Food Science –

Physical vs Chemical Changes:

Laboratory for Primary Level Students

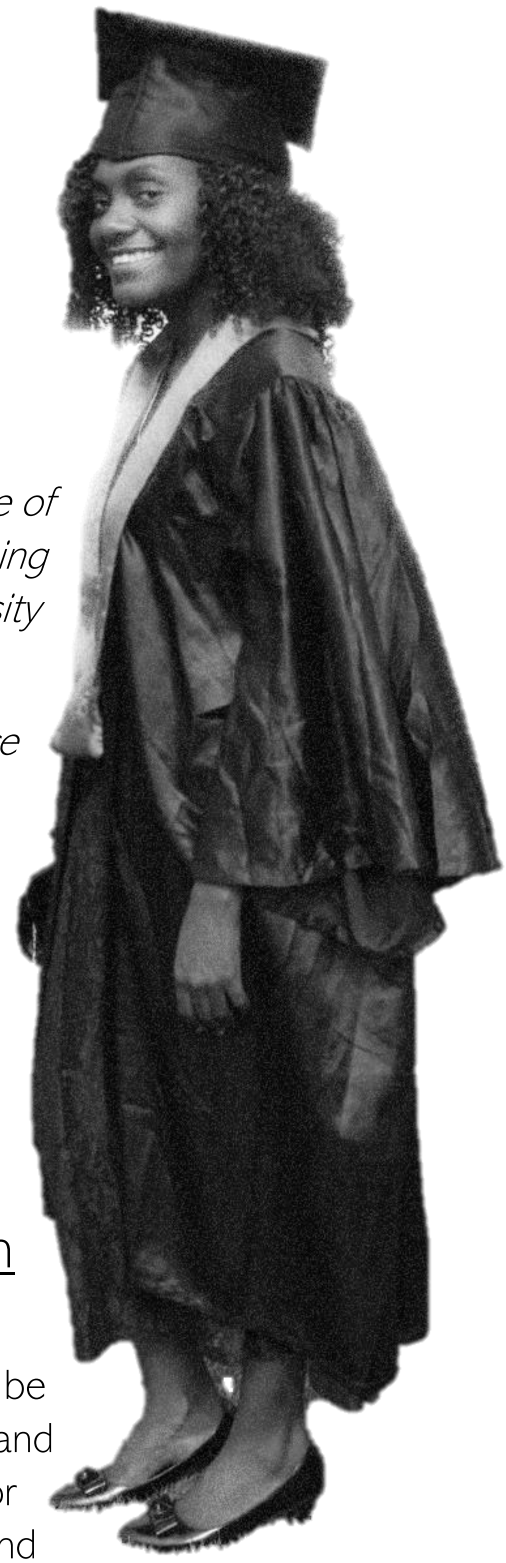
Student Manual

WS2

WOMEN SUPPORTING
WOMEN IN THE SCIENCES

Meet a Scientist

Henriette Manishimwe



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About me:

I am a biology teacher, biotechnologist and a researcher in science education. My interests lie in plant biotechnology, and I have a passion to improve agriculture practices via biotechnology, knowledge, and skills.

My advice for students interested in science:

Students interested in science should be encouraged to pursue their dreams, work hard, and approach teachers and mentors in science for career guidance. You can make a scientific and positive influence on our community! When you have a passion and are willing to work hard, opportunities will appear to you.

Mission Statement

This laboratory will teach chemical versus physical changes to a target audience of elementary/primary-aged students (ages ~6-12) through experiments related to food spoilage.

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1. Introduction to WS2 Laboratories

1.1. Information about WS2

Women Supporting Women in the Sciences (WS2), an international organization unifying and supporting graduate and professional-level women and allies in science, technology, engineering, and mathematics (STEM), was awarded an American Physical Society (APS) Innovation Fund in 2020 to form international teams to design and distribute low-cost physics and materials science lab kits to 5000 primary and secondary school students, predominantly in eastern Africa. The lab kits are intended to utilize local resources and include topics that are especially relevant to young girls in order to spur their interest in STEM subjects. The international teams, which designed the content found in these laboratory manuals, worked with WS2 Partners in eastern Africa in order to successfully deliver and teach the science lab kits to their local communities through 2022. WS2 gratefully acknowledges the hard work of the teams in the creation of this lab kit content. For more information about WS2, please visit our website at ws2global.org.

