Lab 1: Common Measurements

Introduction and Procedure

For accuracy and for successful lab experiments, familiarity with common measurements and their conversions is necessary. Complete the following:

1 cup = ______ fluid ounces

2 cups = ______ pints

1 tablespoon = ________ teaspoons

1 teaspoon = ______ milliliters

4 tablespoons = ______ cup

4 fluid ounces = _cup 1 quart

= _______ pints

1 pint = ______ cups

1 quart = ______ cups

1 gallon = _______ quarts or _______ pints or _______ cups

1 gallon of water weighs = _______ pounds

1 pound = _______ ounces or _______ grams or _______ kilograms

½ pound = _______ ounces

1 lb of butter = ________ cups

1 cup = ______ milliliters

1 quart = ______ liters

1 gallon = ______ liters

1 lb granulated sugar = ______ cups

1 lb whole wheat flow = _______ cups

5 gallons = ______ quarts

2 quarts is also called ______

¼ lb = ________ ounces

A recipe calls for 1/3 cup of sugar. You are going to quadruple the recipe. How many cups of sugar will you need? _______ cups.

To mix powdered milk you need 2/3 cup per quart of water. How many cups will you need to mix 1.5 gallons? _______ cups

At sea level, water boils at _______ °F. About what temperature does it boil in Burley, Idaho _______ °F?

Why?

Plain water freezes at_______° F, but water with 50% sugar freezes at_______° F.
Why?

A recipe from England calls for 30 milliliters of an extract. What common U.S. measure will you use to measure out 30 milliliters?_______. How many of these will you need? _______

Below is a recipe for baked macaroni and cheese. It serves 8 people. Adjust the recipe to feed 20 people. Adjust it again to feed 4 people.

Recipe	Multiply by _____	Adjusted amount
300 grams of macaroni		
1 ½ cups grated cheddar cheese		
2 tablespoons flour		
½ teaspoon salt		
¼ teaspoon pepper		
2 tablespoons butter		
2 cups milk		
⅔ cup soft buttered crumbs*		
Recipe	**Divide by _____**	**Adjusted amount**
300 grams of macaroni		
1 ½ cups grated cheddar cheese		
2 tablespoons flour		
½ teaspoon salt		
¼ teaspoon pepper		
2 tablespoons butter		
2 cups milk		
⅔ cup soft buttered crumbs*		

Lab 2: Critical Analysis of a Website

Introduction

An important part of an education today is the ability to evaluate the validity of information. The advent and proliferation of the World Wide Web has provided individuals with incredible opportunities to share and gather information quickly across large geographical distances. It has also opened the doors for anyone with a computer and an Internet connection to publish information for the world to see – information that is often incorrect or unreliable. How can you tell the difference? Here are a few suggestions:

Guidelines for Evaluating Websites

- Who wrote/sponsored/published the site? Read the "About Us" or other similar section, check the publisher (next to the copyright date at the bottom of the page), and take note of any bylines on individual pages. Make sure the people and organizations affiliated with the site are reliable, knowledgeable, and not hiding a bias or ulterior motive. If you're unsure, use a search engine (Google, Bing, etc.) to look up the person or organization.
- When was the site last updated/copyrighted? Accurate information is up-to date information. Check the bottom of each page for a copyright date or "Last Updated" note. Currency is particularly important in medicine and health sciences.
- What links connect the site? Look at the links the site provides to other sites. Are those sites reputable and reliable? Also, look at what other sites link to the site you're evaluating. To do this, use a search engine like Google or Yahoo and type in "link:[name of your website]" (i.e. "link:http://www.usa.edu"). The results will contain websites that link to your site. Are those sites reputable/reliable?
- Who is the website trying to reach? Determine the audience of the web site by reading its "About Us" section, mission statement or purpose statement, layout (graphics, animation, banner advertising, etc.), and tone. Is the information presented in an unbiased manner, or does the writing indicate an extreme or passionate position?
- What is the site's domain? Look at the domain name of the site (i.e. .com, .net, .org, etc.). Sites with ".gov" or ".edu" are almost always reliable; sites with .org are generally sponsored by a non-profit organization and are usually (not always) reliable; sites with .com, .net, or a domain from another country (i.e. .ca for Canada) can be reliable. Never evaluate a site by the domain alone – use other criteria as well.
- Where is the site getting its information? Check that the site has references, citations, or otherwise includes or cites the source of its information.

Procedure

Part 1: Visit these websites and analyze the type of information they are providing, using the guidelines above and any other methods:

Dr. Joseph Mercola
http://www.mercola.com/
The "Health Ranger," Mike Adams
http://www.healthranger.com/

The "Food Babe," Vani Hari
http://foodbabe.com/

Dr. Mehmet Oz
http://www.doctoroz.com/

Answer these questions about websites:

1. What is the name of the website?
2. What is the site's domain?
3. Who sponsored or published the website and what type of credentials/reputation do they have?
4. What is the purpose of the website?
5. Is the information presented in an unbiased manner, or does the writing indicate an extreme or passionate position?
6. What is your conclusion about the validity of the website information? Why?

Part 2: After analyzing the four websites, read the following:

4 Big Quacks:
http://www.alternet.org/personal-health/four-biggest-quacks-plaguing-america-their-bad-claims-about-science

Science Daily:
https://www.sciencedaily.com/releases/2008/11/081125203145.htm

1939 Government Document: (Opening the document is safe.)
http://naldc.nal.usda.gov/download/IND43893648/PDF

Answer these questions:

1. Why do people "fall" for food fads?
2. Have you "fallen for a food fad? If so, which one?
3. Why do you think that there is so much interest in food (and drink) in the popular press and the news? For example: gluten-free, non-GMO, sugar addiction, low-carb/no-carb and vegan.
4. What can, or do you do to avoid food misinformation and fads?

Lab 3: Changes in Food System Technology

Introduction

The Internet is a vast resource of information and photos. Your assignment is to use a search engine such as Google and find two photos or diagrams that represent technology from the food system that is at least 50 years old. Download the images that you select and email them to me with a short description of what is in the photo. Think broadly when you consider the food system; for example: tractors, refrigeration, packaging, processing, harvesting, milking, cleaning, grinding, etc. Check out some websites for agricultural museums.

Procedure

Email your two photos or diagrams to your instructor no later than________________. Send the images as attachments to the email with your descriptions in the body of the email. When you find your image and save it, be sure that it is not too small. See what it looks like on your full computer screen. Small/thumbnail type images will not work since they will be very grainy when shown to the class.

Notes

Lab 4: Food Label and Ingredient Scavenger Hunt

Procedure

Search through the empty food packages and container provided to the class and complete a table provided by the instructor. Use the table below to help identify the ingredients on the labels.

Types of Food Additives/Ingredients

The following summary lists the types of common food additives/ingredients, why they are used, and some examples of the names that can be found on product labels. Some additives are used for more than one purpose.

Types of Ingredients	What They Do	Examples of Uses	Names Found on Product Labels
Preservatives	Prevent food spoilage from bacteria, molds, fungi, or yeast (antimicrobials); slow or prevent changes in color, flavor, or texture and delay rancidity (antioxidants); maintain freshness	Fruit sauces and jellies, beverages, baked goods, cured meats, oils and margarines, cereals, dressings, snack foods, fruits and vegetables	Ascorbic acid, citric acid, sodium benzoate, calcium propionate, sodium erythorbate, sodium nitrite, calcium sorbate, potassium sorbate, BHA, BHT, EDTA, tocopherols (Vitamin E)
Sweeteners	Add sweetness with (called nutritive) or without (called non-nutritive) the extra calories	Beverages, baked goods, confections, table-top sugar, substitutes, many processed foods	Nutritive sweeteners: Sucrose (sugar), glucose, fructose, sorbitol, mannitol, corn syrup, high fructose corn syrup; Non-nutritive sweeteners: saccharin, aspartame, sucralose, acesulfame potassium (acesulfame-K), neotame
Color Additives	Offset color loss due to exposure to light, air, temperature extremes, moisture and storage conditions; correct natural variations in color; enhance colors that occur naturally; provide color to colorless and "fun" foods	Many processed foods, (candies, snack foods margarine, cheese, soft drinks, jams/jellies, gelatins, pudding and pie fillings)	FD&C Blue Nos. 1 and 2, FD&C Green No. 3, FD&C Red Nos. 3 and 40, FD&C Yellow Nos. 5 and 6, Orange B, Citrus Red No. 2, annatto extract, beta-carotene, grape skin extract, cochineal extract or carmine, paprika oleoresin, caramel color, fruit and vegetable juices, saffron (Note: Exempt color additives are not required to be declared by name on labels but may be declared simply as colorings or color added)
Flavors & Spices	Add specific flavors (natural and synthetic)	Pudding and pie fillings, gelatin dessert mixes, cake mixes, salad dressings, candies, soft drinks, ice cream, BBQ sauce	Natural flavoring, artificial flavor, and spices
Flavor Enhancers	Enhance flavors already present in foods (without providing their own separate flavor)	Many processed foods	Monosodium glutamate (MSG), hydrolyzed soy protein, autolyzed yeast extract, disodium guanylate or inosinate

Types of Ingredients	What They Do	Examples of Uses	Names Found on Product Labels
Fat Replacers & components used in Formulations used to replace fats	Provide expected texture and a creamy "mouth-feel" in reduced-fat foods	Baked goods, dressings, frozen desserts, confections, cake and dessert mixes, dairy products	Olestra, cellulose gel, carrageenan, polydextrose, modified food starch, microparticulated egg white protein, guar gum, xanthan gum, whey protein concentrate
Nutrients	Replace vitamins and minerals lost in processing (enrichment), add nutrients that may be lacking in the diet (fortification)	Flour, breads, cereals, rice, macaroni, margarine, salt, milk, fruit beverages, energy bars, instant breakfast drinks	Thiamine hydrochloride, riboflavin (Vitamin B_2), niacin, niacinamide, folate or folic acid, beta carotene, potassium iodide, iron or ferrous sulfate, alpha tocopherols, ascorbic acid, Vitamin D, amino acids (L-tryptophan, L-lysine, L-leucine, L-methionine)
Emulsifiers	Allow smooth mixing of ingredients, prevent separation Keep emulsified products stable, reduce stickiness, control crystallization, keep ingredients dispersed, and to help products dissolve more easily	Salad dressings, peanut butter, chocolate, margarine, frozen desserts	Soy lecithin, mono- and diglycerides, egg yolks, polysorbates, sorbitan monostearate
Stabilizers, Thickeners, Binders and Texturizers	Produce uniform texture, improve "mouth-feel"	Frozen desserts, dairy products, cakes, pudding and gelatin mixes, dressings, jams and jellies, sauces	Gelatin, pectin, guar gum, carrageenan, xanthan gum, whey
pH Control Agents and acidulants	Control acidity and alkalinity, prevent spoilage	Beverages, frozen desserts, chocolate, low acid canned foods, baking powder	Lactic acid, citric acid, ammonium hydroxide, sodium carbonate
Leavening Agents	Promote rising of baked goods	Breads and other baked goods	Baking soda, monocalcium phosphate, calcium carbonate
Anti-caking agents	Keep powdered foods free-flowing, prevent moisture absorption	Salt, baking powder, confectioner's sugar	Calcium silicate, iron ammonium citrate, silicon dioxide
Humectants	Retain moisture	Shredded coconut, marshmallows, soft candies, confections	Glycerin, sorbitol
Yeast Nutrients	Promote growth of yeast	Breads and other baked goods	Calcium sulfate, ammonium phosphate
Dough Strengtheners and Conditioners	Produce more stable dough	Breads and other baked goods	Ammonium sulfate, azodicarbonamide, L-cysteine
Firming Agents	Maintain crispness and firmness	Processed fruits and vegetables	Calcium chloride, calcium lactate

Types of Ingredients	What They Do	Examples of Uses	Names Found on Product Labels
Enzyme Preparations	Modify proteins, polysaccharides and fats	Cheese, dairy products, meat	Enzymes, lactase, papain, rennet, chymosin
Gases	Serve as propellant, aerate, or create carbonation	Oil cooking spray, whipped cream, carbonated beverages	Carbon dioxide, nitrous oxide

Additional information is available from the following organizations:

Food and Drug Administration
www.fda.gov

Center for Food Safety and Applied Nutrition (CFSAN)
www.fda.gov/Food

Color additives information
www.fda.gov/ForIndustry/ColorAdditives

U.S. Department of Agriculture: Food Safety and Inspection Service
www.fsis.usda.gov

Food additives information
www.fsis.usda.gov/Fact_Sheets/Additives_in_Meat_&_Poultry_Products/index.asp

Meat and Poultry Hotline:
Email: fsis@usda.gov

Food and Nutrition Information Center
www.nal.usda.gov/fnic/

International Food Information Council Foundation
www.foodinsight.org

American Dietetic Association (ADA)
www.eatright.org

The Food Allergy and Anaphylaxis Network (FAAN)
www.foodallergy.org

Institute of Food Technologists
www.ift.org

Notes

Lab 5: Extraction of Gluten and Starch from Wheat Flour

Introduction

Gluten is an elastic protein substance that gives wheat flour good bread, making qualities. The elastic gluten developed by kneading surrounds and holds the leavening gas produced by yeast, resulting in light loaves of bread.

Gluten as a food substance results when flour is kneaded well and "washed" to remove the starch. It can be used in making gluten dishes, as a meat substitute, or in a vegetarian diet. Gluten is high in protein and very low in carbohydrates. Most of the carbohydrate (starch) is washed out in the process of making gluten.

How to use wheat gluten? It can be sliced and steamed or boiled, then treated as a piece of meat; it can be fried or baked, or ground and used in meat loaf or patties; it can be used as dumplings. If you plan to cook with it experiment!

Gluten can be flavored by mixing in bouillon, soups, juices, etc. After washing and before cooking you can add spices such as sage, poultry seasoning, oregano, etc.

Learning Objectives

- Observe how protein sticks together and how starch can be washed from flour
- Describe the physical properties of a protein
- Compare the properties of protein to starch
- Determine the yield of protein and starch from a flour extraction
- Examine uses of gluten and starch

Materials

- 2 cups flour
- Approximately 1¼ cups cold water
- Mixing container (plastic or metal) at least one quart (See note below about using a plastic Ziploc bag.)
- Quart bottle (collecting starch)
- Strainer
- Plastic bag (storage of extracted gluten)

Remove the mixture from the bag and then proceed to the step where the mixture is placed in the strainer.

