

**A Spicy Little Radish**

**A radish’s journey from farm to fork: cultivation through preservation.**

**How are radishes cultivated, prepared, and preserved?**

Students will learn about the cultivation of radishes, grow and harvest radishes, prepare radishes for fresh dishes using safe practices, and ferment (pickle) radishes for storage/preservation/ and future use.

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**Objectives**

Ag Ed (when met, these are highlighted in blue)

AP41 HRT I: *7.00 Apply procedures to plan and plant a vegetable garden.*

AU10 Agriscience Applications: *3.03 Understand basic horticultural (ornamental, fruit and vegetable) and agronomic principles and practices.*

AP 71 Biotech I: *11.00 Analyze the impact of cells on the formation and function of living organisms,*

AP72 Biotech II: *6.00 use advanced laboratory techniques and procedures in agriscience research, 13.00 Examine techniques and biological food process in food science related to biotechnology.*

FACS (when met, these are highlighted in pink)

FN41 Foods I: *1.00 understand methods for safety, sanitation, processes and conserving resources., 2.00 Understand methods of food preparation, 4.00 Understand the relationship between food choices and health, 5.00 Understand food choices, 6.00 Apply methods for meal planning and preparation.*

FN43 Foods II Technology: *3.00 Understand the functions of food constituents, 5.00 Understand how microorganisms affect food safety and food quality, 7.00 Understand food production systems.*

FN42 Foods II Enterprise: *1.00 Understand causes of foodborne illness, 2.00 Understand factors that influence food safety, 3.00 Understand safe facilities, pest management, and sanitation, 5.00 Apply specialty food preparation skills.*

**Introduction**

Radishes are a spicy and nutritious root vegetable that has been cultivated and used in various culinary dishes around the world for centuries. This plant has been bred to various shapes, sizes and colors. Regardless, radishes share a common trait: a taproot that not only anchors it into the ground but is also used to store nutrients and water.

Radishes are typically harvested within 25 days when grown in a sunny spot during North Carolina’s cool fall or spring seasons. Radishes can be grown in loose soil or in potting soil within a garden or container. Once harvested, this crop can be cleaned and eaten raw or roasted, sautéed, grilled or boiled. In addition, the radish is easily pickled (fermented) and added to countless culinary creations. The fermentation process not only adds many different flavor and texture elements to the radish but also prolongs the storage of this root vegetable.

**Real Science and Life Application**

In the year 2050, nine billion people will sit down for dinner on the planet. These people will need to be fed with fewer resources (like water and space) available to farmers growing the crops.

The radish offers a very short life cycle before harvest, the ability to be interplanted amongst other crops, and a wealth of nutritional qualities. Additionally, a pickled radish can help to preserve a food source through the process of fermentation.

Growing radishes and using them in various dishes can help to feed the world a nutritious dish using a sustainable, quick, and easily cultivated crop.

**Time & Location**

This lesson requires five 90-minute sessions of instruction. An entire day will be spent in the classroom and a garden-like location on the first day. In addition, each week (for between three and four weeks) students will need to spend 20-45 minutes in the garden observing their space, cultivating, and seeking solutions to problems. One full day will be spent harvesting and analyzing their radish cultivation. A half day will be spent fermenting and pickling radishes and an additional half to a full day will be spent preparing radishes for an edible dish.

Teachers rarely teach an entire unit from start to finish. Just like all lessons, this can be cut and pasted. If you are not interested in growing your own radishes, skip it and just buy some radishes and try fermenting and pickling them. No time after the radishes are harvested? Just send some of the radishes home and have the students direct their own exploration for homework or a project. Have them try fermentation at home and document their work with pictures and have them upload their photos and observations to a class blog. This curriculum can be worked into your classroom… promise. Just choose your activity.