WS2 is sponsored by the APS Innovation Fund, Northwestern University Materials Research Science and Engineering Center, and Northwestern University Multicultural Student Affairs. WS2 Partners receiving lab kits are representatives from Makerere University (Uganda), Masinde Muliro University of Science and Technology (Kenya), Mbeya University of Science and Technology (Tanzania), Mkwawa University College of Education (Tanzania), Nelson Mandela African Institution for Science and Technology (Tanzania), University of Dar es Salaam (Tanzania), University of Dodoma (Tanzania), and University of Rwanda (Rwanda). The APS, Materials World Modules, SciBridge, and Projekt Inspire have provided valuable input on WS2 lab kit design. WS2 especially thanks WS2 Partner representatives (John Bakayana, Pendo Bigambo, Daudi Mazengo, Lawrence Robert Msalilwa, Celine Omondi, Marcellin Rutegwa), Tom Coon and students of Haile-Manas Academy (Debre Birhan, Ethiopia), and Carla Johnston and students of Frank Bergman Elementary School (Manhattan, KS, USA) for piloting the lab kits with small focus groups in late 2021. WS2 also tremendously thanks the virtual lab kit design team that created the content for this lab manual.

1.2. Key Vocabulary

- Matter: Material that has a mass and takes up space ('stuff')
- Physical change: The process by which matter remains the same, but may change shape or form
- Chemical change: The process by which matter turns into something else
- Irreversible: A change that cannot be undone
- Food spoilage: A process by which food becomes unsuitable to eat by a consumer
- Preservatives: A chemical additive used to prevent or slow food spoilage caused by chemical change

1.3. Key Questions

- What is the difference between a physical change and chemical change? Can you think of some examples?

- What are some factors that slow the rate of food spoilage?

1.4. Purpose

In this lab, students will learn the difference between a physical and chemical change. They will also learn about factors that slow down the rate of food spoilage. This includes the use of preservatives (lemon juice, or some form of citric acid) and/or packaging that reduces light and oxygen exposure.

2. Background on Main Topics

2.1. Physical vs Chemical Changes

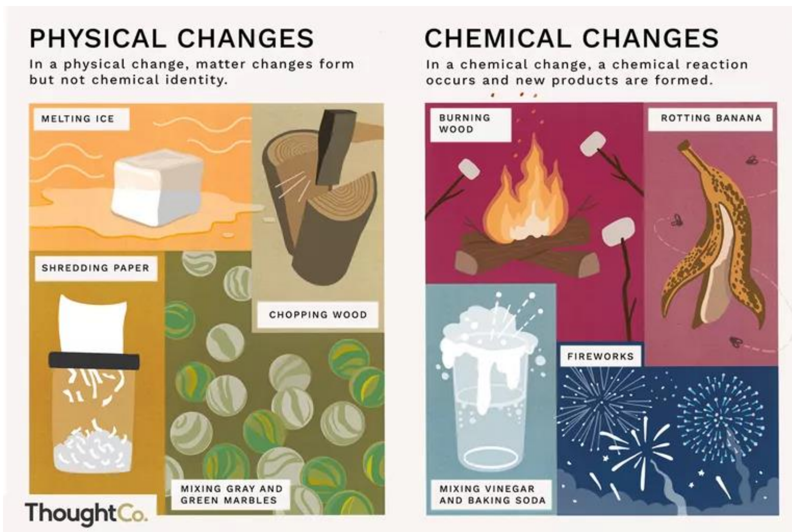

Figure 1. Examples of physical changes on left – melting ice, chopping wood, shredding paper, mixing marbles – and chemical changes on right – burning wood, rotting banana, mixing vinegar and baking soda, fireworks. Source: ThoughtCo.

A physical change occurs when matter changes form, but not chemical identity. Cutting produce (here, produce means many types of farm-produced crops like fruits and vegetables), crumbling a piece of paper, or dissolving sugar in water are examples of physical change. Chemical identity does not change; therefore, physical change is usually reversible (can return to its original form). For example, dissolved sugar in water can be reversed by evaporating the water from the solution. Once the water evaporates, sugar crystals will be left behind. Examples of physical changes are shown in Figure 1 (left). For the example of marbles in Figure 1, think about two boxes of marbles: one contains gray marbles, and one contains green marbles. Now think about mixing the two boxes together. Since the gray and green marbles can still be separated after mixing and no new types of marbles have been created, like blue marbles, this change is physical.

A chemical change occurs when a reaction forms new products. Baking a cake, leaves changing color on trees, and food digesting in your stomach are examples of chemical changes. There may be clues that a chemical reaction has taken place, such as the release of light or heat, a color change, gas production, an odor, or a sound. Since chemical changes make new products, they are usually irreversible. Irreversible means the change cannot be undone. For example, when you burn wood, you cannot really turn the heat and gases back into a log very easily. Examples of chemical changes are shown in Figure 1 (right).