Methods

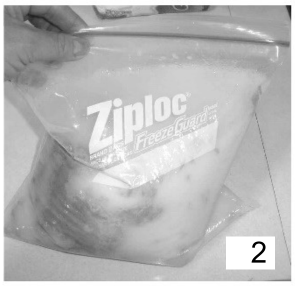
1. Combine flour and water in mixing container by hand mixing
2. Mix vigorously by hand for 10 min (Knead into ball; beat, pound or stretch the ball of dough; treat it rough)

Note: Don't worry about how sticky your hand becomes. You can wash the flour from it as you complete the next step.

3. Wash out the starch; to separate the water-soluble starch from the gluten, cover the ball of dough with cold water and let it stand about an hour
4. Mix by hand several times during the hour
5. Remove the ball of dough and place in a strainer
6. Pour the water containing the starch into a quart bottle and set aside
7. Run warm water from the faucet over the dough in a strainer
8. Work the dough with your hands in the water, washing out the milky starch; rinse the dough until the water is clear
9. Allow the gluten ball to drain
10. Work with the gluten to determine some of its properties.
11. Fry or boil some to determine its taste and food value
12. Store your gluten in a plastic bag and turn in with your lab report

Note: As an alternative you can use a 1-gallon size Ziploc bag for mixing. Add the flour and water to the bag; squeeze out most of the air; close the bag and mix it from the outside. This prevents your hands from becoming sticky. After mixing add the cold water and let it set over the mixture. Rock back-and-forth a few times and mix a few times while mixture sets in cold water.

Plastic Ziploc bag method



Captions for Figures 1 through 4

1 = mixing flour and water in bag
2 = covering mixture with cold water
3 = removing gluten ball from bag
4 = washing starch from gluten

Starch

1. After the starch settles out from the water pour off the dough ball, describe your starch yield
2. Feel the starch
3. Compare it to cornstarch
4. What would happen if you added amylase to the starch?

Results and Discussion

When you write your lab report, answer the following questions:

- Describe your yield of starch and gluten. What factors affected your yield?
- Describe the physical properties of your gluten and the starch?
- Why is it important to mix the dough, pound and stretch it?
- From what of products can gluten and starch be extracted?
- How could the starch from the extraction be used?
- How is gluten used?
- Does gluten have uses outside of the food industry?
- How could gluten and starch be separated on a large scale?

Based on the label on a bag of white flour, each one-fourth cup of flour contains 23 grams of carbohydrate, 3 grams of protein and 1 gram of fiber. How much starch and gluten should you be able to extract from the flour in this lab? How does the starch and protein in whole wheat flour compare to white flour?

What is Gluten and Why does it Matter?

Gluten is a substance made up of the proteins found in wheat flour that gives bread its structure, strength, and texture. Without these marvelous little proteins, bread would not be bread. Gluten doesn't even exist until flour becomes wet. Water is what coaxes the two wheat proteins glutenin and gliadin to combine and form gluten. It also explains why it is so hard to make bread from rice, potato, or oat flour and why wheat flour must be added to rye flour to make bread—only wheat has enough protein. The gluten makes the bread.

Gluten is developed in the dough when the proteins absorb water and are pulled and stretched in the kneading process. As the proteins are worked, they become long, flexible strands. As the yeast produces gases in the dough, mostly carbon dioxide, these strands trap the gas bubbles and the dough expands. When we put the bread in the oven, the gluten strands coagulate or solidify much as the protein in eggs solidifies as the egg cooks.

How is it that we can use flour to make both a tender cake and firm chewy French bread? The gluten makes the difference. In a cake, we want little gluten development. In a chewy bread, we want a high percentage of well-developed gluten. We can control this texture in our baked goods by changing four conditions:

1. **Selection of flours**: Cake flours are “weak” or “soft” and have a low protein content, probably around 8%. Bread flours and high-gluten flours are “strong” and usually have a protein content of 12 to 14%.

2. **Amount of shortening**: Any fat is referred to as a shortening because it shortens the gluten strands. It does so by lubricating the fibers, so they cannot stick together. The more shortening in the dough, the more tender and less chewy the product will be.

3. **Amount of liquid**: Gluten must have liquid to absorb and expand. If dough does not have enough liquid, the gluten will not fully form, and the product will not be tender. That's why we put a minimal amount of water in pie crusts.

4. **Mixing methods**: Generally, the more a batter or dough is mixed, the more the gluten develops. Tender muffins use low-protein flour and are mixed only until the moisture is absorbed while breads are kneaded for a relatively long time.

Wheat Gluten

This is made from washing out the starch from wheat dough until only the adhesive, glutinous substance remains. It is usually boiled or deep-fried and then cooked with other ingredients. Dried, spongy cakes of gluten dough are often used in Chinese cuisine, but especially so in vegetarian cooking where wheat gluten forms the basis of many 'mock meat' dishes. Gluten itself has very little taste, but its virtue is that it readily absorbs the flavors of seasonings and other ingredients that are cooked with it.

Shopping Tips

Wheat gluten can be found in the refrigerated section of Chinese grocers or supermarkets. Canned varieties are available. All brands are good, but I prefer those from Taiwan and China.

Storage Notes

If purchased fresh from Chinese grocers or supermarkets, it should be used within 1 week. Keep in water, changing the water every day.

Notes

Lab 6: Addendum – Starch

Introduction

During the extraction of gluten from flour, you will be removing the starch. Gluten is protein and starch is a carbohydrate. Both have unique properties used in food science. This activity provides information about starch and demonstrates that when heated with water, a physical change called gelatinization occurs.

Starch

Starch is a complex carbohydrate that is considered by nutritionists to be a healthful source of energy. In food preparation at home, starch is important as a thickening agent. However, starch is but one of several polysaccharides that are used as thickeners in the food industry.

Starch consists of two fractions: amylose and amylopectin. The two fractions occur together in starch from most sources, so the overall behavior of a starch is determined in large measure by the relative amounts of amylose and amylopectin in the specific starch. Each of the fractions has unique properties that contribute to the functionality of starch from various plant sources.

Amylose, the linear fraction of starch characterized by 1,4-alpha-glucosidic linkages ranges widely in molecular weight, from a few thousand to as large as 150,000. This large polymer of D-glucose is slightly soluble, a characteristic of importance in starch cookery. The actual length of amylose molecules varies considerably even within a single sample of starch, but generally cereal starches (like com and rice) have shorter, lighter amylose molecules than are found in potato and other starches from roots and tubers.

The other starch fraction, amylopectin, is also a polymer of D-glucose. However, the presence of 1,6-alpha-glucosidic linkages in addition to 1,4-alpha-glucosidic linkages results in a different spatial arrangement. In contrast to the linearity of amylose, amylopectin molecules are dendritic (branching) because of the shift in direction of the D-glucose chain at each 1,6-alpha-glucosidic linkage. Typically, amylopectin is far more abundant in starches than is amylose. In root and tuber starches, amylopectin exceeds amylose content by approximately four times; amylopectin ordinarily constitutes about 80% of the starch. Cereal starches are composed of around 75% amylopectin. However, genetic variations containing starches composed of virtually only amylopectin (like waxy maize) have been developed and are of commercial significance. The relative proportions of amylopectin and amylose in starches are of considerable importance because of the different behaviors of these two starch factions in cooked starch products.

In plants, starch is deposited in an orderly fashion in the form of granules. These granules, composed of amylose and amylopectin molecules, are made in the leucoplasts within the cytoplasm of the cells. Each granule consists of concentric layers of amylopectin molecules interrupted by some amylose molecules, which often are arranged in a somewhat organized manner.

For starch to be used as a thickening agent in foods, it must be heated with water, a physical change called gelatinization. If it is heated without water, it undergoes a chemical change termed dextrinization. These processes are important in food preparation, for they determine the behavior of starch, its thickening ability in sols, and also its gel-forming properties.

Gelatinization is a physical process that is unique to starches. The transformation that occurs when starch is heated in water is truly remarkable. The heat energy causes hydrogen bonds in the starch granules to break, which facilitates the entry of water into the granule and the shifting of some amylose molecules into the water surrounding the granules. Water continues to migrate into the granules, causing considerable swelling when the starch mixture is heated to the temperature range required for gelatinization. Because water is not compressible in the starch granule, the volume of the granule increases as more and more water enters and forms hydrogen bonds with the amylopectin and amylose molecules. This bound water not only affects the viscosity of the starch mixture by increasing the physical size of the starch granules, but also reduces the amount of free water external to the granules. The tight organization of the starch granule is disrupted during the gelatinization process

Corn Starch

Corn starch is a fine, powdery substance derived from the endosperm of the corn kernel. Starch is a storage product found in all plants containing chlorophyll. Both types of starch molecules, amylose and amylopectin, are polyhydroxy compounds which hydrate when heated in water. As the starch molecules hydrate, they increase in size and immobilize most of the free water, thickening the solution towards a paste like texture. For this reason, corn starch is commonly used as a thickener in puddings, gravies, sauces and fruitcompotes.

Corn starch is derived from the endosperm of the corn kernel (*Zea mays*), comprising almost 70% of the corn kernel.

The use of starch is chronicled in records of the early Egyptians, who manufactured papyrus using a starch coating. Roman records indicate that those early innovators found uses for starch in foods, medicine, cosmetics and fabrics. It was not until the middle of the nineteenth century, however, that the process for large-scale efficient extraction of starch from corn was developed.

The primary function of corn starch is its thickening capabilities. Corn starch is to assist different ingredients in binding together. Starch gelatinization is a vital function of corn starch in baking. Upon adding heat and moisture, starch irreversibly breaks down allowing water or moisture to seep into the granule causing swelling and gelatinization. Besides its use as a thickening agent (the first physiochemical property), corn starch serves to disperse or suspend food ingredients within a mixture. For instance, corn starch is used to suspend fats in protein mixtures, as well as suspend proteins in fat mixtures. The third physiochemical property is starches ability to form gels. The fourth physiochemical property is corn starch's ability to form strong adhesive films. For this reason, corn starch is one of the most widely used food ingredients in baking and beyond.

Easy Vanilla Pudding

Ingredients

- 1⁄3 cup sugar
- 1⁄4 cup cornstarch
- 1⁄8 teaspoon salt
- 2 3⁄4 cups milk
- 2 tablespoons butter
- 1 teaspoon vanilla

Directions

1. Mix sugar, cornstarch, and salt into a saucepan. Gradually stir in milk.
2. Bring to a boil over medium heat. Boil 1 minute, stirring constantly or the milk will scorch.
3. Remove from heat. Stir in butter and vanilla. Chill.

Note: To make this chocolate pudding, increase the sugar to 2/3 cup and add 2-3 Tbs cocoa with the cornstarch.

Notes

Lab 7: Yeast Bread from Ground Whole Wheat

Introduction

The mission of the bread baker is to convert a relatively tasteless flour starch into a sweet, multilayered flavor or to evoke the fullest potential of flavor from the grain, while understanding how to manipulate time and temperature in all of the bread making stages. The hands, eyes, ears, smell, senses, creative touches and experience of the baker also play a role in the final success of any recipe.

Yeast bread is one of our most celebrated foods by every culture in some form or another, found in a myriad of types. All bread making goes through specific stages, from raw ingredients to a baked loaf to storage.

Bread recipes can be made with a minimal of ingredients: typically yeast; wheat and related grains, or non-wheat flour (or gluten-free substitutes); water or other liquids; and, optionally, salt. Recipes can include a variety of ingredients added to the structure of the dough, such as eggs, milk, butter, flavorings and non-wheat grains. Others can be added after the structure of the dough has been formed, such as seeds, nuts, or dried fruit, to create thousands of unique varieties. These ingredients are expressed as a percent ratio to flour, by the Baker's Percentage Method or simply by weight and/or volume (measuring cups and spoons).

<u>Supplies</u>

- Wheat grinder
- Mixing bowl
- Measuring cups/spoons
- Stirring spoon
- Cookie sheets
- Wheat (hard red and soft white)
- Flour

<u>Ingredients</u>

- 2 Tbl active dry yeast
- 1 Cup warm water, plus
- 2 Tbl warm water
- 1/3 Cup vegetable oil
- 1/4 Cup sugar
- 1 Egg
- 1 Tsp salt
- 3-3 ½ Cups flour

Note: You will be grinding either hard red wheat for flour or soft white wheat for flour as determined by the instructor. You will also make a batch of bread using commercial flour.

Procedure

Using a wheat grinder, grind enough hard red or soft white wheat to make one batch of bread.

<u>Directions</u>

1. In a mixing bowl, dissolve yeast in warm water
2. Add oil and sugar and let stand for 5 minutes
3. Add the egg, salt and enough flour to form a soft dough
4. Turn onto a floured surface and knead until smooth and elastic, about 3 to 5 minutes
5. Do not let rise
6. Divide into 12 pieces and shape each into a ball
7. Place 3" apart on greased baking sheets

8. Cover and let rest for 10 minutes
9. Bake at 425 degrees for 8 to 12 minutes or till golden brown
10. Remove from pans to wire rack to cool
11. Taste-test your product
12. Clean up your area and the equipment used.

Lab Report Questions

1. What is the difference between hard red and soft white wheat?
2. What common unit operations are used?
3. Was your bread successful? If not, why?
4. What food science principles are demonstrated by this exercise?
5. Explain why the bread browns.
6. What is the role of shortening?
7. How does the texture of your bread compare to the texture of commercial bread?

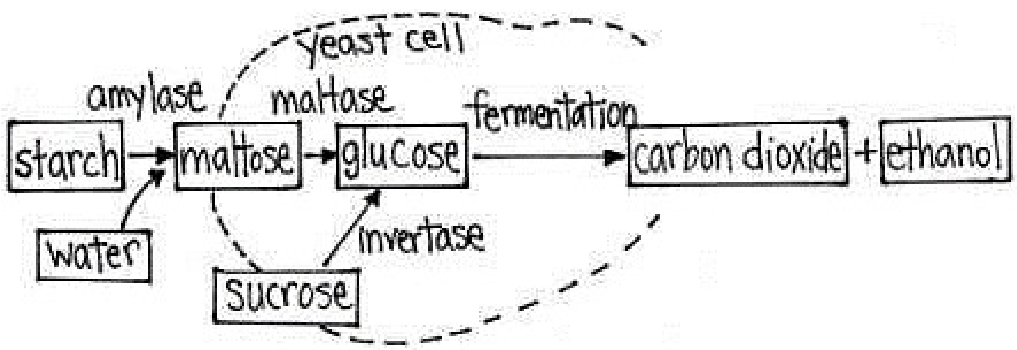
Science of Bread-Making Notes

The hard wheats have the most amount of gluten and are used for making bread, rolls and all-purpose flour. The soft wheats are used for making flat bread, cakes, pastries, crackers, muffins, and biscuits. Bread wheat protein content ranges from 10% in some soft wheats with high starch contents, to 15% in hard wheats. The quality of the wheat protein gluten can determine the suitability of a wheat to a particular dish.

