# ALGINATE GUMMIES Background

Alginate is a type of polysaccharide that occurs naturally in all brown algae as a skeletal component of their cell walls. Alginate is used in food because it is a powerful thickening, stabilizing, and gel-forming agent. Some foods that may include alginate are ice cream, fruit-filled snacks, salad dressings, pudding, onion rings, and even the pimento strips that are stuffed into green olives.

Most alginate used in foods is in the form of sodium alginate. In order to form a gel, sodium alginate needs to come into contact with divalent ions such as calcium ( $Ca^{2+}$ ). As soon as sodium alginate (Figure 1) is added to a solution of calcium chloride, a gel forms as the sodium ions ( $Na^+$ ) are exchanged with calcium ions ( $Ca^{2+}$ ) and the polymers become crosslinked (Figure 2).

The calcium ions are able to crosslink the alginate polymers because they can form two bonds, as opposed to monovalent ions such as sodium, which can only form one bond. The longer the alginate is in contact with the calcium chloride solution, the more rigid the gel will become, as more crosslinks are formed. Also, depending on the concentration of calcium ions, the gels are either thermoreversible (low concentrations) or not (high concentrations).

#### References

Waldman, AS, Schechinger, L, Govindarajoo, G, Nowick, JS, Pignolet, LH. 1998. The alginate demonstration: polymers, food science, and ion exchange. Journal of Chemical Education 75(11): 1430-1431.

Belitz, HD and Grosch, W. 1999. Food Chemistry. Berlin: Springer. 992 pgs.

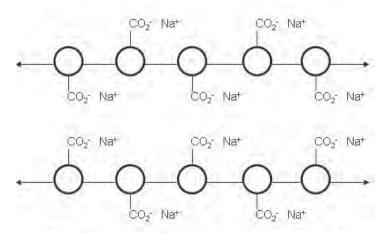


Figure 1. Alginate polymer in NaCl solution (no crosslinking) (Waldman et al. 1998)

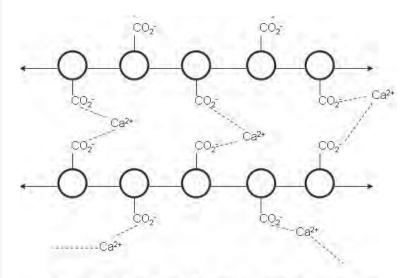


Figure 2. Alginate polymer in CaCl<sub>2</sub> solution (crosslinking) (Waldman et al. 1998)

## ALGINATE GUMMIES Administrator's Guide

Grade levels: 3 - 12

Estimated Preparation Time: 30 minutes Estimated Demonstration Time: 30 minutes

Standard Addressed: Content Standard C (Chemical Reactions)

Chemical reactions occur all around us; for example, in healthcare, cooking, cosmetics, and automobiles. Complex chemical reactions involving carbon-based molecules take place constantly in every cell in our bodies.

#### Reference:

Waldman, AS, Schechinger, L, Govindarajoo, G, Nowick, JS, Pignolet, LH. 1998. The Alginate Demonstration: Polymers, Food Science, and Ion Exchange. Journal of Chemical Education. 75(11): 1430-1431.

### Objectives:

- To introduce food science to students
- · To demonstrate the formation of an alginate gel

#### Materials:

- Distilled water (the demonstration will not work properly unless distilled or deionized water is used)
- 2 grams of alginic acid sodium salt (call TIC Gums at 1.800.899.3953 and request the free University Kit)
- 2 grams of sodium chloride (NaCl)
- 2 grams of calcium chloride (CaCl<sub>2</sub>)
- · Food coloring
- Pipette
- Two beakers (larger than 100mL)
- Optional: Also bring in a product which contains an alginate gel.
  For example, green olives with pimentos.



## Set-up Procedures:

- Add 2 grams of alginic acid sodium salt to 100 mL of distilled water.
  Stir the suspension vigorously for several minutes. Add several drops of food coloring to the suspension. For best results, prepare the suspension the day before.
- 2. Add 2 grams of sodium chloride to 100 mL of distilled water. Stir vigorously. Label the jar  $\rm Na^+.$
- Add 2 grams of calcium chloride to 100 mL of distilled water. Stir vigorously. Label the jar Ca<sup>2+</sup>.

#### Procedures:

- Using the pipette, pour a thin stream of the alginate solution into the calcium chloride. This should form worm-like gels.
- 2. Using the pipette, pour a thin stream of the alginate into the sodium chloride. This should not form a gel.
- 3. Ask students to describe what they see. Allow students to touch the alginate worms.
- 4. Explain why the alginate formed a gel in the presence of calcium chloride and not in the presence of sodium chloride. Waldman et al (1998) recommend:

For 3rd through 6th-grade students: Have students line up in two rows representing the alginate chains (polymers). Have a few "volunteer ions" who represent Na+ stand in between the rows and hold onto any student with one hand. To model the crosslinked calcium alginate, have the volunteer ions (now magically converted to Ca<sup>2+</sup>) touch two students each in a different row. Explain that the Na+ ions can only form one bond while the Ca<sup>2+</sup> ions can form two.

For 7th through 12th-grade students: Draw a cartoon on the board of the sodium alginate (see background Figure 1). Describe what happens during the ion exchange by replacing the sodium ions with calcium ions (see background Figure 2). Explain that the process is reversible at low calcium concentrations.

 Optional: Pass around the jar of olives containing pimentos, and have students look at the label. It should read: Olives, Water, Minced Pimento (Sodium Alginate, Guar Gum, Calcium Chloride), Salt, Lactic Acid.





**Extension:** Milk can also be used as a source of calcium. Using a pipette, pour a thin stream of the alginate solution into milk. The gel formed will be very weak.

## ALGINATE GUMMIES Student Handout

**Background:** Alginate is a type of polysaccharide that occurs naturally in all brown algae as a skeletal component of their cell walls. Alginate is used in food because it is a powerful thickening, stabilizing, and gel-forming agent. Some foods that may include alginate are ice cream, fruit-filled snacks, salad dressings, pudding, onion rings, and even the pimento strips that are stuffed into green olives.

Objectives: To investigate how an alginate gel is formed



# Observations: 1. What happened when a thin stream of 2% sodium alginate was poured into the calcium chloride (Ca<sup>2+</sup>)? 2. What happened when a thin stream of 2% sodium alginate was poured into the sodium chloride (Na+)? Conclusion Questions: 1. What needs to be present for an alginate gel to form? 2. Why does it need to be present?