**Student Materials**

Day 1:

* A Spicy Little Radish (student handout)
* Just Eat It: Radishes (student handout)
* Radishes (a Prezi) by Jodi Riedel
* Radish Seeds (one packet per student, partners, or group)
* Garden plot or media (potting soil or container with potting soil)
* Water

Days 2-25ish:

* A Spicy Little Radish (student handout)
* Water
* Garden cultivation tools (gloves, hoes, other garden tools)

Day 25ish:

* A Spicy Little Radish (student handout)
* Food Science Literacy Anticipatory Guide (student handout)
* Camera for taking photograph of student with radishes
* Water
* Garden cultivation tools
* Scale

Days 26ish:

* An Exploration of a Radish Preservation (student handout)
* Food Science Literacy Anticipatory Guide (student handout)
* Ingredients for fermentation
  + Water
  + Sea Salt
  + 2 pounds of radishes
  + 1 small onion
  + Vinegar
  + Sugar
  + Whole peppercorns
* Knives, cutting board to slice radishes
* 1 wide mouth quart mason jar
* 1 quarter pint jar (4-ounce jelly jar)
* 1 mixing bowl
* Plastic wrap
* A laboratory equipped with heating units to boil water
* Area for washing hands and proper food handling

Days 32ish:

* An Exploration of Radish Preservation(student handout)
* A Fascination with Fermentation (student handout)
* Equipment and materials to use the fermented radish in a dish

**Safety**

Students should thoroughly wash hands, have hair pulled back and practice all other methods of safe food handling.

Students will be using knives with have a slew of potential hazards. Oh, and in case you did not know- glass can break and cut anybody pretty badly, too.

Maybe your students could get some vinegar in the eyes. Perhaps they should wear a pair of safety goggles if you are really nervous. Oh, and onions can make you tear up just as badly so the glasses could help with that. Now, if the kids start to snort the sugar you could use a clothes pin on the nose. I say those are all part of the experience, but you be Captain Safety on your own level.

**Student Prior Knowledge**

* Students should be familiar with the scientific method.

**Teacher Materials and Preparations**

Day 1 (Radish Cultivation):

* Read Radish Background Information (handout). This will give information about how to cultivate radishes in the garden, in potting soil bags, or in a container.
* Make copies of Radish Background Information or provide access to this document virtually
  + Radish Background Information is attached to the Radish Prezi.
* **From Rock to Radish Activity**- All of these items will need to be gathered into a bucket
  + a rock
  + a baggie of gravel or sand
  + a baggie of garden soil
  + trowel (miniature shovel)
  + packet of radish seeds
  + bottle of water
  + lightbulb
  + watering can or nozzle
  + small hand rake or cultivator or pair of gloves
  + radish
  + two little toy trucks
  + dollar bill
  + cooking utensil
  + fork
* Radishes (a Prezi) by Jodi Riedel
* Make copies of A Spicy Little Radish student handout (one per student).
* Make copies of Just Eat It: Radishes student hand out (one per student).
* Plastic or garden gloves for students wanting them (many are crazy about not getting their hands dirty!)
* Have a garden site prepared for students
  + There are various ways to do this: a garden site with good soil broken into individual or group plots, a bag of potting soil or garden soil for an individual or group
  + A garden plot could be weed free or get those students working and pulling out weeds
* Radish seeds (could be one bag per student, one per group or buy in bulk at Wyatt Quarles, Johnny’s Seeds online, garden store or big box store)
* Water (hose, watering can or sinks and containers)
* Garden tools (only needed if using garden plots): hoes and rakes
* Plot marker (a wooden stake, popsicle stick, a vinyl tag (made from a window blind) one for each student or group
* Permanent marker or pencil

Days 2-25ish (Radish Cultivation):

* A Spicy Little Radish (student handout)
* Water (hose, buckets, or sprinkling cans)
* Garden tools (gloves, hoes, etc.)