Scientists can determine if a chemical change has occurred by asking the question: Are different or new products present after the change takes place? If not, then the change is physical.

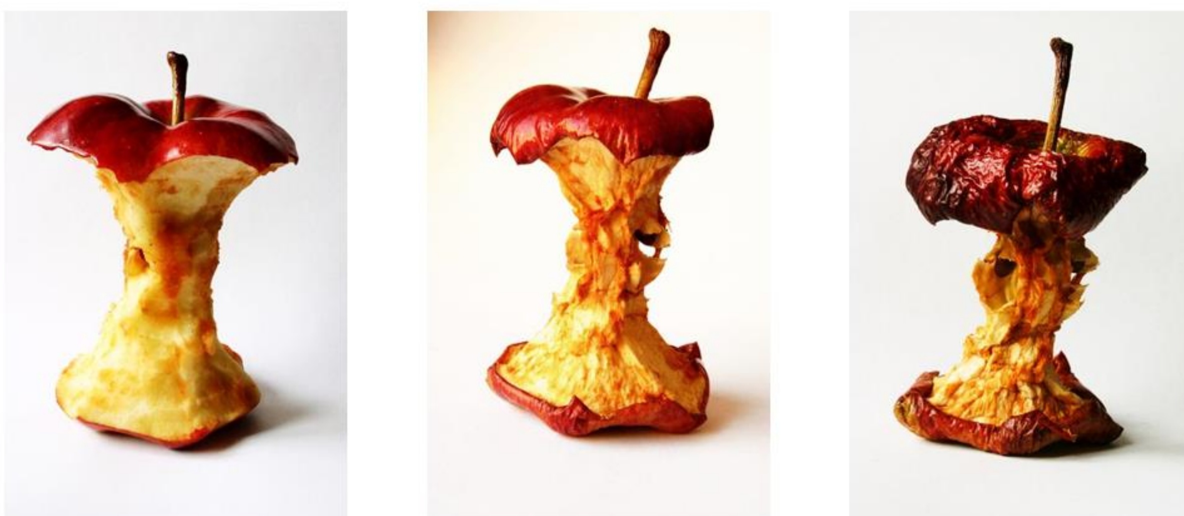

Figure 2. Example of a chemical change as an apple core sits out over several days. Notice how the core browns over time. Source: Roger Karlsson

When the flesh of the apple turns brown, it undergoes a chemical change. See an example of this chemical change in Figure 2. The browning of the apple is irreversible. Another example of a chemical change is rusting, which occurs when certain metals, like iron, are left outside and exposed to air and water over time. See an example of rusting chains in Figure 3. Like the browning of an apple, rusting is irreversible.

Figure 3. Example of a chemical change as metal chains rust over time. The chains on the left have rusted. The chains on the right have not because they have a special coating that prevents them from rusting. Source: photostock-israel/getty images

If an apple browns significantly, the apple is likely spoiled. Spoiled food can look, feel, taste, and smell unpleasant. It can also make you sick if you eat it. Various factors such as light, oxygen, heat, humidity, temperature, bacteria, and fungi can spoil food making it unsuitable for consumption. Food is more likely to spoil when exposed to one or more of these factors over time.

2.2. Supplies List

- Tools: knife, paper, pen or pencil
- Produce: Potato, banana, or plantain (additions and/or alternatives: apples, pears, lettuce)
- Preservatives: Lemon juice, table salt (additions and/or alternatives: lemon, orange, orange juice, lime, lime juice, vinegar, raw honey)
- Packaging: Aluminum foil, paper (additions and/or alternatives: newspaper, paper bags, wastepaper, cloth, wax paper, metal container, foil wrappings from candy)
    - The key is to find two types of packaging: one that is mostly impermeable to air and non-absorbent, like a metal can or foil, and one

that is permeable to air and absorbent, like paper or cloth. You are encouraged to recycle waste materials when possible

2.3. Safety Information

Before the students begin the laboratory, please take into consideration the following safety concerns:

- Demonstrate to the students how to safely hold a knife and cut produce to avoid injuries. You may also pre-cut the produce to avoid any safety concerns.
- Lemon and lime juice (or citrus juice) are acidic and may sting open cuts and wounds as well as if they get into students' eyes.
- While tasting food is part of the food preparation process, please do not taste the food in this lab because the spoiled food may cause the taster to get sick.

