

Investigative Lab 15

Eat Your Greens

Exploring Classification

Questions How can humans distinguish between crucifers and edible plants of other families? Can white cabbage butterflies recognize crucifers?

Lab Overview In this investigation you will learn how to use a tool called a dichotomous key to classify species. Then you will use your senses to distinguish between crucifer plant leaves and other edible plant leaves. Finally, you will perform an experiment to find out if white cabbage butterfly larvae can distinguish the leaves of crucifers from the leaves of other plants.

Introduction Crucifers (KROO suh furs) are a family of plants that include broccoli, mustard, cabbage, and several other familiar edible plants. Plants in the crucifer family produce chemicals called glucosinolates (gloo KOH sin oh lays). These plants also produce an enzyme that breaks down glucosinolates into two compounds. One of these two compounds is toxic to many insects. This keeps many insects from feeding on crucifers. However, some insects, such as the larvae of white cabbage butterflies, can tolerate the compound and in fact prefer crucifer leaves to any other type of leaf. This ability to tolerate the glucosinolate product provides an evolutionary advantage to the white cabbage butterfly larvae, since they do not have much competition for this food source.

Although larvae can kill a crucifer plant if they consume too many of the plant's leaves, the interaction between the adult butterfly and the crucifer is beneficial to both insect and plant. Adult butterflies feed on the nectar from the crucifer plant's flowers. As they travel from flower to flower, they pollinate the plants, enabling the crucifer to produce offspring.

In the Prelab Activity, you'll practice classifying crucifers. Then in the investigation you will test your own and the white cabbage butterfly larvae's abilities to distinguish crucifers from other leafy plants.

Prelab Activity Observe the flowers or flower photos provided by your teacher. Use the dichotomous key on the next page to identify the crucifers. You may also be able to tell which plants are most closely related to each other. After you are finished, find out the correct identifications from your teacher. Then answer the Prelab Questions.

A Dichotomous Key for Identifying Crucifers

- 1. Number of petals
 - 1a. Four petals go to Step 2
 - 1b. Other number of petals cannot be a crucifer
- 2. Shape of flower petals
 - 2a. Shaped like a cross go to Step 3
 - 2b. Not shaped like a cross cannot be a crucifer
- 3. Location where petals attach
 - 3a. On top of the ovary cannot be a crucifer
 - 3b. Below the ovary crucifer, go to Step 4
- 4. Shape of crucifer seed pod
 - 4a. Long and narrow some common examples
are: turnip, cabbage,
cauliflower, radish,
wallflower, mustard,
jewel flower
 - 4b. Oval some common examples
are: peppergrass, bladder
pod, alyssum, watercress

Prelab Questions

- 1. Which, if any, of the flowers did you classify as crucifers? Explain your reasoning.

- 2. Based on the dichotomous key, what flower characteristics do *all* crucifers have in common?

- 3. Describe any difficulties you had in classifying the flowers.

4. A researcher placed male and female adult white cabbage butterflies in a container with the three plants listed in the table below. Compare the numbers of eggs the females laid on the different types of leaves. Use the information from the Background and dichotomous key to help you develop one or more hypotheses that might explain the data.

Type of Plant	Total Number of Eggs
Radish	158
Alyssum	45
Primrose	0

Materials

- numbered paper plates
- leaves from selected greens
- petri dish
- paper towel
- pencil
- scissors
- water
- white cabbage butterfly larvae
- paintbrush or feather

Procedure

Part A: Using Senses to Classify Greens



1. Your teacher will provide you with numbered samples of washed leafy greens from a supermarket. These are all edible plants that are in the crucifer family or in the lettuce family. Smell each numbered sample. Describe the smell of each sample in Data Table 1 on the next page.
2. As directed by your teacher, taste a tiny piece of each leaf type.
CAUTION: *Only taste the leaves your teacher directs you to taste. Do not taste other plant leaves, as many plants are toxic. This part of the procedure should only be performed in a non-laboratory classroom using no laboratory equipment.* In Data Table 1 on the next page, write a short description of the flavors you detect in each leaf.

