillin:** Working together, British and NCAUR scientists invented the method to mass-produce penicillin and opened the era of antibiotics.
- **Xanthan gum:** The thickening agent found in nearly every bottle of salad dressing and many other products on grocery shelves is also used to extend the life of gas and oil wells.
- **SuperSlurper:** The super absorbent technology found in disposable baby diapers is based on an NCAUR invention that stimulated the development of many absorbent products.
- **Oatrim:** A fat replacer and nutraceutical, it was the first of four related technologies from NCAUR contributing to improved foods and greater health.
- **Ethanol research**: Key discoveries in the alcohol fermentation process have reduced production costs of biofuels.
- **Soybeans:** NCAUR research, in partnership with universities, resulted in the growth of a small forage crop to the second largest row crop in the U.S. This number one source of vegetable oil is used in food and industrial products created by NCAUR scientists.

Note: This information was provided by the USDA-ARS-NCAUR.

How Absorbent Are They?
Small Group Experiment Directions

1. Label the sections of the tray substance 1, substance 2, substance 3, and substance 4. You will find out the identity of each substance later.
2. Fill the graduated cylinder with 25 ml of water.
3. Obtain ¼ teaspoon of substance 1 from your teacher in the labeled section of the tray. Describe the appearance of the substance on the data sheet.
4. Complete the following:
    a. Predict how much water this substance can absorb.
    b. On the data sheet, record your prediction.
    c. Use the pipette to take water from the graduated cylinder.
    d. Slowly (by drops not squirts) add water to the substance, observing what happens.
    e. Only add enough water so that the substance can absorb it. Stop adding water when the substance becomes saturated and water begins to puddle around it. Empty any water left in the pipette back into the graduated cylinder.
    f. On the data sheet, record the amount of water added in ml, NOT drops.
    g. On the data sheet, describe the appearance of the substance when water was added to it.
5. Refill the graduated cylinder so it again contains 25 ml of water.
6. Obtain ¼ teaspoon of substance 2 from your teacher in the labeled section of the tray. Describe the appearance of the substance on the data sheet. Repeat STEP 4 with this substance.
7. Obtain ¼ teaspoon of substance 3 from your teacher in the labeled section of the tray. Describe the appearance of the substance on the data sheet. Repeat STEP 4 with this substance.
8. Obtain ¼ teaspoon of substance 4 from your teacher in the labeled section of the tray. Describe the appearance of the substance on the data sheet. Repeat STEP 4 with this substance.
9. Sprinkle (just a dash or two) each substance with sodium chloride (salt). On the data sheet, record your observations.

Name _____

How Absorbent Are They? Worksheet

In this experiment, you will try to determine which product holds the most water. Then, you should decide how water-holding products can be beneficial to us.

Your task is to test several products for their ability to hold water. When the product becomes saturated and can absorb no more water, record your results.

Hypothesis:

Materials:

Procedure:

Data:

Name _____

How Absorbent Are They? Worksheet Continued

Results:

Conclusion (Did the data support the hypothesis?):

Which product/s absorbs the most water?

How did sodium chloride affect each substance?

Why did this occur?

What are some possible uses for super absorbent products (Super Slurper and polyacrylate)?

Note: This activity was adapted from Maryland Ag in the Classroom.

Name _____

How Absorbent Are They? Data Sheet

Substance	Dry Appearance (before adding water)	Predicted Amount of Water Substance Will Hold (ml)	Actual Amount of Water Held (ml)	Wet Appearance (after adding water)	Appearance of Substance When Sprinkled With Sodium Chloride
Substance #1					
Substance #2					
Substance #3					
Substance #4					

Super Slurper Information Sheet

Super Slurper is a powder until you add water. Then the starch-based polymers within quickly absorb the water transforming it into a gel capable of retaining nearly 2,000 times its weight in moisture. It was created in 1973 by researchers at the USDA Agricultural Research Service (ARS) National Center for Agricultural Utilization Center in Peoria, Illinois. Bill Doane along with the development team of Mary Ollidene Weaver, Edward B. Bagley, and George F. Fanta first attached a synthetic polymer to cornstarch molecules based on a grafting technique pioneered by ARS chemist Charles Russell.