Yeast becomes active when combined with sugar and warm water. The yeast reacts with the sugar to produce carbon dioxide (CO_2) which creates bubbles and makes the dough rise. Kneading creates gluten; gluten is a combination of two proteins bonded together - glutenin and gliadin. Proteins from the gluten form the barrier that keeps the CO_2 within the bread while baking.

Yeast is a live, single-celled fungus. There are about 160 species of yeast, and many of them live all around us. However, most people are familiar with yeast in its mass-produced form: the beige granules that come in little paper packets. This organism lies dormant until it comes into contact with warm water. Once reactivated, yeast begins feeding on the sugars in flour, and releases the carbon dioxide that makes bread rise (although at a much slower rate than baking powder or soda). Yeast also adds many of the distinctive flavors and aromas we associate with bread.

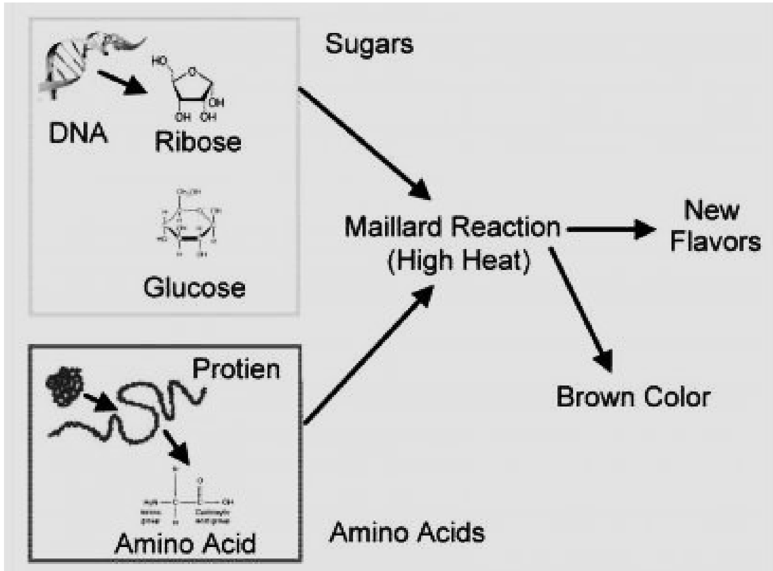
Starch, a carbohydrate that makes up about 70% of flour by weight, also gets in on the act. When starch granules are attacked by enzymes present in flour, they release the sugars that yeast feeds on. Starch also reinforces gluten and absorbs water during baking, helping the gluten to contain the pockets of gas produced by the yeast.



The Maillard reaction:

When amino acid groups combine with a sugar; the reaction is what creates the browning when bread is baked.

Maillard reactions are responsible for many colors and flavors in foods; for example: caramel made from milk and sugar; browning and flavor of bread and toast; the color of beer, chocolate, coffee and maple syrup and the flavor and color of roast meat



More on Bread-Making

The really sweet breads are carrot bread and zucchini bread—quick breads made with baking powder or soda. Why is this? When dough contains a lot of sugar, the two gluten proteins link with the sugar instead of with each other. Very little gluten isformed.

Too much sugar is also damaging to yeast. It draws water from the yeast and inhibits its growth. Bakers sometimes add extra yeast to sweet breads just to compensate for some loss

All sugars interfere with gluten development, but sugars are not identical in other ways. Glucose, corn syrup, browns at lower temperatures than many sugars. Most sugars are hygroscopic and absorb water from the atmosphere, but fructose, fruit sugar, which is one of the two sugars in table sugar, is more hygroscopic than most. Yeast doesn't like lactose, the sugar in milk, so breads with milk and dairy products will have more residual sugars than those containing only sucrose.

Wheat flour is a necessity for these bubble gum-like sheets. Corn, rye, oats, barley, rice, millet, and other grains can be ground into flour to make light baking powder-leavened products. But only wheat flour contains enough of the two proteins glutenin and gliadin to make good sheets of gluten. A yeast bread made with any grain that does not contain these two proteins will not rise, no matter how much yeast is used. The yeast can produce millions of bubbles of gas, but without gluten to hold them, the bubbles float off into the air.

This stretchy gluten film traps and holds air bubbles as the dough is mixed and kneaded. Yeast, a one-cell plant that feeds on simple sugars from the dough the yeast continues to feed. If there is oxygen in the dough (from the mixing), yeast divides and multiplies to produce even more carbon dioxide.

After the dough rises, it is punched down. The clumps of yeast are broken up and spread so that each cell is surrounded by a new food supply. Then the dough is shaped and set aside. Because of all the well-fed new yeast cells, the bread rises faster during this second rise. Finally, the bread goes into a hot oven and rises even more. Yeast makes carbon dioxide faster as it warms, until the heat kills the yeast.

High-protein wheat flour containing good-quality glutenin and gliadin, sometimes called strong flour, come from the hard spring wheats grown in colder climates—in the great northern plains and Canada Soft winter wheats, grown in moderate climates where the ground never freezes to a depth greater than 10 inches, have much less glutenin and gliadin. Also, flour from different strains of wheat be different, and flour from the same strain of wheat can vary. Many things—soil, temperature, rainfall, maturity at harvest—influence protein content.

Finally, whole wheat flour contains germ and bran. Cup for cup, whole wheat will have less of the gluten-forming proteins than plain flour from the same wheat just because it contains these other parts of the kernel. Whole wheat flour will make a heavier bread.

Notes

Lab 8: Leavening Agents

Background

Leavening agents are used to enhance the rising of dough in the manufacture of baked products. Inorganic salts, especially ammonium and phosphate salts, favor the growth of yeasts which produce the carbon dioxide (CO_2) gas that causes dough to rise. Chemical leavening agents which react to form CO_2 are also used in baked goods. When either sodium bicarbonate, ammonium carbonate or ammonium bicarbonate is reacted with either potassium acid tartrate, sodium aluminum tartrate, sodium aluminum phosphate or tartaric acid, CO_2 is produced. Baking powder is a common household leavening agent that contains a mixture of chemical compounds that react to form CO_2, producing the leavening effect.

Most commercially available baking powders are made up of sodium bicarbonate (also known as baking soda or bicarbonate of soda) and one or more acid salts. Typical formulations (by weight) call for 30% sodium bicarbonate, 5-12% monocalcium phosphate, and 21-26% sodium aluminum sulfate. The last two ingredients are acidic: they combine with the sodium bicarbonate and water to produce the gaseous carbon dioxide. The use of two acidic components is the basis of the term "double acting." Another typical acid in such formulations is cream of tartar, a derivative of tartaric acid. Baking powders also include components to help with the consistency and stability of the mixture.

Commercial baking powder formulations are different from domestic ones, although the principles remain the same. Instead of sodium aluminum sulfate, commercial baking powders use sodium acid pyrophosphate as one of the two acidic components.

Monocalcium phosphate ("MCP") is a common acid component in domestic baking powders.

Baking soda ($NaHCO_3$) is the source of the carbon dioxide and the acid-base reaction can be generically represented as shown:

$$NaHCO_3 + H+ \rightarrow Na+ + CO_2 + H_2O$$

The real reactions are more complicated because the acids are complicated.

The acid in a baking powder can be either fast-acting or slow-acting. A fast-acting acid reacts in a wet mixture with baking soda at room temperature, and a slow-acting acid will not react until heated in an oven. Baking powders that contain both fast- and slow-acting acids are double-acting; those that contain only one acid are single-acting. By providing a second rise in the oven, double-acting baking powders increase the reliability of baked goods by rendering the time elapsed between mixing and baking less critical, and this is the type most widely available to consumers today. Double-acting baking powders work in two phases; once when cold, and once when hot. Common low-temperature acid salts include cream of tartar and monocalcium phosphate (also called calcium acid phosphate). High-temperature acid salts include sodium aluminium sulfate, sodium aluminum phosphate, and sodium acid pyrophosphate

Cakes and Cookies

Leavening in these products is produced chemically, and there is no yeast fermentation. The chemicals used to produce CO_2 are sodium bicarbonate ($NaHCO_3$; the source of CO_2) and sources of acid to react with the bicarbonate, such vinegar (CH_3COOH; acetic acid; as potassium hydrogen tartrate ($C_4H_5O_6K$; cream of tartar), sodium dihydrogen pyrophosphate ($Na_2H_2P_2O_7$), monocalcium phosphate [$Ca(H_2PO_4)_2$], and alum [$NaAl(SO_4)_2 \cdot 12H_2O$; sodium aluminum sulfate]. The desirable chemical leavener produces small bubbles of gas at a constant rate consistent with the period involved in mixing and baking to temperatures which set the structure of the cake.

Soft wheat flour or flour of low or moderate protein content is used for cakes. In premixes, the flour, egg powder, shortening, fruit or flavoring components and leavening agents are combined in the dry state, although, when mixed, the shortening is in the melted or liquid state, and emulsifiers, such as monoglycerides, which improve air incorporation during mixing, may be used. Much of the successful preparation of cake mixes depends upon the kind and quantity of chemical leaveners used. Angel cakes contain egg white (protein) and are leavened by the incorporation of air into the mixture. During baking, the air in the cake expands and acts as the leavening agent.

Lab Assignment

During the lab you will make one of these three products which rely on different leavening agents.

Busy-Day Cake

Ingredients:

- 1 ½ cups of all-purpose flour
- 3/4 cup of sugar
- 2 ½ teaspoons baking powder
- 3/4 cup of milk
- 1/3 cup of shortening
- 1 egg
- 1 ½ teaspoons vanilla

Directions

1. Grease and lightly flour a 9x9x2-inch baking pan.
2. In a small mixer bowl combine all of the ingredients and 1/2 teaspoon of salt. Beat with electric mixer until all combined.
3. Beat 2 minutes on medium speed.
4. Turn into pan.
5. Bake at 375ºF for 25 to 30 minutes or until done.
6. Cool.

Crazy Cake or 5-Minute Cake

Ingredients:

- 3 cups sifted flour
- 2 cups sugar
- 3 Tablespoons cocoa
- 1 teaspoon baking soda
- 1 teaspoon salt

Directions

1. Mix all ingredients (above) together
2. Then add: 2 cups water; 2 Tablespoons vinegar; 1 cup oil; 1 Tablespoon vanilla
3. Add more flour if needed.
4. Bake at 350°F for 30 minutes

Easy Sugar Cookies

Ingredients

2-3/4 cups all-purpose flour
1 teaspoon baking soda
1/2 teaspoon baking powder
1 cup butter, softened
1-1/2 cups white sugar
1 egg
1 teaspoon vanilla extract

Directions

1. Preheat oven to 375°F (190°C). In a small bowl, stir together flour, baking soda, and baking powder. Set aside.
2. In a large bowl, cream together the butter and sugar until smooth. Beat in egg and vanilla. Gradually blend in the dry ingredients. Roll rounded teaspoonfuls of dough into balls, and place onto ungreased cookie sheets.
3. Bake 8 to 10 minutes in the preheated oven, or until golden. Let stand on cookie sheet two minutes before removing to cool on wire racks.

Notes

Leavening Agents Data/Work Sheet

Name of product made: ____________________________

Was the product successful?__________If not, explain why:

How did your product taste?

What leavening agents were used in your product? (Provide actual chemical names and formulas.)

How did your leavening agents produce CO_2?

What is “double-acting,” when referring to a leavening agent?

Name a product that uses incorporated air or steam to produce leavening.

How do emulsifiers aid leavening?

What other method of leavening have we used in the class? And how did this method produce CO_2?

Lab 9: Using Dehydration to Preserve Fruits and Vegetables

Introduction

Many foods are dehydrated to preserve them. If you walk through any grocery store you may notice the following dehydrated products:

- Powdered milk
- Dehydrated potatoes in a box
- Dried fruits and vegetables
- Dried meats (like beef jerky)
- Powdered soups and sauces
- Pasta
- Instant rice

Since most bacteria die or become completely inactive when dried, dried foods kept in air-tight containers can last quite a long time.

Drying (dehydrating) food is one of the oldest and easiest methods of food preservation. Dehydration is the process of removing water or moisture from a food product. Removing moisture from foods makes them smaller and lighter. Dehydrated foods are ideal for backpacking, hiking, and camping because they weigh much less than their non-dried counterparts and do not require refrigeration. Drying food is also a way of preserving seasonal foods for later use.

How Dehydration Preserves Foods

Foods can be spoiled by food microorganisms or through enzymatic reactions within the food. Bacteria, yeast, and molds must have a sufficient amount of moisture around them to grow and cause spoilage. Reducing the moisture content of food prevents the growth of these spoilage-causing microorganisms and slows down enzymatic reactions that take place within food. The combination of these events helps to prevent spoilage in dried food.

When drying foods, the key is to remove moisture as quickly as possible at a temperature that does not seriously affect the flavor, texture and color of the food. If the temperature is too low in the beginning, microorganisms may grow before the food is adequately dried. If the temperature is too high and the humidity too low, the food may harden on the surface. This makes it more difficult for moisture to escape and the food does not dry properly.

Bacteria, yeast, mold and enzymatic reactions need water. Drying removes the water from the food so bacteria, yeast and mold cannot grow and spoil the food. Drying also slows down the action of enzymes. Because drying removes moisture, the food becomes smaller and lighter in weight.

Water activity or aw is the partial vapor pressure of water in a substance divided by the standard state partial vapor pressure of water. In the field of food science, the standard state is most often defined as the partial vapor pressure of pure water at the same temperature. Using this particular definition, pure distilled water has a water activity of exactly one. As temperature increases, a_w typically increases, except in some products with crystalline salt or sugar.

Higher aw substances tend to support more microorganisms. Bacteria usually require at least 0.91, and fungi at least 0.7.

Water activity is used in many cases as a critical control point for Hazard Analysis and Critical Control Points (HACCP) programs. Samples of the food product are periodically taken from the production area and tested to ensure water activity values are within a specified range for food quality and safety.

