Why Do Most Foods Contain Salt?

Meat Science Unit

Grade Level
9-12

Lesson Length
3 periods x 55 minutes

STEM Careers
- Food or Meat Scientist
- Food Technologist
- Biochemist
- Microbiologist
- Nutritionist

Next Generation Science Standards
- HS-PS1-2
- HS-PS1-5
- HS-LS1-3

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These lessons aim to bring the science, skills of inquiry, critical thinking, and problem solving to life through an agricultural context.

Learning Objectives

By the end of this unit, students should be able to:

- Describe the roles of salt in meat.
- Predict the effects of salting raw meat.
- Investigate phenomena of salting meat and connect observations to basic science principles.
- Evaluate their predictions based on their observations.

Materials List

- 2 pounds of ground pork, ground turkey, or ground beef
- Salt, black pepper, and sage.
- Gram scale
- Patty former
- Digital thermometer
- 2 Petri plates filled with agar
- Plastic wrap
- Electric grill
- Cutting board or mats
- Knife
- Small mixing bowls

Preparation

- Prepare agar plates

Do

Introduction (Interest Approach that Aligns with the Investigation)

To introduce students to the importance of salt in food preparation, show the following video titled “Why Does Salt Make Food Taste Better?”. Stop the video at 3:20.

- https://www.youtube.com/watch?v=ATrSoMlx5PE

Facilitate a 1-2 minute discussion with students over their experiences with food that is salted vs. food that is unsalted.

Essential Questions

- *What are the roles of salt in meat?*
- *How does salt affect raw meat?*

Learning Activity 1: [PowerPoint Discussion]

Please use the provided information and/or associated PowerPoint to introduce students to salt. If teachers prefer to show a recording, that is available at … https://use.vg/SXuufJ.

Salt is one of the most common ingredients in the foods we eat, but have you ever wondered why? Salt is added for many reasons and provides many positive impacts on food. In this lesson and activities, you will learn how salt interacts with meat and how it impacts the quality and shelf life of sausage.

Principal Concepts
These are principal concepts that help explain observations in this project.

1. Water is a polar molecule that results from distribution of electrons around the molecule. This means that water has positive and negative poles which are attracted to other charged molecules.
2. Table salt is sodium chloride. When salt is added to water, it dissolves (breaking an ionic bond between sodium and chloride) creating a solution of positive sodium cations and negative chloride anions. This happens because water is a polar molecule, and charges on the ions can associate with the opposite polar charge in water.
3. Lean meat is composed of approximately 70% water, and the water in meat can dissolve salt and other soluble compounds.
4. Proteins are composed of amino acids. While some amino acids are neutral, other amino acids may have charges dependent on pH. Within the normal pH range for meat, meat proteins (amino acids) will have a slight negative charge.
5. Proteins are folded in a specific manner to provide their biological function. Adding ingredients or heat can change how the protein is structured or folded.

When salt is added to meat, it interacts with the water in the meat and dissociates. Once salt is dissociated, the ions interact with the meat and provide the functionality of salt.

Taste: One reason salt is added to meat is for taste and flavor. Salty is one of the basic taste buds we have on our tongues. The sodium cation (Na^+) interacts with the taste bud and is perceived as "salty." However, salt provides more than just salty flavor; it also enhances the other flavors around it. Perception of bitter flavor is reduced when salt is added which increases the other tastes (sweet, sour, umami). You can think of this as salt making a food taste more like itself. For example, if you add salt to a steak, it will taste more beefy, or if you add salt to green beans, it will taste more like green beans.

Water retention and product juiciness: While the sodium ion primarily affects flavor, the chloride ion is responsible for physically changing the structure and electrical charge of meat protein. The chloride anion (Cl^-) interacts with the muscle protein myosin and increases the net negative charge on that protein. The increase in net negative charges on myosin results in increased attraction with the positive pole of water molecules (the hydrogen side). Because of this interaction, the water molecules are held more tightly in the meat resulting in less weight loss during cooking. When eating the meat, the enhanced moisture retention provides for greater juiciness.

Protein solubilization and unfolding: The increased negative charges associated with the chloride ions also changes how the protein is folded. Myosin proteins are organized in a parallel structure in muscle. When chloride anions interact with meat, the myosin proteins unfold and become more sticky or tacky. When cooked, these sticky myosin proteins cross-link (protein-protein covalent bonds) with other myosin molecules to create a solid gel. That is why a hot dog has a cohesive texture, but a hamburger is crumbly. The meat and salt mixture can also be formed into and hold specific shapes when cooked (e.g., a dinosaur-shaped chicken nugget).

Preservative effects: Salt was originally used in meat products as a preservative because it can slow or stop the growth of bacteria. Bacteria, like all living organisms, have certain conditions required to grow and survive. The ability to self-regulate and maintain these conditions is referred to as homeostasis. Sodium and chloride ions can create a stressful environment for bacteria as bacteria must use more energy to combat the stress created by salt. As more salt is added to the environment, more ions are present (increases ionic strength) causing the bacteria to use more energy to maintain homeostatic conditions. This stress caused by salt is referred to as osmotic pressure. When more energy is expended to maintain homeostatic conditions, less energy is available for bacteria to reproduce, reducing microbial growth.

