Winning Experiment Procedures from the NIH LAB Challenge

Toxicity Testing: The Effect of Chemicals on Radish Seed Germination

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Suggested Grade Level: middle school, high school

Background

The beneficial and harmful effects that a chemical has on an organism depend, in part, on the amount of the chemical that gets into the organism. The total amount of chemical administered to, or taken by, an organism is called a dose, and the effect a chemical has on a living organism is called the response. The effect a chemical has on a living organism is related to its dose and the resultant concentration of chemical in the organism. Toxicity tests enable toxicologists to learn about responses of living organisms, especially humans, to doses of chemicals.

In this experiment, students perform toxicity tests on seeds, paying careful attention to the dose and concentration of chemicals. From this experiment, students can understand the importance of using model systems in science when human subjects cannot be used because of the potential risk. Students can also understand that many questions in science suggest a variety of investigation methods and that their use of models in scientific inquiry can help them establish relationships based on evidence from their own observations.

Radish seeds are ideal for the experiment because they are easily found at local garden stores and will germinate in one to three days.

Purpose

The experiment has three purposes:

- To test the effects of different doses of chemicals on seed germination and collect data for two consecutive days.
- To understand that the effect a chemical has organisms is related to the dose and the resulting concentration of chemical in the organism.
- To demonstrate how toxicity tests enable toxicologists to learn about responses of living organisms to doses of chemicals (dose-response relationship).

Hypothesis

Exposure to solutions of increasing concentrations of chemicals will have an effect on normal radish cell germination. Students may hypothesize that certain chemicals are more toxic than others.

Duration

Set-up time: 45 minutes (one class period)
Experiment run time/data collection: two consecutive days, 15 minutes each day, for observations and data collection
Take-down time: 5 minutes

Materials

For a team of three students:

- 6 resealable plastic sandwich bags
- 12 paper napkins
- 6 50-mL beakers of chemical solution, ranging from 0% to 100% concentration*
- 1 bag of seeds (approximately 60 seeds in a bag)
- 1 permanent marker
- latex gloves
- safety glasses
- 1 tray

*Safe, easily available chemicals for testing include water-soluble plant food, artificial sweetener, liquid detergent, shampoo, soft drinks, window cleaner, instant coffee, salt, non-toxic environmental cleaner, sugar, tempura paints, fruit and vegetable cleaner (Fit), all-purpose disinfectant cleaner (Lysol).

Experiment Set-Up

Prepare 20 mL solutions of each % concentration of chemicals (0%, 6.25%, 12.5%, 25%, 50%, 100%) according to table below for each team of students. Assemble materials together and set out.

Beaker #	**Amount of water**	**Amount of chemical**	**Total volume of liquid**	**Concentration of chemical**
1	20.00 mL	0.00 mL	20 mL	0%
2	18.75 mL	1.25 mL	20 mL	6.25%
3	17.50 mL	2.50 mL	20 mL	12.5%
4	15.00 mL	5.00 mL	20 mL	25%
5	10.00 mL	10.00 mL	20 mL	50%
6	0.00 mL	20.00 mL	20 mL	100%

Experiment Execution

1. Label all six bags with your team members' initial, plus the bag number and a percent concentration of chemical, like this:

Bag **number**	**Chemical concentration**
#1	0%
#2	6.25%
#3	12.5%
#4	25%

#5	50%
#6	100%

2. Put two napkins together and fold them in half so that they fit into the plastic bag. Fill each bag with two folded paper napkins.

3. Put on the safety glasses and latex gloves. Carefully pour the chemical solutions into the bags, making sure to match the numbers and concentration percentages of the bag and the chemical. Each bag now will contain 20 mL of chemical solution that is absorbed by the paper napkins.

4. Count out 10 seeds. Carefully place the seeds on the moist paper napkins in the control bag (#1), making sure to space them evenly (do not clump them in one spot). Seal the plastic bag, pushing out the air as you go.

5. Repeat Step 2.4 for the remaining bags.

6. Place the seed bags in a stack, lying flat with the seeds up, on the tray. Put the tray of seeds in the spot designated by your teacher. Put this worksheet in your science notebook.

7. Observe the seeds for two days and fill in the following data table.

Table 1. Response of radish seeds to different concentrations of chemical

Bag #, dose	Day 1, # seeds germinated	Day 1, # seeds not germinated	Day 2, # seeds germinated	Day 2, # seeds not germinated
1, 0% (control)				
2, 6.25%				
3, 12.5%				
4, 25%				
5, 50%				
6, 100%				

Experiment Take-Down

Clean up your work area. Everything can go into the regular trash.

Data Analysis and Questions to Consider

- On Day 1, predict what you think will happen to the seeds in each bag.

- What was your chemical? Describe what you know about the chemical. (Do you consider it harmful, beneficial, or neither? What is it used for? How would a human be exposed to this chemical?)

- In which bag was the dose of chemical the highest? In which bag was the concentration of chemical in the solution the highest? Describe how you know.

- Did you see a difference in the effect on seeds of a small dose of chemical compared with the effect of a larger dose?
- What did you see?
- Is there anything else you saw that you would like to tell us?
- Is there anything else you are still wondering about?

Conclusion

This is an example of one possible conclusion.] "In our classroom experiment, we were able to observe the dose-response relationship of radish seeds after the seeds were given different types and doses of chemicals." Students will see that different chemicals have various effects on radish seed germination. They should be able to compare various levels of toxicity of these chemicals to radish seeds.

This procedure was adapted from Chemicals, the Environment, and You*, a curriculum supplement from the National Institutes of Health Office of Science Education and Biological Sciences Curriculum Study, 2000. Available at* *http://science.education.nih.gov/supplements/nih2/Chemicals/default.htm*.