The Basics of Food Dehydration

Three things are needed to successfully dry food:

1. Heat— hot enough to force out moisture (140°F), but not hot enough to cook the food;
2. Dry air— to absorb the released moisture;
3. Air movement— to carry the moisture away.

Foods can be dried using four methods

1. In the sun— requires warm days of 85°F or higher, low humidity, and insect control; recommended for dehydrating fruits only
2. In the oven
3. Using a food dehydrator— electric dehydrators take less time to dry foods and are more cost efficient than an oven
4. In a microwave

Supplies

For this lab you will need:

- Fruits or vegetables for drying (tomatoes, apples, zucchini) or as provided by the instructor
- Knives for cutting
- Cutting boards
- Dehydrators

Preparing Fruits and Vegetables for Drying

Many fruits and vegetables can be dried. Use ripe foods only. Rinse fruits and vegetables under cold running water and cut away bruised and fibrous portions. Remove seeds, stems, and/or pits. Suitable fruits include: apples, apricots, bananas, cherries, grapes (seedless), peaches, pears and plums. Some vegetables include: carrots, onions, zucchini, sweet corn, tomatoes and peppers.

Most vegetables and some fruits should undergo a pretreatment, such as blanching or dipping. Blanching is briefly precooking food in boiling water or steam, and it is used to stop enzymatic reactions within the foods. Blanching also shortens drying time and kills many spoilage organisms. For the fruits that need pre-treatment we will use dipping. Fruits may be dipped in ascorbic acid or citric acid in place of blanching.

Dipping

Dipping is a pretreatment used to prevent fruits such as apples, bananas, peaches, and pears from turning brown. Ascorbic acid, fruit juices high in vitamin C (lemon, orange, pineapple, grape, etc.), or commercial products containing ascorbic or citric acid may be used for dipping. For example, dipping sliced fruit pieces in a mixture of ascorbic acid crystals and water (1 teaspoon ascorbic acid crystals per 1 cup of water), or dipping directly in fruit juice for 3 to 5 minutes will prevent browning. Dipping lowers, the pH on the surface of the fruit. Fruits may also be blanched as a means of treatment.

Drying with a Food Dehydrator

1. Select and wash the fruit or vegetable
2. Weigh the batch of whole fruit or vegetable and record: ________________
3. Slice, peel and pre-treat (if necessary)
4. Weigh waste and record: ____________________
5. After pretreatment and a short draining time weigh and record the actual amount of product that will go in the dehydrator: _______________________
6. Arrange fruits or vegetables in a single layer on each tray so that no pieces are touching or overlapping.
7. Place food dehydrator in a dry, well-ventilated, indoor room.
8. Dehydrate at 140°F.
9. Turn dehydrator on and determine a schedule to check for dryness. (Test for dryness by cutting the fruit. There should be no moist areas in the center.)
10. Clean up your area and the tools you used.
11. Remove from dehydrator when proper dryness is achieved
12. Record drying time and weight of dry product: ___________________
13. Taste-test note the color of your product(s) and record your impressions.
14. After cooling, seal dry product in air tight bag.

When food is dehydrated, 80% of the moisture is removed from fruits and up to 90% of the moisture is removed from vegetables, making the dried weight of foods much less than the fresh weight.

Conditioning Dried Fruits

Dried fruits must be conditioned prior to storage. Conditioning is the process of evenly distributing moisture present in the dried fruit to prevent mold growth. Condition dried fruit by placing it in a plastic or glass container, sealing, and storing for 7 days to 10 days. Shake containers daily to distribute moisture. If condensation occurs, place fruit in the oven or dehydrator for more drying and repeat the conditioning process.

Storing Dried Fruits and Vegetables

Cool-dried food should be placed in a closed container that has been washed and dried before storing. Home-canning jars are good containers for storing dried foods. Store in a cool, dry, and dark place. Dried foods can maintain quality for up to a year depending on the storage temperature. The cooler the storage temperature, the longer dehydrated foods will last.

Reconstituting Dried Fruits and Vegetables

Dried fruits and vegetables may be reconstituted (restoring moisture) by soaking the food in water. Time for reconstituting will depend on the size and shape of the food and the food itself. Most dried fruits can be reconstituted within 8 hours, whereas most dried vegetables take only 2 hours.

To prevent growth of microorganisms, dried fruits and vegetables should be reconstituted in the refrigerator. One cup of dried fruit will yield approximately 1½ cups of reconstituted fruit. One cup of dried vegetable will yield approximately 2 cups of reconstituted vegetable.

Note: Reconstituted fruits and vegetables should be cooked in the water in which they were soaking.

Analysis/Lab Report

Your lab report will be due in one week. You can write it as a team. Include each team member's name on the report. Use the standard lab report format.

Answer the following questions in your lab report:

1. What is the science behind removing the water in a food to preserve it?
2. What common unit operations were used?
3. What causes some fruits (like apples) to brown after they have been cut and exposed to the air? What is the reaction?
4. Explain why tomatoes and zucchini do not require a pretreatment.
5. How does the dipping pretreatment prevent browning?
6. Discuss the nutrient density of dried versus fresh fruits or vegetables.
7. Identify some of the disadvantages of drying/dehydration as a means of preservation.
8. How much waste product was created and how could it be used?
9. Calculate the percentage water of whole apples. (weight of the fresh sample minus the weight of the dried sample divided by the weight of the fresh sample times 100)

Lab 10: Making Yogurt with Powdered Milk

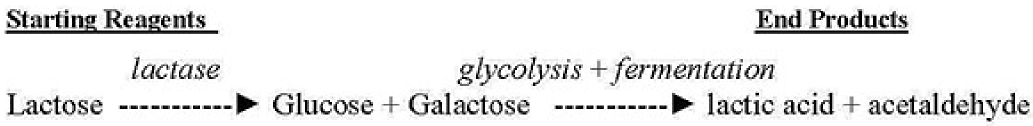
Introduction

In this lab students will make yogurt using powered milk and a live bacterial culture from commercial plain yogurt. (Note: Alternative milk type drinks will not work for this process.)

Yogurt is made by the fermentation of lactose (milk sugar) by bacterial enzymes. This process is anaerobic, meaning that it occurs in the absence of oxygen. Lactose is a compound sugar, made up of the two simple sugars glucose and galactose. During the making of yogurt, the lactose is broken down by the lactase enzyme (provided by bacteria) into these two components. Further processing of glucose and galactose results in the end products of lactic acid and acetaldehyde. The production of lactic acid and acetaldehyde lowers the pH of the milk, causing it to have a sour, tart taste. The lower pH also affects the casein (milk protein), causing it to coagulate and precipitate, forming the solid curd that makes up yogurt. The leftover watery liquid is the whey.

The two bacteria most commonly used to make yogurt are *Lactobacillus bulgaricus* and *Streptococcus thermophilus.*

<u>Enzymatic reaction in yogurt production</u>



Lactobacillus bulgaricus and *Streptococcus thermophilus* are not the only bacteria that can convert lactose into lactic acid. Fresh milk begins acquiring microbes from the very moment it leaves the cow. Milking equipment, people processing the milk, even bacteria in the air can all contaminate milk. To prevent the milk from going bad, all milk sold at the grocery store is pasteurized. Pasteurization is the process in which milk is heated for a certain length of time to kill most of the microorganisms that might be present. The U.S. Public Health Service guidelines say that heating milk at 62.8°C (145°F) for 30 minutes or 71.7°C (161°F) for 15 seconds meets pasteurization standards.

These standards are based on the amount of heat necessary to kill most of the bacteria that are commonly found in milk. Once you open a container of milk, it can contain or acquire a mix of bacterial species that can ferment milk in an undesirable fashion. Therefore, before you start making yogurt, it is necessary to heat the milk so that the only bacteria it contains are the ones we will add. Adding specific bacteria is called using a “starter culture”. Refer to the chart below when observing your finished yogurt. In general, a “sniff” test is a good idea.

Materials

Powdered milk
4 to 6-quart pan
Stirring spoon
Bleach
Liquid and dry measuring cups
Thermos
Sugar
Measuring spoons

Methods

1. Using a mild bleach solution (2 oz. per gallon of water) clean the final container (thermos) for holding the yogurt product.
2. In a 4 to 6-quart pan, mix 2 quarts of powdered milk by adding 2/3 cup of powdered milk per quart of water. (Note: For instant powdered milk the ratio of powdered milk to water is different.)
3. Add 3 to 4 tablespoons of sugar
4. Place the pan with the milk and sugar on the stove and cook for 1.5 hours to 140° to 150°F, being careful to not scorch the milk mixture. Stir occasionally.
5. Remove from the heat and allow to cool to 118°F
6. Remove 2 cups and mix in ½ cup of the commercial yogurt; then add this mixture to the remaining milk and stir well to distribute the culture.
7. Transfer the mixture to a clean, warmed thermos to allow it to incubate.
8. Put the lid on and place the thermos in the "cooler" for overnight.
9. In the morning open the thermos and check the yogurt development and then place thermos in the refrigerator until the next class period. (Refrigerate yogurt for at least 3 hours before eating.)
10. When removing yogurt from the thermos, scoop it out but do not stir.
11. Chill before serving.

(This recipe was adapted from National Center for Home Preservation)
http://nchfp.uga.edu/publications/nchfp/factsheets/yogurt.html

The Science

Fermentation is an enzymatically controlled anaerobic breakdown of an energy-rich compound like a carbohydrate to carbon dioxide (CO_2) and alcohol or to an organic acid.

The main method of producing yogurt is through the lactic acid fermentation of milk with harmless bacteria. The primary bacteria used are typically Lactobacillus bulgaricus and Streptococcus thermophilus, and US law requires all yogurts to contain these two cultures (though others may be added as probiotic cultures). These bacteria produce lactic acid in the milk culture, decreasing its pH and causing it to congeal. The bacteria also produce compounds that give yogurt its distinctive flavor. An additional effect of the lowered pH is the incompatibility of the acidic environment with many other types of harmful bacteria. For a probiotic yogurt, additional types of bacteria such as Lactobacillus acidophilus are also added to the culture.

Additionally, the milk proteins coagulate and set, to form yogurt. A colorless liquid called acetaldehyde is also produced during fermentation and gives yogurt its distinct flavor.

Yogurt can be made from different types of milk, including skimmed, semi-skimmed, whole, evaporated or powdered forms.

Basic fermentation reaction:

Lactose
↓
Glucose + Galactose
↓
Pyruvic acid
↓
Lactic acid

<u>Problems Presented by Common Microorganisms in Milk</u>

Type of Microorganism	Sources	End Products
Streptococci (acid producer)	Dairy utensils, plants	Lactic acid, acetic acid, ethanol, and carbon dioxide (not tasty)
Coliforms (acid producer)	Manure, polluted water, soil, and plants	Lactic acid, other
Proteolytic (acts on protein)	Soil, water, utensils	Degrades casein; may be proceeded by coagulation of milk (smells & tastes bad)
Lipolytic (acts on milk fat)	Soil, water, utensils	Hydrolyzes milk fat to glycerol and fatty acids (rancid odor and taste)

Lab Report

Consider the following in the Results and Discussion section of your lab report:

1. Why is sanitation so important?
2. Why does the temperature of the milk need to be maintained for several hours?
3. What bacterial cultures were in the commercial plain yogurt?
4. Identify the by-products of yogurt production.
5. Was your yogurt successful? If not, what do you think happened.
6. Describe the taste your yogurt.
7. Using pH test strips, what is the pH of your yogurt?

This lab report is due: ____________________

Lab 11: Pasta Making

Introduction

Pasta is a staple food of traditional Italian cuisine, with the first reference dating to 1154 in Sicily. Some form of pasta is consumed in almost every country. Typically, pasta is a noodle made from an unleavened dough of a durum wheat flour mixed with water and formed into sheets or various shapes, then cooked and served in any number of dishes. It can be made with flour from other cereals or grains, and eggs may be used instead of water. Pastas may be divided into two broad categories, dried (pasta secca) and fresh (pasta fresca).

Most dried pasta is commercially produced via an extrusion process. Fresh pasta was traditionally produced by hand, sometimes with the aid of simple machines, but today many varieties of fresh pasta are also commercially produced by large-scale machines, and the products are widely available in supermarkets.

Both dried and fresh pasta come in a number of shapes and varieties, with 310 specific forms known variably by over 1300 names. Common forms of pasta include long shapes, short shapes, tubes, flat shapes and sheets, miniature soup shapes, filled or stuffed, and specialty or decorative shapes.

Pasta is mostly starch because it is made of flour. It also contains other minerals and vitamins either directly from wheat or from artificial enrichment. Whole wheat pasta contains considerable amounts of minerals such as magnesium, iron, calcium, potassium, zinc, selenium and manganese. Pasta also contains a small amount of sodium, and has no cholesterol. Pastas also contains vitamin B, which includes folic acid and niacin.

Note: The amount of protein in pasta depends on the type of flour used to manufacture it. If it is made from durum wheat, the pasta contains protein and gluten. Pasta contains protein comprising six of the nine essential amino acids. If the pasta is made with eggs, it contains more protein.

United States Pasta

In the United States, regulations for commercial pasta products occur both at the Federal and State levels. At the Federal level, consistent with Section 341 of the Federal Food, Drug, and Cosmetic Act, the Food and Drug Administration (FDA) has defined standards of identity for what are broadly termed macaroni products. These standards appear in 21 CFR Part 139.In those regulations the requirements for standardized macaroni products of 15 specific types of dried pastas are detailed, including ingredients and product specific labeling for conforming products sold in the U.S., including imports:

Macaroni products – is defined as the class of food prepared by drying formed units of dough made from semolina, durum flour, farina, flour, or any combination of those ingredients with water. Within this category various optional ingredients may also be used within specified ranges, including egg white, frozen egg white or dried egg white alone or in any combination; disodium phosphate; onions, celery, garlic or bay leaf, alone or in any combination; salt; gum gluten; and concentrated glyceryl monostearate. Specific dimensions are given for the shapes named macaroni, spaghetti and vermicelli.

Enriched macaroni products – is largely the same as macaroni products except that each such food must contain thiamin, riboflavin, niacin or niacinamide, folic acid and iron, with specified limits. Additional optional ingredients that may be added include vitamin D, calcium, and defatted wheat germ. The optional ingredients specified may be supplied through the use of dried yeast, dried torula yeast, partly defatted wheat germ, enriched farina, or enriched flour.