Day 25ish (Radish Cultivation and Fermentation):

* A Spicy Little Radish (student handout)
* Make copies of have access to “Let’s Preserve: fermented and pickled foods” article
* Make copies of Food Science Literacy Anticipatory Guide (student handout)
* Camera for taking photograph of student with radishes
* Water, soap and maybe a bristled brush for washing radishes
* Garden cultivation tools
* Scale to measure weight of radishes
* Knives or pruners (to remove greens from radish bulbs)
* Cutting boards or a surface for cutting
* Refrigerator

Days 26ish (Radish Fermentation):

* Food Science Literacy Anticipatory Guide
* Make copies of An Exploration of Radish Preservation (student handout).
* Ingredients for fermentation and pickling
  + Water
  + 2 T Sea Salt (per student or per group)
  + 2 pounds of radishes (per student or per group)
  + 1 small onion (per student or per group)
  + ½ c White Vinegar (per student or per group)
  + ½ c Sugar (per student or per group)
  + 1 T Peppercorns (per student or per group)
* Knives, cutting board to slice radishes
* 1 wide mouth quart mason jar (per student or per group)
* 1 quarter pint jar (4-ounce jelly jar per student or per group)
* A mixing bowl (per student or per group)
* Plastic wrap
* A laboratory equipped with heating units to boil water for the class
* Area for washing hands and proper food handling for the class

Day 32ish (Radish Food Use):

* Make copies of The Fascination with Fermentation (student handout)
* An Exploration of Radish Preservation (student handout)

Beyond Day 32- Supplementary:

* + Make copies of An Industry Focusing on Fermentation (student handout).
  + Make copies of She’s the Johnny Appleseed of Pickling Reading Review (article and student handout)
  + Make copies of The Collard Green Queen (student handout and video online)
  + Create radish dishes: A radish recipe of the students choice (available on the internet: students can find for themselves or you can supply one for a student, team or class). Provide equipment and materials to prepare radish dish (a FACS/food science lab or kitchen)

**Activities**

Day 1:

1. Ask students if they have ever heard of rock and roll. What about rock and radish?
   1. How many students know what a radish is? Describe.
   2. How many students have eaten a fresh or cooked radish?
   3. What ways can you prepare a radish?
   4. How can we get from a rock to a radish?
2. Give each student an item From **Rock to Radish** bucket. Ask them to put the items in order (in front of the classroom) from the farm to the fork. How does a radish end up in your stomach from a rock?
   1. The basis for all soil is a rock. (rock)
   2. Rocks weather to become sand, silt, gravel, clay. (baggie of sand or gravel)
   3. Sand, clay, and silt mix with organic matter to form SOIL. Soil is the habitat where plants grow and where we harvest food. (baggie of soil)
   4. Farmers use tools like this trowel to grow food. (trowel)
   5. Farmers will use seeds, like this radish and put them in the soil. (radish seeds packet)
   6. The radish needs essential things to grow like water and light (bottle of water and lightbulb).
   7. When there is not enough rain, this is called a drought. A farmer (also called a grower) will apply additional water with irrigation (watering can or hose nozzle).
   8. Weeds will definitely grow around a plant and must be removed so they don’t compete with the radish (cultivator or gloves).
   9. A radish grows and is harvested (radish from store).
   10. The radishes are packaged, cooled, and transported to a distribution warehouse and then to a store (toy truck).
   11. Someone buys the radish (dollar bill).
   12. The radish is then taken to a restaurant or a home (toy truck).
   13. The radishes are prepared using a number of different cooking methods like grilling, sautéing, roasting, and pickling (cooking utensil).
   14. The radish is eaten (fork).
   15. This is what is known as a *food system*. There are a lot more steps than are even shown here to make the farm to fork or farm to table continuum work. This class will grow radishes and use them to experience this food system and how it functions in the real world and what role you can play in this system.
   16. This would be a great time to give students the leftover radishes to sample (just try eating fresh with ranch). Discuss some benefits of eating radishes in one’s diet.
3. Give each student a copy of A Spicy Little Radish (student handout). Fill out p.1 of the packet and tell them what will be happening over the course of the next month.
   1. For the “What will happen if”: This is the question of the scientific method. Guide your students or give little direction here (depending on their level). Write what will happen if you plant your radish seeds in a garden or a plot at your school OR what will happen if I take a package of seeds and try to learn how to grow them. This can be as detailed or as broad as you need depending on the level of your student or class.
   2. For the “I think what will happen is”: This is their hypothesis. Once students have posed their question they should write down a guestimate. Students can refine this later with actual numbers or data after they learn more about how radishes are cultivated.
4. Show the Radish Prezi. Complete p.2 of A Spicy Little Radish packet.
5. Help students design their plot on p.3 of A Spicy Little Radish packet.
   1. This will depend on whether your class will be using a garden or a bag of soil or a container.
   2. Encourage students to create a scale like 1”on the paper =1’ of garden space.
   3. Go outside and start sowing. Use the Radish Background page and help students to sow their radishes in ground, in a potting soil bag, or in a container. This is known as *direct sowing* (they will not be transplanted).
   4. Be sure to label plots with a marker (Popsicle, plastic tag, vinyl blinds cut up) and a permanent marker or pencil. Write the name of the plant, the sow date, and the name of the student or group.
   5. Water (irrigate) the plots so that the soil is thoroughly saturated at least to a 2” depth.
   6. Complete p.3 of A Spicy Little Radish the date of germination and the number of seeds sown.
6. For review, grab some of the items from the Rock and Radish bucket and have students describe where or how they fall on the farm to fork continuum (food system).
7. As a homework piece, have students research radishes as a healthy food choice. Use radishes in a meal plan and find a recipe that uses radishes. Give students a copy of Just Eat it: Radishes (student handout). This should be completed for homework. Use the Radish Background Information to help complete the assignment.

