Carrots: Crispy or Shriveled?

Have you ever had carrots in your refrigerator that became limp? Not too tantalizing. Do you know a way to rejuvenate them? Carrots (and celery), as well as other biological systems, have a membrane covering through which various substances can pass. This activity will show you how to rejuvenate limp carrots and why it happens.

Materials

- 2 carrots or sticks of celery
- 2 tall glasses or jars nearly filled with tap water
- tablespoon measure
- table salt

Exploration

Step 1 To one of the tall containers of water, add 3 tablespoons table salt and stir occasionally over a 15-minute period. If all the salt dissolves, add additional table salt in 1-tablespoon increments until some solid remains undissolved, even after extended stirring. (This undissolved table salt will not interfere with the activity.) What is the systematic chemical name of table salt? What is the general chemistry name of the salt-water portion of the contents of the container?

Step 2 Place one of the carrots (or sticks of celery) in the container of salt water and the other in a container of tap water. Allow the two containers to stand for several days, recording the appearance of the immersed portion of each carrot after each day. You may need to remove a carrot from its container to get a closer look, but if you do so, be sure to return it to its appropriate container. What specific substance do you suppose is gained or lost to cause these changes?

Step 3 After several days, remove the carrots and rinse them thoroughly. Now switch the carrots, putting each into the opposite liquid: that is, place the carrot from the salt water in the container of tap water and the carrot from the tap water in the salt water. Repeat Step 2. Because of residual salt on the outside of the previously salt-soaked carrot, you may need to change the water in the tap-water container daily to effect a significant change.

Challenge

How can the effects of tap water and salt water on carrots be explained, and what general phenomenon does it illustrate? (Hint: Consider relative concentrations inside and outside the carrot.)

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Concepts

osmosis, colligative properties

Expected Student Responses to Exploration

Step 1 (a) The systematic chemical name of table salt is sodium chloride.
(b) The salt-water portion of the contents is known as a saturated solution.

Step 2 (a) The carrot in tap water stays crisp, while the carrot in the salt water shrivels or becomes limp.
(b) The crisp(er) carrot gained molecules of water; the limp carrot lost molecules of water.

Step 3 Depending on the amount of residual salt on the carrot and the frequency with which the water is changed, the limp carrot (previously in the salt water) becomes less shriveled and may even become crisp. The crisp carrot shrivels when placed in the salt water. The limp carrot gained molecules of water to become crisper. The crisp carrot lost molecules of water.

Expected Student Answer to Challenge

The order of increasing concentration is:

tap water < inside of carrot < saturated salt solution

Molecules of water flow into a carrot when it is in a lower concentration solution (tap water) and out of a carrot when it is in a greater concentration solution (salt water). This general phenomenon is osmosis: when a semipermeable membrane is between two solutions of different concentrations, solvent moves into the solution of higher concentration.

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