Enriched macaroni products with fortified protein–similar to enriched macaroni products with the addition of other ingredients to meet specific protein requirements. Edible protein sources that may be used include food grade flours or meals from nonwheat cereals or oilseeds. Products in this category must include specified amounts of thiamin, riboflavin, niacin or niacinamide and iron, but not folic acid. The products in this category may also optionally contain up to 625 milligrams of calcium.

Milk macaroni products – the same as macaroni products except that milk or a specified milk product is used as the sole moistening ingredient in preparing the dough. Other than milk, allowed milk products include concentrated milk, evaporated milk, dried milk, and a mixture of butter with skim, concentrated skim, evaporated skim, or nonfat dry milk, in any combination, with the limitation on the amount of milk solids relative to amount of milk fat.

Nonfat milk macaroni products – the same as macaroni products except that nonfat dry milk or concentrated skim milk is used in preparing the dough. The finished macaroni product must contain between 12% and 25% milk solids-not-fat. Carageenan or carageenan salts may be added in specified amounts. The use of egg whites, disodium phosphate and gum gluten optionally allowed for macaroni products is not permitted for this category.

Noodle products – are the class of food that is prepared by drying units of dough made from semolina, durum flour, farina, flour, alone or in any combination with liquid eggs, frozen eggs, dried eggs, egg yolks, frozen yolks, dried yolks, alone or in any combination, with or without water. Optional ingredients that may be added in allowed amounts are onions, celery, garlic, and bay leaf; salt; gum gluten; and concentrated glyceryl monostearate.

Enriched noodle products – similar to noodle products with the addition of specific requirements for amounts of thiamin, riboflavin, niacin or niacinamide, folic acid and iron, each within specified ranges. Additionally, products in this category may optionally contain added vitamin D, calcium or defatted wheat germ, each within specified limits.

Other types described by standard of identity include:

- Enriched nonfat milk macaroni products
- Vegetable macaroni products
- Enriched vegetable macaroni products
- Whole wheat macaroni products
- Wheat and soy macaroni products
- Vegetable noodle products
- Enriched vegetable noodle products
- Wheat and soy noodle products

Beyond the FDA's standards and state statutes the United States Department of Agriculture (USDA), which regulates federal school nutrition programs, broadly requires grain and bread products served under these programs either be enriched or whole grain (see 7 CFR 210.10 (k) (5)). This includes macaroni and noodle products that are served as part the category grains/breads requirements within those programs.

The USDA also allows that enriched macaroni products fortified with protein may be used and counted to meet either a gains/breads or meat/alternative meat requirement, but not as both components within the same meal.

Learning Objectives

- Learn the science, process, and value of pasta making
- Understand the function of each ingredient in a basic pasta recipe
- Make pasta dough, producing the correct consistency to use in pasta maker
- Produce pasta noodles using a pasta maker
- Dry some of the pasta product
- Cook and taste-test some of the pasta

Ingredients

- 2 cups flour, plus extra for rolling the pasta (our flour was a mix of 1/3 cup semolina flour to 1 cup regular flour; all regular flour could be used.)
- 1/2 teaspoon salt
- 3 eggs
- 1 to 2 teaspoons olive oil

Equipment

- Mixing bowl
- Large spoon, fork or dough whisk
- Pasta machine
- Baking sheet (or sheet of freezer paper)
- Clean dishtowel

Instructions

1. Combine the Flour and Salt: Whisk together the flour and salt with a fork or large spoon in a medium mixing bowl.

2. Add the Eggs and Oil: Create a deep well in the middle of the flour and crack the eggs into this well. Mix the eggs with a large spoon or fork to combine.

3. Begin Combining the Flour and Eggs: As you whisk the eggs, begin gradually pulling in flour from the bottom and sides of the bowl. Don't rush this step. At first, the eggs will start to look like slurry. Once enough flour has been added, it will start forming very soft dough. Don't worry if you haven't used all the flour. During this step you will need to add 4 to 5 tablespoons water to get the right consistency.

4. Knead the Pasta Dough: Turn the dough and any excess flour out onto a clean counter. Begin gently folding the dough on itself, flattening, and folding again. It will be extremely soft at first, then gradually start to firm up. Once it is firm enough to knead, begin kneading the dough. Incorporate more flour as needed to prevent the dough from sticking to you or the counter. Slice into the dough with a paring knife; if you see lots of air bubbles, keep kneading. The dough is kneaded when it forms a smooth elastic ball and has very few air bubbles when cut.

5. Rest the Pasta Dough: Clean and dry the mixing bowl. Place the ball of dough inside and cover with a dinner plate or plastic wrap. Rest for at least 30 minutes. Note: At this point, the pasta dough can be refrigerated for up to 24 hours. Let it come back to room temperature before rolling.

6. Divide the Pasta Dough: Sprinkle a baking sheet generously with flour and scrape the ball of dough on top (it will stick to the bowl; use a spatula or bowl scraper if necessary). Divide the dough into four equal portions. Dust the portions with flour and cover with a clean dishtowel.

Note: The name of the game at this point is to keep everything well-floured to prevent the pasta from sticking to itself or the roller as you work. If the dough starts to feel sticky as you roll it, sprinkle it with flour. Also sprinkle flour on any pasta you're not working (rolled, cut or otherwise) with and keep it covered with a dishtowel.

7. Begin Rolling Out the Pasta: Set your pasta machine to the thickest setting (usually marked "1"). Flatten one piece of dough into a thick disk between your hands and feed it through the pasta roller. Repeat once or twice. Fold this piece of dough into thirds, like folding a letter, and press it between your hands again. With the pasta machine still on the widest setting, feed the pasta crosswise between the rollers. Feed it through once or twice more until smooth. If desired, repeat this folding step. This helps to strengthen the gluten in the flour, giving it a chewier texture when cooked.

8. Thin the Pasta: Begin changing the settings on your roller to roll the pasta thinner and thinner. Roll the pasta two or three times at each setting, and don't skip settings (the pasta tends to snag and warp if you do). If the pasta gets too long to be manageable, lay it on a cutting board and slice it in half. Roll the pasta as thin as you like to go. (Recommendation: No thinner than 3 or 4 for the lab.)

9. Cut the Pasta: Cut the long stretch of dough into noodle-length sheets, usually about 12-inches. If making filled pasta or lasagna, proceed with shaping. If cutting into noodles, switch from the pasta roller to the noodle cutter, and run the sheet of pasta through the cutter. Toss the noodles with a little flour to keep them from sticking and gather them into a loose basket. Set this basket on the floured baking sheet and cover with a towel while you finish rolling and cutting the rest of the dough.

Note: Often it is easiest to roll all the pasta at once before proceeding to cutting it into noodles. Sprinkle the sheets of pasta liberally with flour and overlap them on a floured baking sheet, covered with a towel.

10. Cooking, Drying, or Freezing the Pasta: To cook the pasta immediately, bring a large pot of water to a boil, salt the water, and cook the pasta until al dente (to be still firm when bitten), 4-5 minutes. To dry, lay the pasta over a drying rack, coat hangers, or the back of a chair, and let air dry until completely brittle. Store in an airtight container for several weeks. To freeze, either freeze flat in long noodles or in the basket-shape on a baking sheet until completely frozen. Gather into an airtight container and freeze for up to three months. Dried and frozen noodles may need an extra minute or two to cook.

Results and Discussion/Lab Report

- What are the best grains for pasta? Why?
- What is the per capita consumption of pasta in the U.S.?
- What is the nutritional value of pasta?
- Identify the function of the eggs, oil, and flour in the pasta recipe?
- Did your pasta turn out?
- How did it taste?

Lab 12: Making Cheese

Introduction

Cheese is a fermented milk product made from the curds produced when milk is coagulated. Usually it is made from cow's milk but there are many varieties made from sheep's milk and goat's milk. Cheese can also be made from the milk of various other animals. Real mozzarella, for example, is made from buffaloes' milk.

The Legend

Most cheese authorities and historians consider that cheese was first made in the Middle East. The earliest type was a form of sour milk which came into being when it was discovered that domesticated animals could be milked. A legendary story has it that cheese was 'discovered' by an unknown Arab nomad. He is said to have filled a saddlebag with milk to sustain him on a journey across the desert by horse. After several hours riding he stopped to quench his thirst, only to find that the milk had separated into a pale watery liquid and solid white lumps. Because the saddlebag, which was made from the stomach of a young animal, contained a coagulating enzyme known as rennin, the milk had been effectively separated into curds and whey by the combination of the rennin, the hot sun, and the galloping motions of the horse.

The History

It isn't known when cheese making was first discovered, but it is an ancient art. The first cheeses were not cheeses as they are now known, but curds and whey. Curds and whey result when milk is coagulated. The curd is solid, and the whey is liquid. Curds and whey remained a common food (this is what Little Miss Muffet ate) until about 50 years ago. It is still eaten in some areas of the U.S. and in some third world countries.

Egyptian hieroglyphics depict workmen making cheese. In ancient times, the whey was consumed immediately, and the curd was salted and/or dried to preserve it. The Roman Legion was instrumental in spreading the art of cheese making throughout Europe and England. During the Middle Ages, the art of cheese making was improved greatly in the monasteries and feudal estates of Europe. The monks became great innovators of cheese and it is to them we owe many of the classic varieties of cheese marketed today. During the Renaissance period cheese suffered a drop-in popularity, being considered unhealthy, but it regained favor by the nineteenth century, the period that saw the start of the move from farm to factory production.

Basic Principles

The basic principle involved in making all-natural cheese is to coagulate or curdle the milk so that it forms into curds and whey. As anyone knows who has left milk un-refrigerated for a period, milk will curdle quite naturally. The milk sours and forms into an acid curd.

Today's methods help the curdling process by the addition of a starter (a bacterial culture which produces lactic acid) and rennet the coagulating enzyme which speeds the separation of liquids (whey) and solids (curds). There are two basic categories of starter cultures. Mesophilic starter cultures have microbes that cannot survive at high temperatures and thrive at room temperatures. Examples of cheeses made with these bacteria are Cheddar and Gouda. Thermophilic starter cultures are heat-loving bacteria. They are used when the curd is cooked to as high as 132°F. Examples of cheeses made from these bacteria are Swiss and Italian cheeses.

The least sophisticated cheeses are the fresh, unripened varieties typified by Cottage Cheese. These are made by warming the milk and letting it stand, treating it with a lactic starter to help the acid development and then cutting and draining the whey from the cheese. The cheese can then be salted and eaten fresh. This is the simplest, most basic form of cheese.

Acidification

Generally, cheese making starts with acidification. This is the lowering of the pH (increasing acid content) of the milk, making it more acidic. Classically, this process is performed by bacteria. Bacteria feed on the lactose in milk and produce lactic acid as a waste product. With time, increasing amounts of lactic acid lower the pH of the milk. Acid is essential to the production of good cheese. However, if there is too much acid in the milk the cheese will be crumbly. If not enough acid is present, the curd will be pasty.

Rennet

After acidification, coagulation begins. Coagulation is converting milk into curds and whey. As the pH of the milk changes, the structural nature of the casein proteins changes, leading to curd formation. Essentially, the casein proteins in the milk form a curd that entraps fat and water. Although acid alone is capable of causing coagulation, the most common method is enzyme coagulation. The physical properties of enzyme-coagulated milk are better than that coagulated purely with acid. Curds produced by enzyme coagulation achieve lower moisture content without excessive hardening.

Enzymes used to coagulate milk come from a number of sources: animals, plants, and fungi. The traditional source of enzyme is rennet. Rennet is a preparation made from the lining of the fourth stomach of calves. The most important enzyme in rennet is chymosin. Today, most chymosin is a recombinant product made possible by genetic engineering. Until 1990, the only source of rennin was calves. Around 1990, scientists created a system to make chymosin that doesn't require calves. Using genetic engineering, the gene for chymosin was cut from a calf cell and inserted into the genomes of bacteria and yeast. The microbes make an exact copy of the calf chymosin. Microbes replicate and grow rapidly, and can be grown continuously. Thus, the supply of rennet is assured. Approximately 70% of the cheese made in the U.S. is coagulated using chymosin. The chymosin made by the yeast cells is the same as that made by the calf cells.

Cutting and Pressing the Curd

After the coagulation sets the curd, the curd is cut. This step is usually accompanied with heating the curd. Cutting the curd allows whey to escape, while heating increases the rate at which the curd contracts and squeezes out the whey. The purpose of this stage of the process is to make a hard curd. The term hard curd is relative; the cheese at this stage is still quite pliable. The main difference between a soft curd and a hard curd is the amount of water remaining in the curd. Hard curds have very little water left in them.

Once the curds have sufficiently hardened, salting and shaping begins. In this part of the process, salt is added to the cheese. Salt is added for flavor and to inhibit the growth of undesirable microbes. Large curds are formed as smaller curds are pressed together. This will often involve the use of a cheese press.

Ripening

The shaped cheese ripens or ages for various periods of time. During this time, bacteria continue to grow in the cheese and change its chemical composition, resulting in flavor and texture changes in the cheese. The type of bacteria active at this stage in the cheese making process and the length of time the cheese is aged determine the type and quality of cheese being made.

Sometimes an additional microbe is added to a cheese. Blue veined cheeses are inoculated with a Penicillium spore which creates their aroma, flavor, and bluish or greenish veining. Such cheeses are internally molded and ripen from the inside out. On the other hand, cheeses such as Camembert and Brie have their surfaces treated with a different type of Penicillium spore which creates a downy white mould (known as a bloomy or flowery rind): this makes them surface ripened cheeses.

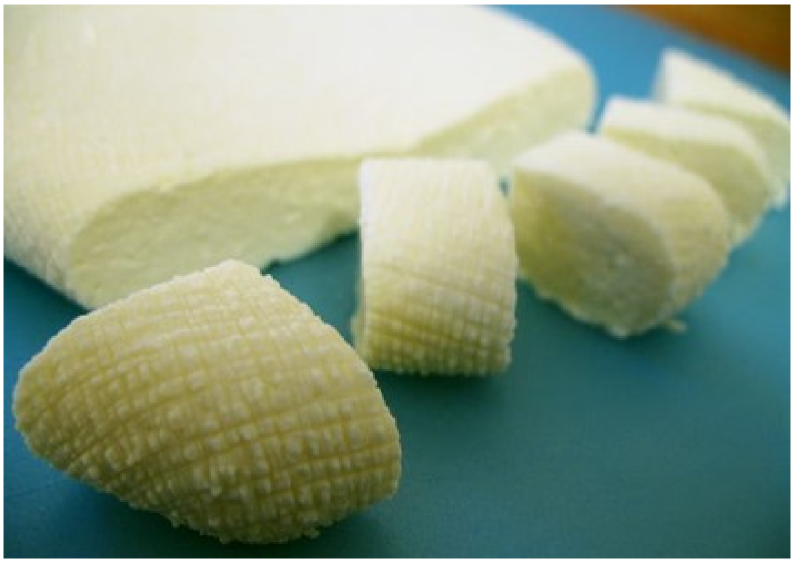
Many surface ripened cheeses have their surfaces smeared with a bacterial broth. With others the bacteria are in the atmosphere of the curing chambers. These cheeses are called washed rind varieties as they must be washed regularly during their ripening period (longer than for Camembert or Brie) to prevent their interiors drying out. The washings also help promote an even bacterial growth across the surfaces of the cheeses. As this washing can be done with liquids as diverse as salt water and brandy, it also plays a part in the final flavor of the cheese.