Days 2-25ish:

1. Have students turn in the Just Eat It: Radishes homework.

Students should spend at least one part of a day each week observing and cultivating their radishes.

1. Water the radishes when the soil feels dry to the touch.
2. On p.3 of A Spicy Radish, write down the germination data, including the germination rate.
   * 1. *Germination rates* = total seeds germinated/ total seeds sown
     2. Germination rates depend upon the skill of the person sowing the seed, seed quality, environmental factors (water, light, and temperature) and pests (animals, diseases, insects).
3. Be sure to *thin* radishes. Use the Radish Background Information for more information on how and when to do *thinning*.
4. On p.3-4 of A Spicy Radish, be sure to write down one weekly:
   * 1. Wonder= question
     2. Problem= something that they notice that might have a solution
     3. Observation= something they see or observe with their senses
5. If there are problems, have students search the internet to find possibilities for the reason, as well as, solutions to the problems.

2. If you have a crop failure, be sure to study this scientifically and determine what the cause of the failure was. The crop’s life cycle is so short and the process so cheap… you could try, try, try again.

Day 25ish:

1. Around day 25 (depending on when most of the radishes are about the size of a quarter), harvest the radishes.
2. Take a photograph of each student or group harvesting the radishes.
3. *Cull* the radishes from the garden(remove any radishes that are too big or too little and add to a compost pile).
4. Clean the radishes with water and remove any debris. Demonstrate and use food safety methods.
5. Weigh the radishes (with tops/greens) and count the radishes.
6. Compile radish data for class.
7. Record radish harvest data on p.4 of A Spicy Radish.
8. Prepare radishes for storage by slicing the greens from the radish bulb. Place greens in plastic bags separately (if planning to use for cooking) and place bulbs in another bag. Use and demonstrate proper slicing techniques. Be sure to discuss proper food storage to prevent food-borne illnesses.
9. Complete p.5, the analysis of A Spicy Little Radish. Students will examine their cultivation journey and make suggestions.
10. Give students each a copy or access to the article “Let’s Preserve: fermented and pickled foods,” by Julie Albrecht from the University of Nebraska (need p.1-5)
    1. <http://www.ianrpubs.unl.edu/epublic/live/ec443/build/ec443.pdf>
    2. Along with this article, have students answer the Food Science Literacy Anticipatory Guide (student handout).
    3. Students should complete the anticipatory guide on their own and then bring it back to class for discussion.
11. For review, take students back through their packets and describe how this was a scientific experiment even though it did not feel like it. Have students explore how they used Science, Technology, Engineering, and Math.
    * 1. Science- physical science (understanding soil), cultivation (horticulture), pest problem and identification (entomology or pathology)
      2. Technology- using the Prezi or other resources on the internet to find solutions to problems
      3. Engineering- designing the garden
      4. Mathematics- determining number of seeds sown, germination rates, harvests statistics