Data Table 1

Plant ID#	Description of Smell	Description of Taste

3. Use your observations to develop a hypothesis classifying the plants into two groups: crucifers and non-crucifers. Explain the reasoning behind your proposed classification.

4. After you are finished classifying the edible leaves, your teacher will reveal which leaves are from plants in the crucifer family and which are from plants in the lettuce family. Record the correct identifications in the spaces provided.

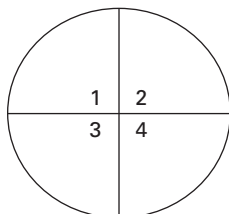
ID numbers and names of the plants in the crucifer family:

ID numbers and names of plants in the lettuce family:

Part B: Preparing a Test of the Ability of White Cabbage Butterfly Larvae to Recognize Crucifers



1. Use a pencil to trace the outline of the bottom of a petri dish onto a piece of paper towel. Cut out the circle. With a pencil, draw two lines to divide the circle into four equal sections as shown. Close to where the two lines intersect, label the sections 1, 2, 3, and 4.



Paper towel circle with sections labeled

2. Place the paper towel circle inside the bottom of the petri dish. Add just enough water to dampen the paper towel.
3. Obtain more samples of the four different types of leafy greens you tested in Part A. Cut about a 2-cm by 2-cm piece from each type of leaf. Place one leaf square in each section of the petri dish. Be sure to make a key so that you know what type of green is in each section. For example:

Section 1 = spinach

Section 2 = mustard greens

Section 3 = lettuce

Section 4 = cabbage

4. With a paintbrush or feather, gently transfer three white cabbage butterfly larvae to the petri dish. Be careful not to injure the larvae during the transfer.
5. Place the lid on the petri dish. Label the lid with your lab group's initials and class. As directed by your teacher, place the closed petri dish in a safe place overnight.
6. What do you predict will happen to the leaf squares after one day with the white cabbage butterfly larvae? Choose one of the following predictions, or make your own. Explain the reasoning behind your prediction.
 - a. The larvae will prefer the leaves of the crucifers, but will eat small amounts of the other leaves as well.
 - b. The larvae will only eat the crucifer leaves and the others will be left untouched.
 - c. The larvae will not be able to distinguish between the different types of leaves and will eat them equally.
 - d. other (Write your own prediction.)

Part C: Observing the Feeding Patterns of the White Cabbage Butterfly Larvae



During your next class, carefully examine all four leaf squares in the petri dish. Look for tiny circles or semicircles chewed out of the leaves. Also look for droppings left by the larvae. Record your observations in Data Table 2 on the next page.

Data Table 2

Plant Sample # and Name	Crucifer? (yes/no)	Observations
1		
2		
3		
4		

Analysis and Conclusions

1. Based on the leaves you tasted in Part A, what flavor(s) would you say that crucifer leaves have in common? Were you able to correctly classify the leaves that were in the crucifer family by tasting them?

2. Based on your findings in Part C, does it appear that white cabbage butterfly larvae can recognize crucifers? Explain.

3. If a scientist wanted to determine whether a certain edible plant was more closely related to cabbage than to lettuce, what are at least three possible ways to find out?

Name _____ Class _____ Date _____

4. Why might it be an advantage for white cabbage butterfly larvae to be able to recognize plants in the crucifer family?

Extension

Humans can distinguish crucifers from other leafy plants due to a chemical in crucifers that causes humans to detect a certain taste. Do white cabbage butterfly larvae detect crucifers in the same way, by recognizing a chemical? Write a hypothesis and a prediction. With your teacher's permission, perform an experiment to find out if your prediction is correct. Grind cabbage leaves with a little water in a blender. Then use cheesecloth to filter out the juice. Soak a lettuce leaf for a few minutes in the cabbage juice. Place the treated lettuce leaf, an untreated lettuce leaf, and a lettuce leaf that was rubbed against another lettuce leaf in a petri dish with white cabbage butterfly larvae. Record your observations. Discuss whether or not your results support your hypothesis and prediction.

