Radish Seed Toxicity Activity

Elementary School Lesson Plan (4th grade and up) - Outline

Summary of Activity

In this activity, students will dose radish seeds with two provided substances (instant coffee and a small packet of salt) and a water control. Students will then observe the treatment effect on radish seed germination over the course of three days, answer questions about experimental design, and interpret their results.

Objectives

* Become more familiar with concepts of experimental design:
  + What is a hypothesis?
  + What are treatments in an experiment?
  + What is a control treatment?
  + What are independent and dependent variables?
  + Gain exposure to the concept of toxicity
* Think about conditions that living things need to grow
  + What do you need to live and grow? How does that compare to a plant?

Guiding Question:

How can we set up an experiment to compare the toxicity of various substances to radish seeds?

Teacher Background

Toxicology is the study of the harmful effects of chemicals on living organisms. Chemicals are all around us every day- some are very useful and beneficial (dish soap, lotion, hand sanitizer), while others may be harmful. In order to test whether chemicals have harmful effects for humans or for the environment, we can select model organisms to use for chemical testing (such as the radish seeds in this experiment). By conducting a controlled experiment where we expose the model organisms to the same amount of various substances, we can determine which substances are more harmful than others. In this activity, our goal is to design a controlled experiment, highlighting elements of experimental design, to compare the toxicity of substances.

Materials provided for each student:

* 1 re-sealable plastic sandwich bags
* 2 paper towels
* 10 radish seeds
* 1 baggie label

Sharable materials:

* Measuring spoons
* Coffee
* Salt

**Activity (Day 0):** (videos for additional support, but amounts may differ)

1. Assemble the test substances: instant coffee (provided), salt (provided), or another substance of your choosing (dish soap or soda pop for example)
2. Prepare the treatment bags.
   1. Have students put 2 folded paper towels in their bag.
   2. Treatments will be split throughout the class: 1/3 of the class will prepare control bags with only water, 1/3 of the class will prepare bags with coffee in them, and 1/3 will prepare bags with salt in them
   3. Have students fill out their name and date on a label with their treatment type (Salt, Coffee or Control (water)) and place it on their plastic bag
   4. For the control treatment, measure 2 tablespoons of water into the bag and seal
   5. For the coffee treatment…
      1. Mix each instant coffee packet with 6 oz. of water
      2. Measure 1 tablespoon of coffee into the bag labelled “Coffee”
      3. Measure 1 tablespoon of water into the same bag
      4. Seal the bag and mix the liquid inside the bag so that the entire paper towel is damp.
   6. For the salt treatment, add 2 tablespoons of water and 1 packet of salt to the bag. Seal and mix well.
3. Put radish seeds into the treatment bags
   1. Count out 10 radish seeds and place them on the wet paper towel in the bag. Make sure to spread the seeds out so they have plenty of room between them. Once again, seal the bags and remove as much air as possible. Repeat these steps until all of the bags have 10 radish seeds in them.
4. Lay the bags on a flat surface where they will be safe for several days and leave them until tomorrow when you will count the number of seeds that germinate.

**Pause: Let’s think about this experiment!** *This is covered in the video if you want to use that as a resource, but could also be a place for teachers to step in if they wanted to lead a discussion.*

Opening question: Generally, what do the students think the purpose of the experiment is?

Let’s think about our experimental design...

* Discuss variables (independent, dependent, controls)
  + Independent variable (what we choose to change) – type of substance
  + Dependent variable (what we measure) – # of seeds that germinated
  + Control variables (what is the same for *all* seeds) – amount of water, procedure, location of seeds, etc.
* Why did the procedure include the control treatment (water)?
  + A control treatment gives you something to compare to. In this case, it tells us how many seeds will germinate *without* any substance added.
  + Example: if you only saw 5/10 seeds germinate when you added salt, you might conclude that the salt caused fewer seeds to germinate. But if you also had a control treatment where only 5/10 seeds germinated, you might conclude that the seeds or one of the other control variables prevented germination, rather than the salt.
* Discuss the importance of keeping good records during your experiments.
  + Good labelling is important
  + You will be drawing your observations, which can help us make sense of our data once the experiment is over
* Hypotheses: What do you think is going to happen in this experiment?

**Activity continued (Day 1-3):**

1. The next day, without opening the bags, count the number of seeds that have germinated (I.e. have little sprouts growing out of them).
2. Tally the number of germinated and not germinated seeds in the “Seed Results” Table on your worksheet (hint: these two numbers should add up to 10).
3. Draw seeds before and after sprouting on the worksheet.
4. Repeat this counting for two more days until you have counts for a total of three days and your Results Table is full.

**Activity continued (Day 3):**

1. Follow the instructions on the Data Worksheet and answer the questions.

Results and Discussion:

**Hypotheses**

* What impact did you initially expect the substances to have on the seeds? Were your expectations correct?

**Experimental Design and Observations**

* How did the setup of the experiment and recording observations go? Did you run into any issues?
* Identify conditions that may not have been consistent across different students (ex. light, temperature). How might this have impacted the seeds? Why might control variables be important?
* Discuss other observations students might have had during the experiment

**Sharing Class Data and Conclusions:**

* What sources of error might there be in the experiment? Experimental error can relate to human actions, the tools we use, or the environment surrounding our experiment.
* Which treatment was most toxic to the seeds based on the class’ data?
* What might you do differently if you were to perform this experiment again?

Toxicology note on dose-response and how relevant our model organism is to humans:

In this experiment, the instant coffee decreased seed germination, but people drink coffee all the time! Does that mean that coffee is bad for humans?

This is a great question and is often asked by scientists when they do toxicity studies using plants, animals, or even bacteria. In general, humans do share some biology with other animals and plants, like how our cells and genes work, but there are also structural features that set us apart. This means that we will probably respond to a substance, like coffee, differently than a plant seed. The amount of coffee is also very important to think about. For the seeds in this study, we gave them *too much* coffee, so they were no longer healthy. But for humans, the amount of coffee that would make someone unhealthy would be different.