3. Experiments

3.1. Part I. Effect of Preservatives on Food Spoilage

3.1.1. Pre-Experiment Questions

1. How is a physical change different from a chemical change?

2. What are some examples of physical and chemical changes while preparing a meal?

    a. <u>Extension question:</u> Are different materials present after the change takes place?

3. What happens when you leave produce, such as potatoes and bananas, out for a week?

    a. <u>Extension question:</u> How does the old produce look?

    b. <u>Extension question:</u> How does the old produce feel?

    c. <u>Extension question:</u> How does the old produce smell?

    d. <u>Extension question:</u> How might the old produce taste?

4. What are preservatives? What are some examples of preservatives?

5. Which preservative do you think will keep your food from spoiling: no preservative, lemon juice, or salt? Or will they all keep the freshness the same? Why do you think this?

3.1.2. Assignment of Tasks (2-4 students per group)

<u>Student 1:</u> One student will be responsible for cutting the food. This student will slice three pieces of food (potato and banana) to be the same size as one another. Put the slices of potato and banana on the paper in rows. This student can also make a table on paper, such as the picture shown in Figure 4.

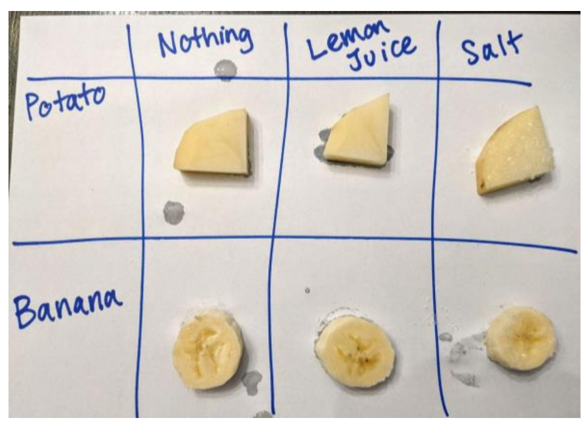

Figure 4. Example of cut produce with different preservatives added. The table helps to organize the produce and preservatives.

<u>Student 2:</u> One student will be responsible for adding the preservatives to the produce. This student will do nothing to the first slice of food in each row. This student will then squeeze a few drops of lemon juice on the second slice in each row so that the whole surface of the piece has lemon juice on it. Lastly, this student will sprinkle salt on the third slice in each row so that the whole

surface has a thin layer of salt on it. See the picture in Figure 4 for the general set-up.

Student 3: One student will be the starting observer. Use the table below to record observations. Draw a picture of the food and write down observations about how it looks, feels, and smells. Record the date and time of observations.

Student 4: The fourth student will be the final observer. At the end of the school day (or the next school day), look very closely at your pieces of produce. Use the second table below to record observations. Record the date and time of observations. Draw a picture of the food and write down observations about how it looks, feels, and smells. Note the changes you see happening (if any).

<table>
<tr><td colspan="2" rowspan="2">Date: ______
Time: ______</td><td colspan="3">Preservatives</td></tr>
<tr><td>nothing</td><td>lemon juice</td><td>salt</td></tr>
<tr><td rowspan="2">Food</td><td>potato</td><td>Drawing:

How does it look?

How does it feel?
(gentle!)

How does it smell?</td><td>Drawing:

How does it look?

How does it feel?
(gentle!)

How does it smell?</td><td>Drawing:

How does it look?

How does it feel?
(gentle!)

How does it smell?</td></tr>
<tr><td>banana</td><td>Drawing:

How does it look?

How does it feel?
(gentle!)

How does it smell?</td><td>Drawing:

How does it look?

How does it feel?
(gentle!)

How does it smell?</td><td>Drawing:

How does it look?

How does it feel?
(gentle!)

How does it smell?</td></tr>
</table>

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<tr><td colspan="2" rowspan="2">Date: ______
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<tr><td rowspan="2">Food</td><td>potato</td><td>Drawing:

How does it look?

How does it feel? (gentle!)

How does it smell?</td><td>Drawing:

How does it look?

How does it feel? (gentle!)

How does it smell?</td><td>Drawing:

How does it look?

How does it feel? (gentle!)

How does it smell?</td></tr>
<tr><td>banana</td><td>Drawing:

How does it look?

How does it feel? (gentle!)

How does it smell?</td><td>Drawing:

How does it look?

How does it feel? (gentle!)

How does it smell?</td><td>Drawing:

How does it look?

How does it feel? (gentle!)

How does it smell?</td></tr>
</table>

3.1.3. Post-Experiment Questions

1. During this investigation, what step is an example of a physical change? What step is an example of a chemical change?

2. Which preservative led to the least spoiled produce: no preservatives, lemon juice, or salt? Or did they all keep the freshness the same? How do you know?

