Molecular Gastronomy

Contributed by: Community STEM Clubs Program

Purpose: to illustrate and explain physical and chemical processes that can be used in the kitchen

Background

Molecular Gastronomy can be viewed as a cross between a kitchen and a science lab in that it uses physics and chemistry to change the tastes and textures of foods. These culinary processes are made possible by studying the physical and chemical transformations that occur while cooking. Although the discussion surrounding molecular gastronomy principles includes chemicals and some scientific lab equipment, the chemicals are natural to the biological ingredients in the recipes.

Overview

This activity includes three recipes that can be made in a classroom with minimal preparation. Safety concerns are fewer than those in a household kitchen and can be avoided by preparing parts of the recipes beforehand. With two facilitators it is possible, although hurried, to complete all three (3) recipes in an hour.

Materials (split by recipe)

- paper plates/bowls
- plastic spoons (recommended)

- Heat safe dish for hot arugula-agar mixture
- Syringes with 12" sections of ¼" tubing
- Twist ties
- Container with cold water (for soaking tubing)

- Bowl with calcium chloride solution (5g CaCl to every 1 litre water)
- Droppers
- Strainer
- Paper towels

- large bowl
- whisk and/or hand mixer

Arugula Spaghetti

Recipe (per batch)
- 2 cups arugula (loosely packed)
- ¾ cups water
- 1 packet (½ tsp) agar-agar powder

Instructions
Put arugula and water into blender and blend to liquefy. Pour into large pot with packet of agar-agar powder. Bring to boil until agar-agar powder is dissolved and pour into heat safe dish.

Loosely coil the tubing and secure bundle with twist ties. Pull up arugula-agar mixture with the syringe, attach syringe to tubing, and push syringe to fill tubing with the arugula-agar mixture. Soak tubing in cold water for three (3) minutes. Push out with air-filled syringe.

The Science
Agar-agar is an unbranched polysaccharide substance derived from the cell walls of red algae that acts as a thickener and stabilizer. It behaves similarly to the animal-based gelatin in JELLO but has a higher melting point, which means it is more stable and holds a more solid shape. When cooled, the agar-agar congeals into a gel, a process known as gellification.

Fruit/Vegetable Caviar

Recipe
- Freshly pureed fruit/vegetable juice
- Sodium-alginate (1 gram to every 200 grams of juice)

Instructions
Strain out pulp from juice. Pour mixture into container and cool in refrigerator for one (1) hour. Slowly whisk sodium alginate into mixture to create a 0.5% solution (follow ratio above).

Pull mixture into droppers and drop droplets, one at a time, into the water to make the caviar. When finished, strain the caviar and dry on paper towels.

The Science
Alginate is a polysaccharide that is derived from the cell walls of brown algae. Alginate differs from agar-agar in that it cannot be dispersed and dissolved into liquid flavoring with heat because it clumps too quickly. Instead, the alginate must be dispersed into a cold liquid through blending. Also, the sodium alginate requires calcium to solidify. When the alginate-mixture is dropped into the water with calcium chloride, a chemical reaction occurs

along the surface of the drop to form a sphere of gel around a liquid center, a gelification process known as spherification.

The specific chemical reaction that occurs is

$$Na^{+}\text{-alginate} + CaCl_2 \Rightarrow \text{Ca-alginate} + NaCl$$

Specifically, the calcium ions cross-link the polymers of alginate since calcium is divalent and sodium is monovalent. Thus the calcium can form more bonds than the sodium which link together to form a gel.

Nutella & Peanut Butter Powder

Ingredients

- 1/3 cup of Nutella
- 1/3 cup of (creamy) peanut butter
- 2 cup maltodextrin powder

Recipe

Hand whisk both Nutella and 1 cup maltodextrin powder and peanut butter and 1 cup maltodextrin powder in separate bowls. Blend separately if hand whisking does not work fully. Add more maltodextrin if necessary.

Science

Maltodextrin is a simple sugar polysaccharide that has a unique ability to absorb fats and oils. Thus, it is commonly used as a thickening agent or for powdering foods with high fat content. The latter used is what the recipe requires, a process known as fat dehydration.

Modifications and Extensions

The first paragraph in the spaghetti and caviar recipes can be prepared beforehand if desired. This speeds up the process and avoids safety concerns surrounding blenders and boiling liquids. If prepared beforehand, the agar-agar mixture should be kept at room temperature and may need reheated in a microwave.

If choosing a subset of the four recipes, we would suggest the spaghetti and caviar. These involve similar processes and have a bigger ‘wow’ factor than the others. Additional recipes/flavors of them can be added to make up time if necessary.

For the spaghetti, agar-agar flakes can be used instead of agar-agar powder and are available at Whole Foods and Asian supermarkets. When preparing, modify the water to agar ratio according to the instructions on the packet. The taste was rather bland; consider adding basil or other spices. Larger tubing worked better than small tubing.

For the caviar, the recipe results in a very heavy ginger flavor. Added sugar helps with the flavor. If experimenting with variations on the recipe, avoid adding highly acidic ingredients and those that contain calcium.

For the fat dehydration, Nutella worked better than peanut butter. This activity can be supplemented with a freezing point depression activity by making home made ice cream in zip-seal bags; instructions readily available via internet search.

Some References

http://www.molecularrecipes.com/molecular-gastronomy/

http://www.pastemagazine.com/blogs/lists/2014/12/10-easy-molecular-gastronomy-recipes.html

http://scienceofeverydaylife.discoveryeducation.com/families/pdfs/activities/Kitchen-Chemistry.pdf

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