Rinds

The rinds of the cheeses are formed during the ripening process, many quite naturally. Some are created artificially. Rinds may be brushed, washed, oiled, treated with a covering of paraffin wax or simply not touched at all. Traditional Cheddars are wrapped around with a cotton bandage. The rind's basic function is to protect the interior of the cheese and allow it to ripen harmoniously. Its presence thus affects the final flavor of the cheese. Salting plays an important role in rind formation. Heavily salted cheeses develop a thick, tough outer rind, typified by the Swiss range of cheeses. Cheddar, another natural rind cheese, is less salted than the Swiss varieties, and consequently has a much thinner rind.

Learning Objectives

- Become familiar with cheese processing
- Produce a processed cheese and taste it
- Compare processing methods and recipes for different cheese products



Simple Rennet Cheese Recipe

This is by far the easiest cheese to make. It can be eaten strait or mixed in with various additions such as, green onion, jalapenos, chives, dried tomatoes, etc. Be creative!

Materials

- Large pan
- Thermometer
- Measuring spoon
- Stirring spoon
- Colander
- Cheese cloth

Ingredients

- 1 to $^3/_4$-gallon whole milk (mixed powdered milk will work)
- $^1/_2$ tsp. Rennet mixed with $^1/_4$ cup water
- $^1/_2$ tsp. salt
- 1$^1/_2$ tsp citric acid dissolved in 1 cup cool chlorine-free water (optional)

Preparation

11. Add the citric acid solution to the milk.
12. Heat milk to 100° F (38° C) stirring constantly. Be careful not to burn the milk. Remove from heat.
13. While mixing with a whisk, slowly add the rennet and water mixture.
14. Cover and let stand for 30-45 minutes to coagulate. (Overnight works best)
15. Cut through coagulated cheese to form curds and allow release of the whey.
16. Slowly reheat curds and whey until larger curds form and whey is completely separated.
17. Line a colander with fine cheesecloth.
18. Pour the curdled milk through the colander and squeeze out as much moisture as you can.
19. Place cheese on a plate and microwave at 30 second intervals to extract more of the whey.
20. The solidified cheese can be broken apart and salted and seasoned to taste or kept unsalted.

Note: Lemon juice (1/4 cup) may also be used in addition to the rennet. The resulting cheese will have a much tangier flavor.

Lab Report Questions

1. Was your cheese recipe successful? If not, why?
2. What was the yield of your cheese?
3. After adding salt, how did you cheese taste?
4. How is whey, a by-product of cheese making used?
5. What food science principles are demonstrated?

Lab 13: Making Butter from Cream

Introduction

Churning is the process of shaking up cream (or whole milk) to make butter, and various forms of butter churn have been used for the purpose. In Europe from the Middle Ages until the Industrial Revolution, this was generally as simple as a barrel with a plunger in it, which was moved by hand. Afterward, mechanical means of churning were usually substituted.

Butter is essentially the fat of milk. It is usually made from sweet cream. In the USA, Ireland and the UK, salt is usually added to it. Unsalted (sweet) butters are most commonly used in the rest of Europe. However, it can also be made from acidulated or bacteriologically soured cream. Well into the 19th century butter was still made from cream that had been allowed to stand and sour naturally. The cream was then skimmed from the top of the milk and poured into a wooden tub.

Butter-making was done by hand in butter churns. The natural souring process is, however, a very sensitive one and infection by foreign microorganisms often spoiled the result. Today's commercial butter-making is the product of the knowledge and experience gained over the years in such matters as hygiene, bacterial acidifying and heat treatment, as well as the rapid technical development that has led to the advanced machinery now used. The commercial cream separator was introduced at the end of the 19th century; the continuous churn had been commercialized by the middle of the 20th century.

Learning Objective

- Students will process butter from cream

Materials

- Whipping cream
- Quart jar with lid
- Small plates
- Strainer

Steps

1. Fill a jar half way with heavy cream and screw the lid on tight.
2. Shake the jar up and down until the cream thickens and begins to stick together.
3. Then, open the jar and pour any remaining liquid into another container; this is the buttermilk. Everything else is butter.
4. Knead the butter under cold running water for several minutes to work out any remaining buttermilk (otherwise the butter will spoil quickly)
5. Knead in salt if desired.
6. Refrigerate.

The Process

Changing whole milk to butter is a process of transforming a fat-in-water emulsion (milk) to a water-in-fat emulsion (butter). Whole milk is a dilute emulsion of tiny fat globules surrounded by lipoprotein membranes that keep the fat globules separate from one another.

Butter is made from cream that has been separated from whole milk and then cooled; fat droplets clump more easily when hard rather than soft. However, making good butter also depends on other factors, such as the fat content of the cream and its acidity.

The process can be summarized in three steps:

1. Churning physically agitates the cream until it ruptures the fragile membranes surrounding the milk fat. Once broken, the fat droplets can join with each other and form clumps of fat, or butter grains.
2. As churning continues, larger clusters of fat collect until they begin to form a network with the air bubbles that are generated by the churning; trapping the liquid and producing a foam. As the fat clumps increase in size, there are also fewer to enclose the air cells. So, the bubbles pop, run together, and the foam begins to leak. This leakage is called buttermilk.
3. The cream separates into butter and buttermilk. The buttermilk is drained off, and the remaining butter is kneaded to form a network of fat crystals that becomes the continuous phase, or dispersion medium, of a water-in-fat emulsion. Working the butter also creates its desired smoothness. Eventually the water droplets become so finely dispersed in the fat that the butter's texture seems dry. Then it is frozen into cubes, then melted, then frozen again into bigger chunks to sell.

Lab Report

1. Was your butter-making successful? If not, why?
2. How much cream did you use and how much butter did you yield?
3. How did your butter taste?
4. Taste the butter-milk left over after removing the butter. How does it taste?
5. What components of milk are still in the butter-milk?
6. What uses are made of butter-milk.
7. How does butter compare to margarine?

Lab 14: Ice Cream in a Bag

Ingredients

1 cup milk
2 tablespoons sugar
2 tablespoons evaporated milk (or whipping cream)
1 teaspoon vanilla extract
4 cups coarsely crushed ice
3/4 cup ice cream salt

Directions

In a small re-sealable plastic bag, combine the milk, sugar, evaporated milk and vanilla. Press out air and seal. In a large re-sealable plastic bag, combine the ice and salt; add the sealed small bag.

Seal the large bag; place in another large re-sealable plastic bag and seal. Shake and knead for 5-7 minutes or until cream mixture is thickened. Serve immediately or freeze. Yield: 1 cup.

For variety use other flavors such as chocolate or add fruit.

What Does the Salt do?

Just like we use salt on icy roads in the winter, salt mixed with ice in this case also causes the ice to melt. When salt comes into contact with ice, the freezing point of the ice is lowered. Water will normally freeze at 32°F. A 10% salt solution freezes at 20°F, and a 20% solution freezes at 2°F. By lowering the temperature at which ice is frozen, we can create an environment in which the milk mixture can freeze at a temperature below 32°F into ice cream.

The Science of Commercial Production

The basic ingredients are mixed and blended in a mixing tank. The mixture is then pumped into a pasteurizer, where it is heated, a food safety precaution in order to kill remaining harmful bacteria. The hot mixture is then "shot" through a homogenizer, where pressure of 2,000 to 2,500 pounds per square inch breaks the milk fat down into smaller particles, allowing the mixture to stay smooth and creamy. The mix is then quick-cooled to about 40°F and frozen.

During freezing, the mix is aerated by "dashers," revolving blades in the freezer. The small air cells that are incorporated by this whipping action prevent ice cream from becoming a solid mass of frozen ingredients. The amount of aeration is called "overrun," and is limited by the federal standard that requires the finished product must not weigh less than 4.5 pounds per gallon.

Lab 15: Processing Meat

Introduction

The consumer who wishes to process meat products in the home should be familiar with both federal (Food Safety and Quality Service of the USDA) and state meat processing rules and regulations. Consumers often process meat products and later wish to sell portions of their production. This cannot be done. A person must know the rules and regulations on home meat processing to know if he or she is in violation of federal, state, or municipal laws. Other federal and state laws were established to ensure production of clean and wholesome meat products from licensed plants for consumers. Consumers of home-prepared products should be familiar with all rules and regulations regarding sale of meat and meat products. Literally hundreds of different types of processed meats with individual recipes exist.

Learning Objectives

- Become familiar with meat processing
- Produce a processed meat and taste it
- Compare processing methods and recipes for different meat products

Materials

Persons who wish to process meat products in the home should have the following materials:

- Clean, wholesome meat
- Necessary spices and curing ingredients
- Easily cleanable processing equipment, mixing bowls, measures (cups and spoons), scales, food service gloves,
- Scales
- Jerky gun and sharp knives
- Proper packaging materials including casings if required
- Adequate refrigeration facilities for perishable products
- Knowledge of the factors affecting meat spoilage, including the nature and control of pathogenic organisms
- Oven, drying oven or food dehydrator

Jerky

1. For this jerky you will use a very lean hamburger/ground beef. Record the fat content of your ground beef: ____________and the amount of ground beef used:__________.
2. This hamburger will be mixed with the commercial jerky spice premixes provided by the instructor. Record the flavor of your spice mix: _________________
3. Using clean, gloved hands mix the hamburger and the spice mix thoroughly until it has the consistency of dough. (Massaging/mixing the ground beef plus the addition of the premix which contains salt causes the protein to become semi-liquid and join together. This connection becomes greater during the cooking/drying process.)
4. Load the "dough" into the jerky gun. Press the "dough" firmly into the barrel to within ½ to ¼ inch of the top.
5. Place "flat" end piece on and extrude the jerky using the "flat" end piece.
6. Extrude directly onto the clean trays from a dehydrator.
7. Stack the dehydrator trays and turn on the dehydrator.
8. Set the timer for 6 to 8 hours.
9. Record the final weight of product produced ______________
10. Taste the product and share with others.
11. Place the extra in a Ziploc bag and store in freezer.
12. Thoroughly wash all utensils, measuring spoons and cups, bowls and jerky gun.
13. Clean up work area.

Jerky Strips

1. Top round steak sliced 3/8-inch thick is suitable for beef jerky. Record the amount used: ___________________________
2. Discard any fat surrounding the muscle and cut the lean into thin strips 1 inch wide or less. Record the amount of fat trimmed: ________________________
3. Mix one of the jerky marinades (see recipes below) as described below.
4. Place the strips and the marinade in a Ziploc bag. Mix thoroughly.
5. Place in a refrigerator and turn bag every day. Marinate for 3 to 4 days.
6. Remove from the refrigerator and drain of excess by placing meat strips in a strainer in the sink.
7. Place meat strips in the dehydrator for 6 to 8 hours.
8. Remove from dehydrator. Record dry weight:_______________.
9. Taste and evaluate flavor other sensory qualities.

Jerky Marinades

Marinade provided by jerky gun manufacturer:

- 1-pound lean ground beef
- ¼ cup liquid smoke
- ¼ cup soy sauce
- ¼ cup Worcestershire sauce
- 1 ½ teaspoons kosher salt
- ½ teaspoon garlic powder
- ½ teaspoon onion powder
- ½ teaspoon cayenne pepper, or to taste
- 1 teaspoon freshly ground black pepper

Dr. Parker's Jerky Recipe (for 1 to 2 pounds of round steak or other lean meat):

- ½ cup Worcestershire® sauce
- ½ cup soy sauce or teriyaki sauce (BBQ sauce could be used)
- ¼ cup brown sugar
- 1 teaspoon crushed garlic
- 2 teaspoons black pepper
- 2 teaspoons ground dried red chili pepper (depends how "hot" you want the jerky)
- 1 teaspoon onion powder
- 2 teaspoons of Liquid Smoke® (more depending on your taste)

Record any adjustments ____
____
____

Jerky Making Tips

Your meat should be as lean as possible. Using lean meat will help the meat dry faster and aid in clean-up by decreasing fat drippings. Ground meat should be 80% to 90% lean. Jerky seasonings are available for all tastes or you can make your own. Ground turkey, venison, buffalo, and elk are other excellent choices for jerky.

Oven Cooking Instructions: Wrap meat in plastic wrap and freeze 30 to 60 minutes until firm, but not rock hard. (This makes it easier to slice evenly.) Using a sharp knife, slice the meat into thin strips about ¼ -inch thick.

Sausages and Salami

Sweet and Savory Sausage

Brown sugar gives this sausage its sweet taste and good browning qualities. The recipe also contains part beef for those who prefer that flavor and texture.

Pork (ground)	3 lb.
Beef (ground)	1 lb.
Spice premix (below)	8 packed level Tablespoons

If the meat is not ground, grind meat through a fine plate and mix together. Sprinkle spice premix onto meat and mix thoroughly with hands. Wrap in meal-sized packages, or form patties and separate with waxed paper, and then freezer wrap. It may also be stuffed in small casing and cooked as breakfast links.

Spice Premix

Brown sugar	1 lb.
Ground black pepper	4 tbsp.
Monosodium glutamate	5 tbsp. (Accent)
Salt	1 cup
Sage	5 tbsp.
Crushed red pepper	2 tsp.
Nutmeg	2½ tsp.

Mix spices and sugar together thoroughly. A pastry cutter works well to blend them together. Store in a tightly covered container for up to 6 months. Premix may be used in a proportion of 2 packed level tablespoons premix to 1 pound of ground meat.

