

Potatoes: Starch Test, Shallot mashed potatoes with Garlic and Oven-Fried Potatoes

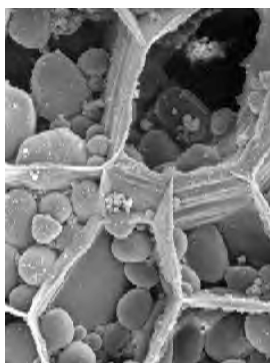
Introduction: There are three parts to this experiment where you will learn the starch content and gellification of the complex carbohydrates of sugars. Part I will investigate starch content, Part II is a discovery of making tasty mashed potatoes using this knowledge while Part III also builds on your knowledge of science to make oven-fried potatoes.

Background:

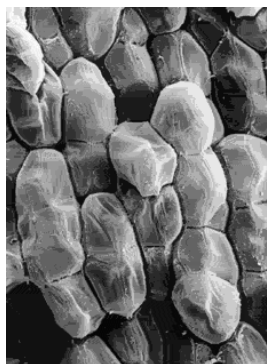
Russet (Idaho) potatoes are "high-starch" potatoes. Red potatoes are waxy or "low-starch" potatoes. The starch granules of a **Russet potato** are also larger than other types of potatoes. High-starch potatoes contain starch granules that are densely packed with amylose and amylopectin (most potatoes have between 20-30% amylose. **Russet potatoes** have more amylose than waxy potatoes). High-starch potatoes make fluffy baked potatoes, creamy mashed potatoes and french fries with a flaky interior, why is this?

When a **Russet potato** is cooked, the starch granules absorb water (this could come from inside the potato if you are making a baked potato), the heat and water cause *gelation* of amylose and amylopectin molecules making the granules swell and separate from one another. This results in a dry, mealy texture.

When we cook whole potatoes, the starch granules are *inside of cells*. The image below is a potato cell (the square-ish looking box) with starch granules inside (the brownish oval particles) as visualized using a *very powerful microscope*.

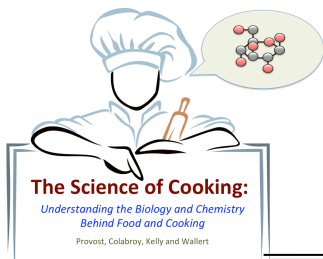


Potato, uncooked. Compact starch granules.
http://www.ifrn.bbsrc.ac.uk/fb/tex/2_5.html



Potato, cooked, swollen starch granules full of gelled starch.
http://www.ifrn.bbsrc.ac.uk/fb/tex/2_6.html

The potato is a plant after all...and it is made of cells. Therefore, "gelling" of the starch is occurring within this matrix of cells - this is why a whole potato doesn't turn to goey gel when cooked (remember what pure cornstarch turned into when heated? pure cornstarch or potato starch is *just* the starch



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1. Place the salometer (sal-o-meter) in the brine solution and measure the salinity. The salometer degree measurement directly correlates to the specific gravity of the solution as shown in Table 1. Adjust the salinity of the brine if necessary until the specific gravity of the solution is 1.08 (salometer score of 40-42) at 60 degrees F.

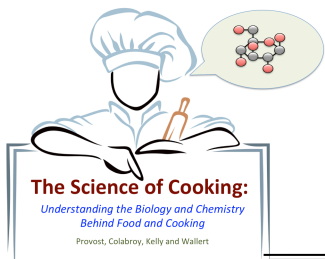
Record the salometer measurement of the brine and determine the specific gravity of your brine. Gather the information from the other brines created by your classmates.

2. Pour the brine into the graduate cylinder. Drop each type of potato into the brine and record if it sinks or floats.
3. Repeat until all groups have tested their potatoes. Record all the data and share with your classmates. Rank the potato types by starch content. Which types have the most starch and would therefore make the best-mashed potatoes?

Use this information to choose the type of potato to make a mashed potato or an oven-fried potato. Review information on vegetables for specific details on which starch content makes for a better type of potato.

An **alternative approach** to determine the starch content of your potato is to observe how far a potato sinks.

1. Measure out 1 cup of salt (chem stockroom salt), and 11 cups of room temperature tap water.
2. Dissolve 1 cup salt in the 11 cups of water in the 1 gallon pitcher. This salt water solution is called *brine*.
3. Carefully pour the brine into the tall, graduated cylinder, but leave a few inches of room at the top.
4. (*one group at a time*) Gently drop a potato into the brine. Record how far it sinks (in your notebook and on the chalkboard). The more starch a potato has, the more dense it will be and the farther it will sink. To retrieve the potato and re-use the brine solution (for the next group), carefully pour the brine and potato back into the one gallon pitcher. Use a clean hand to retrieve the potato from the pitcher. The used potato can be washed with soap and water, and then thrown away or composted.



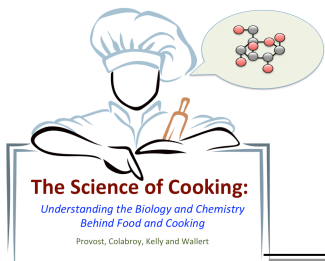
Discovery Laboratory #2

Table of Results:

Type of potato	Float or Sink? At what density or how far did the potato sink?
Russet (Idaho)	
Red Potato	
Other Potato	

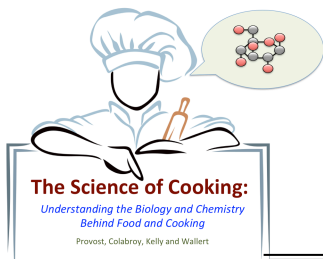
Based on these results, rank the potato types in terms of starch content.