3. Which preservative led to the most spoiled produce: no preservatives, lemon juice, or salt? Or did they all keep the freshness the same? How do you know?

4. What are some other preservatives that may affect the spoilage of produce?

5. What are some additional consequences of using a preservative?

3.2. Part II. Effect of Packaging on Food Spoilage

3.2.1. Pre-Experiment Questions

1. How do you store your produce?

2. What food storage do you think will keep your food the freshest: no storage, aluminum foil, or paper bag? Or will they all keep the freshness the same? Why do you think this is?

3.2.2. Assignment of Tasks (2-4 students per group)

Student 1: One student will be responsible for cutting the food. This student will slice three pieces of food (potato and banana) to be the same size as one another. Put the slices of potato and banana on the paper in rows.

Student 2: One student will be the starting observer. Use the table below to record observations. Write the date and time of observations. Draw a picture of the food and write down observations about how it looks, feels, and smells. Record the date and time of observations.

Student 3: One student will be responsible for wrapping the produce. This student will do nothing to the first slice of food in each row. This student will then wrap the second slice of produce tightly with aluminum foil. Lastly, this student will wrap the third slice of produce with paper. See the picture in Figure 5 for the general set-up.

Figure 5. Example of cut produce with different packaging. The table helps to organize the produce and packaging.

Student 4: The fourth student will be the final observer. At the end of the school day (or the next school day), look very closely at your pieces of produce. Use the second table below to fill in your observations. Draw a picture of the produce and write down your observations about how it looks, feels, and smells. Note the changes you see happening (if any). Record the date and time of observations.

<table>
<tr><td colspan="2" rowspan="2">Date: _____
Time: _____</td><td colspan="3">Packaging</td></tr>
<tr><td>nothing</td><td>Aluminum foil</td><td>paper</td></tr>
<tr><td rowspan="2">Food</td><td>potato</td><td>Drawing:

How does it look?

How does it feel? (gentle!)

How does it smell?</td><td>Drawing:

How does it look?

How does it feel? (gentle!)

How does it smell?</td><td>Drawing:

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</table>

<table>
<tr><td colspan="2">Date: ______
Time: ______</td><td colspan="3">Packaging</td></tr>
<tr><td colspan="2"></td><td>nothing</td><td>Aluminum foil</td><td>paper</td></tr>
<tr><td rowspan="2">Food</td><td>potato</td><td>Drawing:

How does it look?

How does it feel? (gentle!)

How does it smell?</td><td>Drawing:

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How does it feel? (gentle!)

How does it smell?</td><td>Drawing:

How does it look?

How does it feel? (gentle!)

How does it smell?</td></tr>
</table>

3.2.3. *Post-Experiment Questions*

1. Which packaging preserved the food the best: no packaging, aluminum foil, or paper? How do you know?

2. Which packaging did not really preserve the food: no packaging, aluminum foil, or paper? How do you know?

3. What are other packaging methods that may preserve produce longer?

4. We've tested preservatives (Part I) and packaging (Part II) for their effects on food spoilage. What are some other ways you can keep food fresh longer?

4. Design Challenge

This challenge may require additional food/materials: sliced apples or sliced avocados or more bananas.

<u>The Challenge:</u> You are packing (sliced apples/ sliced avocados /a banana) for lunch tomorrow. Design a method that will keep the food (sliced apples/ sliced avocados/ a banana) as fresh as possible (or to be ready) for lunch.

<u>Extra Challenge:</u> Can you keep the food fresh for 2 days? How about 3 days?

4.1. Pre-Design Questions

1. What results from both labs will you use to design your method?

2. What other information do you need to know in order to design your container/environment?

3. What other variables may you want to test during the design process? A variable is something you change during the test.

Extension Question: What are the risks of testing new variables during the design process?

Extension Question: What are the benefits of testing new variables during the design process?

Extension Question: Do you think the benefits outweigh the risks? Are you willing to test new variables with your design?

4.2 Post-Design Questions

Answers are personal and will vary. There are no wrong answers. Teachers can encourage classmates to share their answers and to listen to others.

1. Explain your method to keep produce fresh.

2. How do you feel about the results of your design?

3. Which method had the most success? What characteristics made it have the most success?

4. How would you change your method for next time after viewing yours and your classmates' results?

5. What was challenging about completing the design challenge? How did you work through those moments of confusion or frustration?

6. What did you enjoy most about completing this design challenge?

7. What advice would you give a group about completing this design challenge?

5. Sources

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For more advanced information on apples browning, visit the following website:

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