Days 26ish:

1. Explain that fermentation and pickling are super “hot” topics in the culinary world. Chefs are fermenting and pickling everything from tea to eggs to onions and, of course, the radish.
2. Have students take out their Food Science Literacy Anticipatory Guide (student handout). As a class focus on the following questions:
   1. How are fermentation and pickling of foods a preservation technique?
   2. What makes them similar and different to one another?
   3. How could this article relate to a crop like radish?
3. Students will now ferment and/or pickle some of their radishes. In order to ferment, students need 1 ½ pounds of radishes and to pickle students will need ½ pound of radishes (you may choose to just have some students ferment or pickle, or do both depending upon your harvest).
   1. If you only want students to pickle or ferment, the process of getting them ready will take 45 minutes.
   2. If doing both, this will take a 90 minute period.
4. Give each student a copy of An Exploration of Radish Preservation (student handout).
5. Have them read the introduction together. Assign students to ferment, pickle or both.
6. Students should read through the lab directions and answer the Pre-Lab’s Purpose and Procedure.
7. During the lab, students should make observations for day 1 for fermentation and pickling.
8. To review, have students create a list of foods that are commonly fermented or pickled.
   1. To extend this into homework (or if there is time), have them find 5 items in a catalog or magazine that are commonly fermented or pickled.
   2. On a piece of paper, have them affix the image that they have taken from the magazine.
   3. For each item, have them tell whether they believe the item is fermented or pickled and justify their conclusion.

Days 27-32ish:

1. To review, have students write two paragraphs about how the following statement from [www.wildfermentation.com](http://www.wildfermentation.com) relates to what they have learned today. Students could write this information independently, with a partner, or with a group. (Use 21st century technology and have students answer this question on Edmodo, Google Classroom, or a blog response)

# What is the Difference Between Pickling and Fermentation?

# Pickling covers much ground beyond fermentation. Pickles are anything preserved by acidity. Most contemporary pickles are not fermented at all; instead they rely upon highly acidic vinegar (a product of fermentation), usually heated in order to sterilize vegetables, preserving them by destroying rather than cultivating microorganisms. “For pickles, fermentation was the primary means of preservation until the 1940s, when direct acidification and pasteurization of cucumber pickles was introduced,” according to Fred Breidt of the USDA. Vinegar sterilized pickles offer the advantage of not being perishable; however, certain nutrients, including vitamin C, are diminished by heat treatment, and vinegar pickles do not contain the live lactic acid bacteria found in raw fermented pickles.

* 1. How does this impact their lives or relate to them and their world?

1. Begin observations for the An Exploration of Radish Preservation: Radish and Fermentation Lab (student handout). Each day, make an observation and put this in the Data/Observations (student handout) part of the lab.
2. Around day 5, the radishes should be sampled. If the fermented radishes do not taste sour, they may need one or two more additional days of fermentation.
3. Complete the Questions and Analysis component of the Radish and Fermentation Lab (student handout). Have students use the fermented or pickled radish in a dish.
4. For the remainder of class (and as homework), give students The Fascination with Fermentation (student handout). This assessment helps to guide students through two articles that are extensions of understanding fermentation. One article deals with the making of beer and wine while the other deals with how important fermentation is to industry, biotechnology and society today.