Highest starch
Lowest starch



Discovery Laboratory #2

General Observations:



Part II Shallot mashed potatoes with Garlic

Kitchen equipment for Mashed Potatoes

Medium and Large mixing bowl	2 qt saucepan
Digital thermometer	Hot gloves/oven mitts
Potato peeler	Whisk
Potato masher	Rubber spoonula
Waring single burner	Cuisinart food processor with steel blade
Santoku knife	Cutting board
Liquid measuring cup	Wire mesh strainer

Ingredients for Shallot Mashed potatoes with Garlic

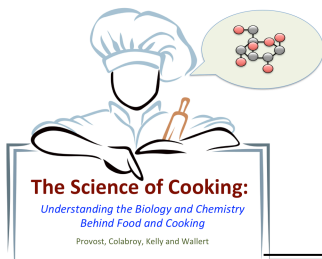
Makes 2-3 servings

2-3 medium high-starch potatoes, peeled and sliced about 1/8 inch thick	1/8 teaspoon of white pepper
2 medium shallots <i>crushed</i> , 2 shallots <i>finely minced</i> A shallot is a mild onion	1/2 cup heavy cream
1 clove garlic <i>crushed</i> , 1 clove garlic <i>finely minced</i>	1/4 cup of milk or half and half
2 teaspoons of salt	2 tablespoons butter
1/4 teaspoon of cider vinegar	

We want to use high-starch potatoes, because the large quantity of starch granules absorbs water, the starch granules swell and separate from each other. High starch potatoes break apart easily when cooked. Use the information gained from our first experiment to test this concept!

Instructions

1. Place the potatoes on your cutting board. Peel your potatoes, wash them briefly in cool water to remove any dirt, dry them in a clean kitchen towel and slice them in ~1/8 inch thick discs. Collect the sliced potatoes in your large mixing bowl.
2. Take ALL 4 shallots and do the following: Smashing one shallot at a time by placing it on your cutting board, covering the shallot with a clean kitchen towel and smashing it with the bottom



of your saucepan (this really does not require much force – don't over-smash it 😊). The crushed

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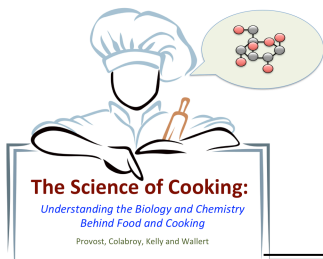
Part III Oven-Fried Potatoes

INGREDIENTS

- 1-3 large (0.75-1 pound) Russet Burbank (Idaho) baking potatoes. *Weigh potatoes to be sure you have between 0.75-1 lb!*
- Nonstick cooking spray
- 1/2 tablespoon olive oil
- 1 teaspoons salt
- 1/8 teaspoon cayenne *(add the cayenne according to your preference for spicy foods)*
- 1 teaspoons finely minced fresh rosemary
- 1/8 cup grated Parmesan

INSTRUCTIONS

1. Place the potatoes, unpeeled, in the refrigerator for a day or two. When ready to cook, scrub but do not peel, and cut into fat "French-fry" sticks. Make sure your potato sticks are uniform in thickness. Rinse the cut "sticks" well under running water.
 - *Letting the potatoes sit for a few days in the refrigerator converts some of the starch to free sugar molecules (glucose monomers) and makes the potatoes brown better in the oven. Although we won't discuss sugar "browning" chemistry until unit 4, free sugars (like glucose monomers) are able to undergo chemical "browning" reactions while starch molecules (polymers of glucose) cannot undergo this chemistry.*
 - *The conversion of starch to sugar in a potato is a process catalyzed by enzymes and (paradoxically) actually occurs FASTER at colder temperatures - this is thought to be a strategy the potato uses to protect itself from frost damage.*
 - *Rinsing the potato under running water removes excess starch (that white filmy liquid that sticks to your knife and your hands). We want crispy fries, so we don't want excess starch gelling on the outside of our potato sticks.*
2. Preheat the oven to 450°F using CONVECTION BAKE. Spray a baking sheet with nonstick cooking spray.



Discovery Laboratory #2

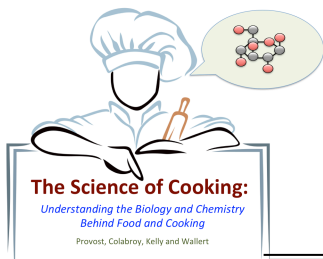
- Heat 2 cups of water to boiling in your saucepan. Place the potato sticks in your wire mesh strainer and sit the strainer over the pot of boiling water. Cover with aluminum foil and/or the pot lid. Steam the potato sticks for **8 minutes**. Remove the wire mesh strainer from over the boiling water. Gently remove potato sticks and pat dry with a clean kitchen towel.

Make observations of the potato sticks after steaming, record by taking an image.

- Stir together the olive oil, salt, cayenne, and rosemary in a medium bowl. Add the steamed potato sticks and toss well to coat. Arrange in a single layer on the baking sheet. **Bake until lightly browned, about 1 hour.**
- Sprinkle the Parmesan over the potatoes and return to the oven just long enough to melt the cheese, about 4 minutes. IF POSSIBLE IN YOUR SETTING, Taste and add salt as needed. Serve immediately.

Observe your fries after baking; take another image for your report.

Break open one of your oven-fries and examine the texture inside of the fry.



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Analysis In your report, explain...

1. Why was the starch content of the potato important to this recipe?
2. Why was cooling the potatoes (the 30 minute *standing*) important to this recipe. What did it accomplish?
3. Did your mashed potatoes turn out as you expected? Why or why not?
4. Compare your potatoes to another group that used a different potato type. How are the two products different? Can this be explained by the starch content of the potatoes?
5. What were the changes to the potato sticks before and after steaming?
6. Why did we steam the sticks before baking them?
7. Using your understanding of starch and gellification, explain the texture changes in the potato before steaming, after steaming and again after baking.