To grind unseasoned pork trimmings, use ½-inch plate (coarse grind). Thoroughly mix the seasoning, spread it over the coarsely ground product, mix and regrind through a 1/8-inch plate. Add ½ cup of cold water to each 4 lbs. of ground, seasoned sausage and knead until it become sticky and dough-like enough to yield a product that will slice and fry without crumbling. Package and refrigerate (or freeze) immediately.

Old Fashioned Sausage

This simple blend of meat and spices tastes like it just came out of Grandma's frying pan.

Pork trimmings	5 lb.
Salt	8 tsp.
Ground black pepper	4 ½ tsp.
Sage	2 tsp.
Ginger	1 ¼ tsp.

Summer Sausage

- 6 lb. ground lean beef
- Mix the following with 2 cups of water in a fairly large pan:
- 6 Tbsp. salt
- 3 Tbsp. brown sugar (makes sausage brown when it cooks)
- 3 Tbsp. liquid smoke
- 2 Tbsp. minced onions (dried)
- 3 Tsp. Accent (monosodium glutamate)
- 1 Tbsp. coarse ground black pepper
- 1 Tsp. (generous) dried minced garlic

Blend the water mixture with the meat. Let stand 24 hours in a cool place or refrigerate. Stir several times during the 24 hours. Roll in to logs of about one pound each. Place on a broiler pan and bake 30 minutes at 300°F. Turn and bake another 30 minutes. Drain liquid. Dust with powdered sugar or ground pepper. Wrap in foil and freeze for later or eat in all and have a party.

Cooked Salami

- 19 lb. lean meat
- 6 lb. pork or beef fat
- 1 cup salt
- ½ cup sugar
- 5 ¼ cups nonfat dried milk
- 1 qt cold water
- 6 tablespoons ground black pepper
- 3 tablespoons coriander seed
- 3 tablespoons garlic powder
- 4 teaspoons ground mace
- 4 teaspoons cardamom
- 2 teaspoons cure (Morton's Tender Quick Cure)

Cut the meat and fat into 1-inch squares or grind through a coarse (1/2 to 1-inch) plate. Season by sprinkling the ingredients over the meat and hand mix. Grind through a 1/8-inch plate. Mix 6 minutes and stuff into natural or artificial casings 2 to 3 inches in diameter. Place in a smokehouse and heat at 185°F until the internal sausage temperature reaches 152°F. Move to a cold-water bath until the internal temperature reaches 100°F. Rinse briefly with hot water to remove grease and hang sausage at room temperature for about 1 hour before refrigeration. The salami should be cooled overnight in a refrigerator before cutting.

Salami can be roasted in casings in a 185°F oven if a smokehouse is not available. Four to eight ounces of liquid smoke per 100 lb. of product can be added for flavor. Follow the above chilling procedures.

Another alternative is to roast salami without casings. The above ingredients must be mixed and left in a refrigerator to chill overnight. The next morning, hand mix the ingredients again and form rolls 2 to 3 inches in diameter and 10 inches long. Liquid smoke can be diluted 1 part to 5 parts water, and sprinkled over the roasts if desired. Then place the rolls on a broiler rack with ½-inch water in the pan underneath and bake in a 160°F oven for 2 hours, then 185°F until internal temperature reaches 152°F. Cool in cold water until internal temperature reaches 100°F and then refrigerate overnight before slicing.

Results and Discussion

After completing the lab, be sure you thoroughly clean all of the utensils with hot water and soap, and clean any countertops used.

Answer the following questions as you prepare your laboratory report:

1. Describe the type of meat used and the yield of product.
2. What adjustments did you make to your "recipe?"
3. Was your meat processing successful? If not, why?
4. What food science principles are demonstrated by this exercise?
5. What are the most commonly consumed processed meats? How much do they cost?
6. How do these "home" formulations compare to commercial processed meats?

7. What possible pathogens or spoilage processes should concern the producer of processed meats?
8. Why did people/cultures develop processedmeats?
9. How do the tastes of your products compare?
10. How long did it take to dry your jerky?
11. How much value did you add to your raw products?
12. What are some advantages and disadvantages of freezing meat products?

After completing the lab, be sure you thoroughly clean all the utensils with hot water and soap, and clean any countertops used.

Science of Curing Meat

Curing is the addition to meats of some combination of salt, sugar, nitrite and/or nitrate for the purposes of preservation, flavor and color. Some publications distinguish the use of salt alone as salting, corning or salt curing and reserve the word curing for the use of salt with nitrates/nitrites. The cure ingredients can be rubbed on to the food surface, mixed into foods dry (dry curing), or dissolved in water (brine, wet, or pickle curing). In the latter processes, the food is submerged in the brine until completely covered. With large cuts of meat, brine may also be injected into the muscle. The term pickle in curing has been used to mean any brine solution or a brine cure solution that has sugar added.

Salting/Corning

Salt inhibits microbial growth by plasmolysis. In other words, water is drawn out of the microbial cell by osmosis due to the higher concentration of salt outside the cell. A cell loses water until it reaches a state first where it cannot grow and cannot survive any longer. The concentration of salt outside of a microorganism needed to inhibit growth by plasmolysis depends on the genus and species of the microorganism. The growth of some bacteria is inhibited by salt concentrations as low as 3%, e.g., Salmonella, whereas other types can survive in much higher salt concentrations, e.g., up to 20% salt for Staphylococcus or up to 12% salt for Listeria monocytogenes.

Fortunately, the growth of many undesirable organisms normally found in cured meat and poultry products is inhibited at relatively low concentrations of salt (USDA FSIS 1997a).

Salting can be accomplished by adding salt dry or in brine to meats. Dry salting, also called corning originated in Anglo-Saxon cultures. Meat was dry-cured with coarse "corns" or pellets of salt. Corned beef of Irish fame is made from a beef brisket, although any cut of meat can be corned. Salt brine curing involves the creation of brine containing salt, water and other ingredients such as sugar, erythorbate, or nitrites.

Age-old tradition was to add salt to the brine until it floated an egg. Today, however, it is preferred to use a hydrometer or to carefully mix measured ingredients from a reliable recipe. Once mixed and placed into a suitable container, the food is submerged in the salt brine. Brine curing usually produces an end-product that is less salty compared to dry curing. Injection of brine into the meat can also speed the curing process.

Nitrate/Nitrite Curing

Most salt cures do not contain sufficient levels of salt to preserve meats at room temperature and *Clostridium botulinum* spores can survive. In the early 1800's it was realized that saltpeter ($NaNO_3$ or KNO_3) present in some impure curing salt mixtures would result in pink colored meat rather than the typical gray color attained with a plain salt cure. This nitrate/nitrite in the curing process was found to inhibit growth of *Clostridium*. Recent evidence indicates that they may also inhibit *E. coli*, *Salmonella*, and *Campylobacter* if in sufficient quantities.

Several published studies indicated that N-nitrosoamines were considered carcinogenic in animals. For this reason, nitrate is prohibited in bacon and the nitrite concentration is limited in other cured meats. In other cured foods, there is insufficient scientific evidence for N-nitrosamine formation and a link to cancer. Source: http://nchfp.uga.edu/publications/nchfp/lit_rev/cure_smoke_cure.html

Morton Tender Quick

Morton® Tender Quick® mix contains salt, the main preserving agent; sugar, both sodium nitrate and sodium nitrite, curing agents that also contribute to development of color and flavor; and propylene glycol to keep the mixture uniform. Morton® Tender Quick® mix can be used interchangeably with Morton® Sugar Cure® (Plain) mix. It is NOT a meat tenderizer.

CAUTION: This curing salt is designed to be used at the rate specified in the formulation or recipe. It should not be used at higher levels as results will be inconsistent, cured meats will be too salty, and the finished products may be unsatisfactory. Curing salts should be used only in meat, poultry, game, salmon, shad and sablefish. Curing salts cannot be substituted for regular salt in other food recipes. Always keep meat refrigerated (36° to 40°F) while curing.

Lab 16: Pickles

Introduction

Pickling is one of the oldest known methods of preserving food, dating back to Biblical times; the Chinese are credited with inventing the process. Pickling does not just refer to processing cucumbers. A pickle or pickled product is any food (fruit, vegetable, or meat) that is fermented in brine (salt) or packed in vinegar to aid preservation.

Learning Objectives

- Become familiar with pickling
- Produce processed pickles and taste them

Processing

Pickles should be canned in a boiling water bath since they are a high-acid food. Processing times and procedures vary according to food acidity and the size of the food pieces. One processing procedure for fermented cucumbers and fresh-pack dills is slightly different from the usual boiling water bath method: start counting the processing time as soon as the filled jars are placed in boiling water. This reduces the development of a cooked flavor and loss of crispness. Consult the USDA's Complete Guide to Home Canning for detailed information on canning brine pickles and as a source of recipes.

<u>Use the right equipment</u>

When making pickles, utensils should be stainless steel, enamelware, glass or food grade plastic. Copper may turn pickles green and iron may turn pickles black. The vinegar and salt react with galvanized metal and produce a toxic substance.

Check your jars carefully and discard any that have chips or cracks.

<u>Words of Caution</u>

The level of acidity in a pickled product is as important to its safety as it is to taste and texture.

- Do not alter vinegar, food, or water proportions in a recipe or use vinegar with unknown acidity.
- There must be a minimum, uniform, level of acid throughout the mixed product to prevent the growth of botulinum bacteria.
- Use only recipes with tested proportions of ingredients.

<u>Key Ingredients</u>

- Salt - Acts as a preservative by encouraging the growth of desirable bacteria (and inhibiting undesirable bacteria) which in turn produces lactic acid, a preservative. Helps draw juices and sugar from the produce to make brine and adds flavor and crispness.
- Vinegar - Gives pickles a tart taste and acts as a preservative due to the acidity of vinegar.
- Sugar - Sweetens taste; counteracts vinegar.
- Spices/Herbs - Adds flavor

- Water - Makes liquid portion of brine.
- Alum* - Improves pickle firmness for fermented pickles; does not improve firmness of quick-process pickles.
- Lime** - Improves pickle firmness.

* According to the USDA, alum may be safely used to firm fermented pickles, but it is regarded as unnecessary.

** The calcium in lime improves pickle firmness. Food grade lime may be used as a lime-water solution for soaking fresh cucumbers 12 to 24 hours before pickling them. Excess lime absorbed by the cucumbers must be removed to make safe pickles. To remove excess lime, drain the lime-water solution, rinse, and resoak the cucumbers in fresh water for one hour. Repeat the rinsing and soaking steps two more times. (See: http://www.four-h.purdue.edu/foods/Pickles%20and%20relishes.htm)

Materials

- 5-quart sauce pan
- Jars with lids
- Jar lifting tongs to pick up hot jars
- Lid lifter - to remove lids from the pot of boiling water (sterilizing)
- Canning jar funnel – to fill the jars and keep the rims clean
- Steam Canner - for sealing jars

Quick Process Bread & Butter Pickles

(Follow instructions on packet given to you by the instructor. This is an example.)

- 15-17 pounds 4 to 6-inch fresh cucumbers, firm for pickling
- 10 cups distilled white vinegar, 5% acidity
- 5 pounds granulated sugar
- 1 pouch Mrs. Wages Bread & Butter Pickle Mix for 10-12 quarts

1. Wash cucumbers thoroughly, rinse and drain. Remove tip ends, slice unpeeled cucumbers into thin slices and pack into hot, sterilized canning jars.
2. Combine Bread & Butter Pickle Mix, vinegar and sugar into 5-quart container of un-chipped enamelware, glassware or stainless steel. Do not use aluminum. Bring mixture just to boiling over medium high heat, stirring constantly until mix is dissolved.
3. Evenly divide hot pickling liquid between packed jars and cap each jar as it is filled.

Note: Avoid long boiling of vinegar solution to prevent loss of acetic acid, which is important in the keeping qualities and safety of pickles.

4. Fill water pan of Steam Canner water pan with 6-8 cups of water and place loaded hot jars on the bottle rack and cover with lid. When steam starts flowing out of the hole in the steam dome start timing. (Process pints 5 minutes and quarts 10 minutes)

Bread and Butter Pickles (without commercial packet)

Alternative

This method of producing bread and butter pickles can be used if prepared, commercial packets, like Mrs. Wages, are not available or not used.

- Nutritional Information per serving:
- Serving size: 1/4 cup (drained)
- Calories per serving: 18
- Fat per serving: .1g
- Saturated Fat per serving: 0g
- Fiber per serving: .5g
- Protein per serving: .4g
- Cholesterol per serving: 0mg
- Carbohydrates per serving: 4.4g

Materials

- 5 1/2 cups (1 1/2 pounds) thinly sliced pickling cucumbers
- 1 cup granulated white sugar
- 1 cup white vinegar
- 1/2 cup apple cider vinegar
- 1/4 cup light brown sugar (packed)
- 1 1/2teaspoons mustard seeds
- 1/2 teaspoon celery seeds
- 1/8 teaspoon ground turmeric

Methods

1. Sterilize jars before canning in a boiling water bath. Remove with tongs or jar lifters. Sterilize the lids by bringing a pot of water to a boil and pouring water over a bowl containing the lids.
2. Carefully rinse the cucumbers, scrubbing away any dirt that may have stuck to the outside. Slice off 1/8-inch from the ends and discard.
3. Slice the cucumbers in 1/4-inch thick slices, and tightly pack into pint jars. (Note: Don't cut the cucumbers too thin. They need to have a little bit of crunch to them!)
4. Combine sugar, vinegar and remaining ingredients in a medium saucepan; bring to a boil medium heat, stirring until sugar dissolves.
5. Pour hot pickling mixture over the cucumbers in the jars. Fill to ½ inch from the top.
6. Place the lids and the rings on the filled bottle. Tighten the rings. (Note: If any of the pickling mixture spilled on the outside top of the bottle, use a wet, clean towel to wipe it off; otherwise, the lids will be difficult to remove.)
7. Using a "Sharpie" place your name or group on the lid.
8. Place the jars in the canner/steamer for 15 minutes. Water in the canner/steamer should be boiling before placing the lid on and water should continue to boil during the process. (showed by steam coming from the small opening on the lower portion of the canner/steamer lid.

9. After 15 minutes, carefully remove the bottles from the canner/steamer using bottle tongs. Place the hot bottles on a hard, non-burnable surface and allow them to cool.
10. Empty the water in the canner/steamer, unless another group is going to use it.

Lab Report Questions

1. Was your pickle processing successful? If not, why?
2. What food science principles are demonstrated by this exercise?