**Extension Activities**

* Have students explore Novozymes through An Industry Focused on Fermentation (student handout). Students can explore food science careers available in Franklinton, North Carolina for high school graduates to those with doctoral degrees.
* Give students the She’s the Johnny Appleseed of Pickling Reading Review (student handout and article). Students can read the article online or you can print. Students can complete a differentiated assignment that helps them to read across the curriculum and employ various interests to complete the assignment about fermentation, food safety, and the food system.
* Watch A Chef’s Life episode #11, Season 1 called The Collard Green Queen (student handout). This is a North Carolina show. It is available for streaming at Amazon and is free for Amazon Prime members or can be purchased for $1.99. Use the video guide for this 24 minutes that takes students on a farm to fork tour and explore food preparation, safety, and the food system.
* Use the remaining radishes in a dish of the student or teacher’s choosing. Students could first research recipes and nutritional content and then use the radishes to prepare a variety of different dishes using radishes. Students could then have a “cook off” to see what preparation method makes for the tastiest radish dish.
  + Do not limit the students’ culinary creativity: use the greens and see what masterpieces can be made.
  + Research how greens have more nutritional value than the roots.
  + What makes the green tops so much better for one’s diet?

**Assessment**

* Use the NC CTE post assessment bank of questions for the objectives that you feel align most with the components of this unit from farm to fork that you are using. See the Curriculum Alignment for standard course of study objectives for Agricultural Education or FACS courses that seamlessly fit into this unit.

**Community Engagement**

* An Industry Focusing on Fermentation career perspective introduces students to Novozymes, a local company that industrially ferments. Students have the opportunity to connect with scientists and workers at Novozymes in this activity.
* She’s the Johnny Appleseed of Pickling Reading Review has some opportunities to work with the community and spread the word about fermentation.

**Critical Vocabulary**

***Acid***

***Alcohol***

***Bacteria****: microscopic organisms that often play a role in the decay of living things, the process of fermentation and sometimes in causing disease*

***Bulbs***

***Cull***

***Cultivation***

***Cultivar***

***Fermentation***

***Food System***

***Germination***

***Hydrolysis***

***Irrigation***

***Media***

***Seedlings***

***Sow***

***Thin***

***Tilth***

***Yeast***

**Modifications**

* **Students needing more rigor:** 
  + **Differentiate assignments for students who are excelling by having them create further investigations.**
  + **Students could add variables to their radish experiment by testing garden soils versus potting soils versus containers. Students could also measure more accurately the amount of water needed in proportion to temperature and current weather conditions.**
  + **Students needing rigor for the fermentation study could further investigate food-borne illnesses and the pathogens often associated with them while fermenting foods. Historical or geographical information could be plotted to represent food-borne illness cases associated with fermentation.**
* **Students on an Occupational Course of Study (OCS) pathway:** 
  + **Modify assignments to meet each students Standard Course of Study blueprint modification that was determined by you, your Special Populations Coordinator and the OCS instructor.**

**Alternative Assessments**

* Students can complete the following as individual assessments or submit them together as one unit’s work.
  + A Spicy Little Radish Packet (student handout)
  + Food Science Literacy Anticipation Literacy Guide (student handout)
  + Radish Fermentation and Pickling Lab (student handout)
  + The Fascination with Fermentation (student handout)
  + An Industry Focusing on Fermentation Career Perspective (student project)
  + She’s the Johnny Appleseed of Pickling Reading Review (student handout)

**References**

* <http://www.seriouseats.com/recipes/2012/06/fermented-radish-slices-recipe.html>
* <http://www.bhg.com/recipes/how-to/cook-with-fruits-and-vegetables/how-to-pickle-radishes/>
* <http://snap.nal.usda.gov/nutrition-through-seasons/seasonal-produce/radishes>
* <http://www.wqseeds.com/documents/WQVegPlantGuide-revised.pdf>
* <http://www.burpee.com/vegetables/radish/all-about-radishes-article10099.html>
* [www.wildfermentation.com](http://www.wildfermentation.com)
* <http://www.foodpolitic.com/food-science-101-fermentation/>

**Author Information**

* **Jodi Songer Riedel is a Michigan native that came to North Carolina to further study tomatoes in 2002. Her love of tomatoes goes on, but she has since added countless other passions like fungus, honey, goats, chickens, and anything agricultural. Food science has been a great way to fuse her love of cooking and food preservation with gardening. She has been an agricultural education teacher at Wakefield High School in Raleigh for her entire career and enjoys teaching students how to sow, hoe, and grow and then add to what they know with food science.**