Learning Activity 2: Salt Experiment

Students will be placed into small groups to conduct the sausage manufacturing and salt experiment. Although students should receive and use experimental instructions, it is advised that the instructor also explain each of the four experimental parts (sausage manufacturing, cooking, sensory, and microbiology) to students at the appropriate time. Each group will use the provided lab report to document findings and record their hypothesis.

Learning Activity 3: Industry and Career Video – Meat Science

Show the industry and career video that discusses “real world” application of these basic scientific concepts, while also introducing students to career possibilities that function to bridge science and agriculture.

Reflection

Using the prompts below to facilitate reflection, allow each student to respond in writing to the prompts and then facilitate a whole class discussion.

1. How did texture of the sausage mixtures change as it was mixed longer? What were the differences in texture between the two sausages? Why were these observed?
2. Calculate the cooking loss for each sausage mixture. How did salt impact the cooking loss of the sausages? When eating the samples, which was juicier? Why were these observed?
3. Which product tasted saltier? Were there any differences in sausage flavor or spice intensity? Why were these observed?
4. Did adding salt to the sausage impact microbial growth? If so, how would this occur?
5. Which sausage was preferred?
6. Is salt an important ingredient to make sausage? If so, why?

Apply

Use the prompts below to facilitate small group and whole class discussion.

1. What basic scientific principles are associated with the manufacturing of sausage (or any processed meat product)?
2. Your “hand-made” beef patty falls apart. What can you do to keep it together?
3. How will you use salt when preparing meat products in the future?

References:

- Why does salt make food taste better? https://www.youtube.com/watch?v=ATrSoMIx5PE

Why Do Most Foods Contain Salt? Experiment Guidelines

Objectives:

1. Describe the roles of salt in meat.
2. Predict the effects of salting raw meat.
3. Investigate phenomena of salting meat and connect observations to basic science principles.
4. Evaluate student predictions based on data and observations.

Instructions

First Process

Sausage Manufacturing – Before starting, students should wash hands with soap and water.

1. To one pound of ground pork, add 3/8 teaspoon ground black pepper (0.9 g), 1 teaspoon ground sage (0.9 g), and 1 3/8 teaspoon Salt (8 g). This will be "sausage, with salt".
2. To the second pound of ground pork, add 3/8 teaspoon ground black pepper (0.9 g) and 1 teaspoon ground sage (0.9 g). This will be "sausage, no salt".
3. Mix each treatment (salt vs. no salt) by hand for a total of two minutes in 30 second intervals. Students should compare how sausage texture changes as it is mixed.
4. After mixing, have students portion each mixture (treatment) into four, 4 oz (~112 g) portions and form into patties using the patty maker. Cover the top and bottom portions of the patty maker with plastic wrap, prior to adding meat, to ease patty removal.
    a. One patty from each mixture (treatment) will be used for microbial comparison and should be covered with plastic wrap or placed in a covered container for ~ 48 hours.
    b. The remaining three patties associated with each mixture (treatment) may be used for cooking and sensory evaluation.

Second Process

Cooking

5. Weigh raw patties from each mixture (treatment) and record raw weights (do NOT include the patty removed for microbial evaluation).
6. Cook patties on the electric grill until they reach an internal temperature of 160°F.
7. Remove patties from grill and weigh. Record cooked weights of patties for each mixture (treatment).
8. Calculate cooking loss for each mixture (treatment). Cooking loss is calculated using the following formula:

$$Cooking\ loss\ (\%) = 100\ x\ ((Raw\ weight - Cooked\ weight)\ /\ Raw\ weight)$$

Third Process

Sensory

9. Cut cooked patties into bite-sized pieces and serve one or more of each sample to each student.
10. Between the two samples, students should compare differences and preferences between samples for sausage texture, juiciness, saltiness, spice flavor/intensity, sausage flavor, and overall preference.

Fourth Process

Microbiology

11. Carefully press patty onto a Petri plate with agar. Be careful not to twist or slide the patty on the agar.
12. Incubate for 48 hours at room temperature. To accelerate the process, an incubator set at 37°C (98.6°F) may be used, if available.
13. Count individual colonies on the plate to compare bacterial growth for each treatment. If unable to count individual colonies, compare overall growth of each.

Name:

Lab Report

Please complete the following report during the design and implementation of your experiment.

Research Problem

- Describe what you are investigating and justify why you are investigating the problem.

Hypothesis

- Formulate one or more hypotheses for your experiment.

Procedures

- Create the steps you will follow for your experiment.

Data Collection

- Describe the data that you will collect during your experiment.
- Provide graphs, tables, charts, and raw data as necessary.

Results

- Explain your results.

Conclusion

- Based on your data:
    - What can you conclude?
    - Were your hypotheses supported?
    - Were their limitations to your experiment?
    - What are new research questions that derived from this study?