When moistened, a flake of Super Slurper captures more than 1,400 times its own weight in water.

Its scientific name - saponified starch-graft polyacrylonitrile copolymers - was too cumbersome to catch on with anyone outside the scientific community. The name "Super Slurper" was coined. The name change, coupled with publicity, stimulated thousands of inquiries, and a multimillion-pound market for the polymer was projected. Now, more than thirty years later, many in science and industry are still amazed at the impact this piece of basic research technology has had on U.S. rural development and the broadest range of consumers.

The transfer of starch modification technology to commercial use has and continues to create new markets for cornstarch. Super Slurper has lead to the development of various products such as disposable diapers, seed coatings, wound dressings, automobile fuel filters, and plastic mesh barriers used at construction sites.

In spite of the nonexclusive licenses that were granted on the Super Slurper technology, a few companies were formed solely to produce the polymer. One of these was Super Absorbent Co. of Lumberton, North Carolina. After reading about Super Slurper, the company’s founder Ed Kirkland contacted Doane. In 1978, they began marketing Ag Sorbent, a polymer mixture that keeps tree roots moist until trees are replanted. His clients include the growers of North Carolina's 30,000 acres of Christmas trees. They continue to make seed coatings and soil conditioners using the original formula.

In 1992, Uni-Star began large scale testing with a Minnesota firm, demonstrating that the polymer could be blended with starch and made into a resilient, loosefill packaging material or “packing peanuts" which are biodegradable. Uni-Star’s President, Don Fisk said, "Because of Bill Doane's and George Fanta's support and technical advice, I was able to file two U.S. patents on technology and improvements on the original work that came out of NCAUR. "I'd have given up long ago without their help and expertise," Fisk adds. "I'm still in contact with George, who is helping me with plastic film development."

Another fan of Super Slurper is Ray Mullikin, technical sales representative for Grain Processing Corporation of Muscatine, Iowa, which was among the first companies to license the technology. Their super absorbent, called WaterLock, is sold to cosmetic and pharmaceutical manufacturers throughout the world. It is also a component of microbial biological control agents and an ingredient in turf mats.

In the fall of 2006, Artifex Equipment, Inc., of Penngrove, California which specializes in book and document restoration began mass-producing Zorbix. Zorbix is a sheetlike product based on Super Slurper that can be used to dry out waterlogged library materials before destructive molds take hold.

Note: This information was provided by the USDA-ARS-NCAUR.

Name _____

Who Am I? Worksheet

Match these scientists at the left to their job descriptions at the right.

_____	Biologist	(1)	Studies diseases of plants
_____	Nutritionist	(2)	Studies the breeding and raising of livestock
_____	Chemist	(3)	Studies water and its properties
_____	Plant Pathologist	(4)	Specializes in growing fruits, vegetables, flowers, and ornamentals
_____	Agronomist	(5)	Uses a microscope to explore things up close
_____	Animal Scientist	(6)	Studies living things, like plants, animals, and microorganisms
_____	Horticulturist	(7)	Studies roundworms
_____	Plant Geneticist	(8)	Studies the basis of physical substances
_____	Engineer	(9)	Studies crops and soils and how they interact
_____	Nematologist	(10)	Works with plant genes to develop certain traits
_____	Hydrologist	(11)	Studies what humans need to eat to live, grow, and stay healthy
_____	Microscopist	(12)	Designs new, better, and more useful structures, machines, and other equipment

What kind of scientist would you like to be? What types of discoveries could you make?

This activity was adapted from the Agriculture Research Service Science 4 Kids website.

Who Am I? ANSWER KEY

Match these scientists at the left to their job descriptions at the right.

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