Lab 17: Fermentation

Introduction

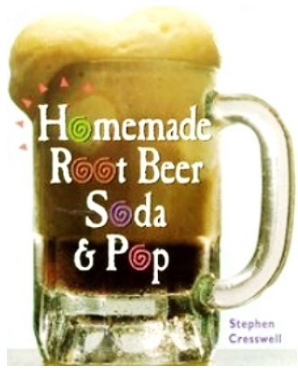
Root beer and soft drinks of many other flavors can be made with commercially available flavorings, sugar, water and yeast. Each batch makes between 4 and 5 gallons. The action of the yeast produces a natural carbonation in the bottle. This natural carbonation will take can take two to three weeks, depending on the yeast and storage temperature.

Materials and Methods

You will need the following materials:

- Root beer extract
- Sugar
- Yeast
- Large spoon for stirring
- 6 to 10-gallon vat for mixing
- Bottles for storing final product
- Tape for labels
- Thermometer for recording water temperature
- Measuring cups and spoons

Follow the instructions on the bottle of root beer extract. Record the following as you make the root beer: quantity of water used, amount of sugar used, amount of yeast, temperature of the water before adding the yeast; and temperature of the final mixture.



Bottle and label the root beer with the date and class period. Store it on a shelf in the classroom. Every other day or so (whatever schedule you determine), taste-test the progress and record. On the date when the root beer is complete (to your satisfaction) refrigerate some of it but allow the yeast to continue acting at room temperature for another 7 to 10 days. Record the taste-test results after the yeast acts for a longer period. Record the room temperature every time you conduct a taste-test.

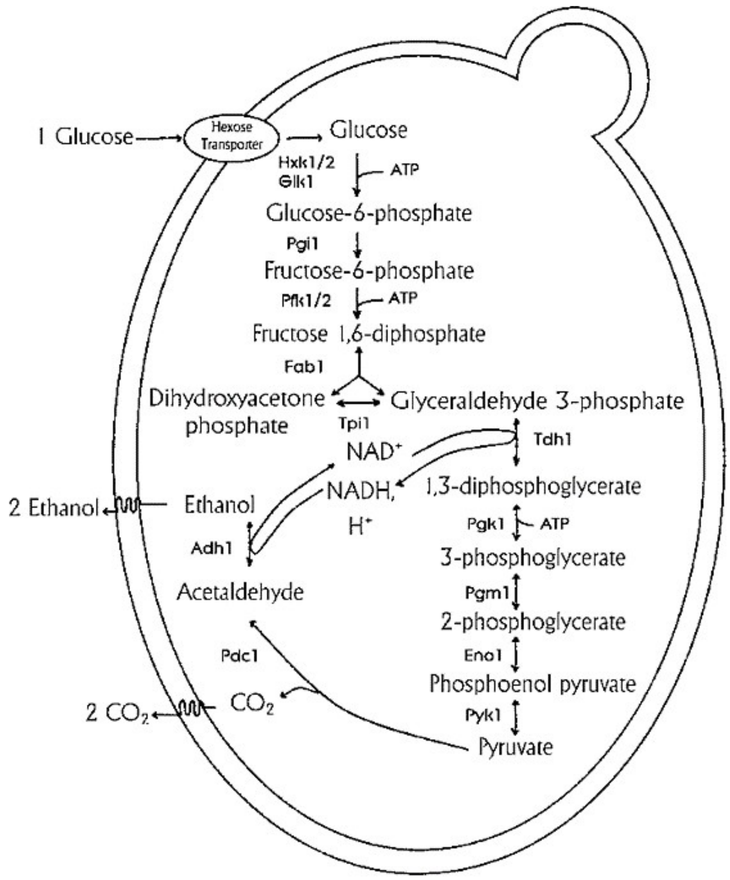
The Science

Fermentation is an enzymatically controlled anaerobic breakdown of an energy-rich compound like a carbohydrate to carbon dioxide (CO_2) and alcohol.

In this case the carbohydrate is sucrose.

First sucrose, a disaccharide, is split into its component monosaccharide's, glucose and fructose.

As the yeast metabolizes the sugar it creates carbon dioxide (CO_2) as one of the end products. The CO_2 creates bubbles in the mix, which carbonates the drink. The complete series of reactions are shown in the diagram to the right.



Requirements for Lab Report

Follow the directions for a standard lab report, being sure to include a discussion of your observations and any of the information that you recorded. Be sure to include these items in your report:

- Describe the action of the yeast on the sugar.
- List the chemical reactions.
- Discuss your taste-test.
- What happens to the yeast when you refrigerate the root beer?
- What is the role of temperature?
- Name three other food production methods that depend on yeast.
- Where does the yeast come from that we use in the food system?
- How is commercial root beetcarbonated?

Lab 18: Making Kimchi/Kimchee

Introduction

Pickling is one of the most ancient forms of preserving food. It involves the microbial conversion of sugars into lactic acid through the growth and activity of acid-forming bacteria known as lactobacilli. As lactobacilli grow, they convert the natural sugars in plant juices into lactic acid. Under the high acidity (=low pH) created by the lactobacilli other food spoiling organisms cannot grow. Lactobacilli are found almost everywhere in our environment and are known as anaerobes because they grow under conditions in which oxygen is lacking. Many foods can be preserved through natural pickling. Some common ones are sauerkraut, yogurt, dill pickles, and silage for cattle. The ancient Chinese and other cultures learned the value of pickling thousands of years ago. Today a spicy pickled Chinese cabbage product known as kimchee is a major part of the diet of Koreans.

Objectives

- Bacteria are involved in the making of some of our foods
- Acid-forming bacteria can live in an acidic environment in which other organisms cannot live
- Release of a gas is a sign that a chemical reaction is taking place
- Acid-forming bacteria (lactobacilli) thrive in oxygen-lacking environments
- Fermentation is the breakdown of sugars in the absence of oxygen (anaerobic) to release energy, producing carbon dioxide and alcohol or lactic acid
- pH scale is a convenient method of expressing the acidity of a solution. (A pH of less than 7 is acidic. The lower the number, the higher the acidity)

Time Required for Fermentation: 7 to 14 days

Materials

This exercise requires the following:

- One two-liter plastic soda bottle
- large lid (92 mm diameter) of a plastic petri plate
- pH indicator paper
- small plastic pipette
- 2 to 3 lbs. of Chinese cabbage (*Brassica rapa*; also called napa or petsai), leaves cut into 5-7 cm chunks. (Do not wash cabbage.)
- 1 hot red chili pepper, chopped (or hot chili powder)
- 2 cloves garlic, thinly sliced or equivalent chopped garlic
- 3 tsp (1 tbsp.) non-iodized (or pickling) salt

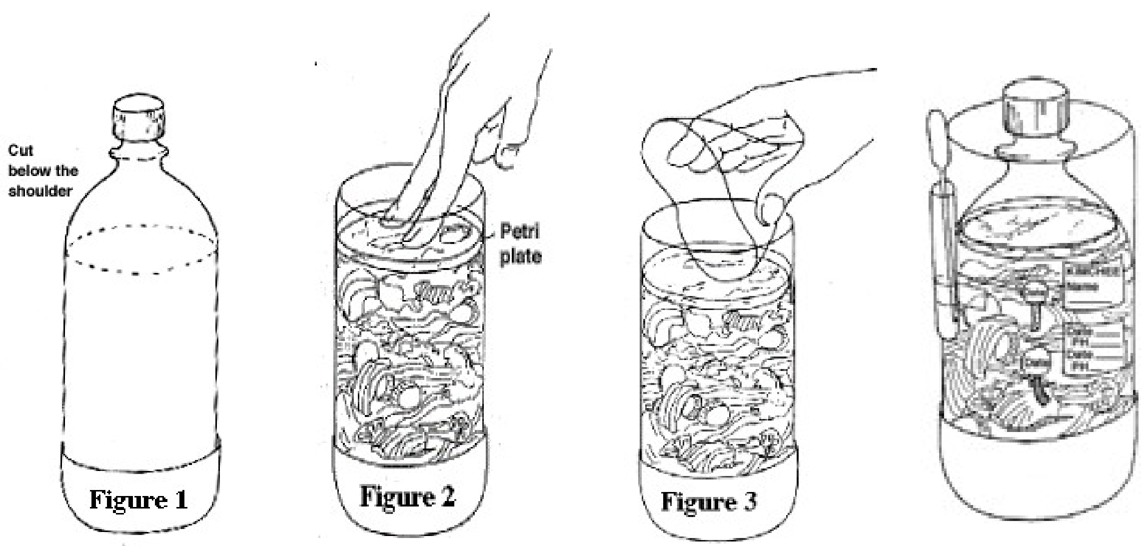
Methods

1. Cut the two-liter soda bottle as indicated in Figure 1. Be sure to cut the top of the bottle just below the shoulder. This top will be used to form the sliding seal.
2. Alternate layers of cabbage, garlic, pepper and a sprinkling of salt in the bottle, pressing each layer down firmly until the bottle is packed full. Notice the aroma of the garlic and pepper. These ingredients flavor the product. Caution: When working with chili pepper, take care not to touch eyes or mouth. Wash hands thoroughly when finished.

3. Place petri lid, rim side up, on top of ingredients and press down again (Figure 2). NOTE: Within a few minutes' liquid begins to appear in bottom of bottle as salt draws liquid from the cells of the Chinesecabbage.
4. Press down occasionally for an hour or two. After that there should be sufficient space to fit the lid cut from the bottle inside the bottle, forming a sliding seal (Figure 3.)
5. Upon pressing firmly with sliding seal, cabbage juice will rise above the petri plate and air will bubble out around the edge of the petri plate.
6. The Chinese cabbage will pack to two-thirds or half the volume of the bottle. Press daily on the sliding seal. Keep the cabbage covered by a layer of juice at all times.
7. Notice bubbles of carbon dioxide (CO_2) gas escape each day when pressed. The gas is produced as lactic acid bacteria grow on the sugary contents of the Chinese cabbage juice in the saltysolution.
8. Measure and record the acidity of the fresh juice on top each day with litmus paper. Tape the indicator paper on the bottle and write the pH (acidity level) above it.
9. Each day take up a quantity of the juice with a plastic pipette and observe the degree of turbidity (cloudiness) representing the growth of lactic acid bacteria in the fermentation solution.
10. Note the increase in turbidity and change in acidity together with the continued production of gas as the pickling proceeds.
11. After a few days to a week or more (depending on the temperature), the pH will have dropped from 6.5 to about 3.5, and yielding kimchee.

Lab Report:

1. How much kimchee did your experiment yield?
2. What was the final pH of your kimchee?
3. Identify other foods preserved byfermentation.
4. Write out the basic chemical reactions in fermentation.
5. As the process began, where did the liquid come from?
6. Why is a sliding seal needed?
7. Describe the taste of thekimchee.



Lab 19 Vinegar Taffy and Invert Sugar

Ingredients

- 2 cups white sugar
- 1/2 cup apple cider vinegar
- 2 tablespoons butter
- 1/8 teaspoon cream of tartar
- 1 pinch salt (a few grains)

Directions

1. In a large saucepan over medium heat, combine sugar, vinegar, butter, cream of tartar and salt. Stir mixture until it begins to boil. Then on medium-high continue to heat, without stirring, until the mixture reaches 270°F. (Use a candy thermometer.) Remove from heat and add food coloring. Stir briefly. Cool in a flat, lightly greased Teflon pan until it can be handled. Fold the edges in so it cools uniformly. (I use a Teflon coated stir-fry pan.)
2. Form the cooled taffy into a ball and begin pulling. Putting cold water on hands and then patting off the excess water before pulling will keep the taffy from sticking to your hands. Pull taffy by stretching with hands, folding the candy over and repeating, until taffy is porous. Just before the taffy becomes too hard to pull, pull it in to one long thin piece about 1/2 thick and lay it on waxed paper. Cut into 1-inch pieces with kitchen shears or a knife. Wrap these pieces with waxed paper.

The Science

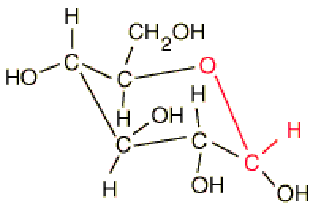
When all the water is boiled off a sugar mixture the sugar melts and breaks down. The more concentrated the sugar syrup becomes the harder the candy will be. To get the proper texture of the taffy it must be boiled for the correct amount of time. Candy makers solved this by dropping a bit of hot syrup into ice water. If the boiling syrup forms an inch or two of thread in the water, it is said to be at the "thread stage." At this point the syrup will cool to nice thick syrup but will not harden. If the boiling syrup forms a soft ball it will harden into a soft but firm candy - like fudge or fondant. If it forms a hard ball or soft crack ball it is perfect for taffy. Overall, the less water there is in syrup, the hotter it can get and the harder the candy will be. The temperatures in the following table list the various stages and their temperature.

Sugar Syrup Temperatures			
Temperature	Term	Description	Use
230-234°F / 110-112°C	Thread	Forms 2-inch threads	Syrup
234-240 °F / 112-115°C	Soft Ball	Ball that flattens	Fondant, fudge, pralines
244-248 °F / 118-120°C	Firm Ball	Ball that hold its shape	Caramels
250-266 °F / 121-130°C	Hard Ball	Ball is hard and firm	Divinity, nougat
270-290°F / 132-143°C	Soft Crack	Hard, pliable threads	Taffy
300-310°F / 149-154°C	Hard Crack	Hard, brittle threads	Brittles, lollipops
320-350°F / 160-177°C	Caramel	Syrup from tan to brown	Flan, caramel cages

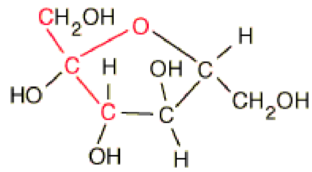
Heat and acid will hydrolyze and invert the sugar to its component monosaccharides – fructose and glucose. This creates changes in the product. Fructose is sweeter. Fructose and glucose are more hygroscopic than sucrose. Cream of tartar, an acid salt, as an added ingredient in a candy formula serves indirectly to decrease the rate of crystallization as well as crystal size. It does this through its ability to hydrolyze sucrose into invert sugar.

Chemical reaction produced by the heat and acid (vinegar) yields an invert sugar by hydrolyzing the sucrose to its component monosaccharides, fructose and glucose.

$C_{12}H_{22}O_{11}$ (sucrose or table sugar) + H_2O (water) -> $C6H_{12}O_6$ (glucose) + $C_6H_{12}O_6$ (fructose)



Glucose

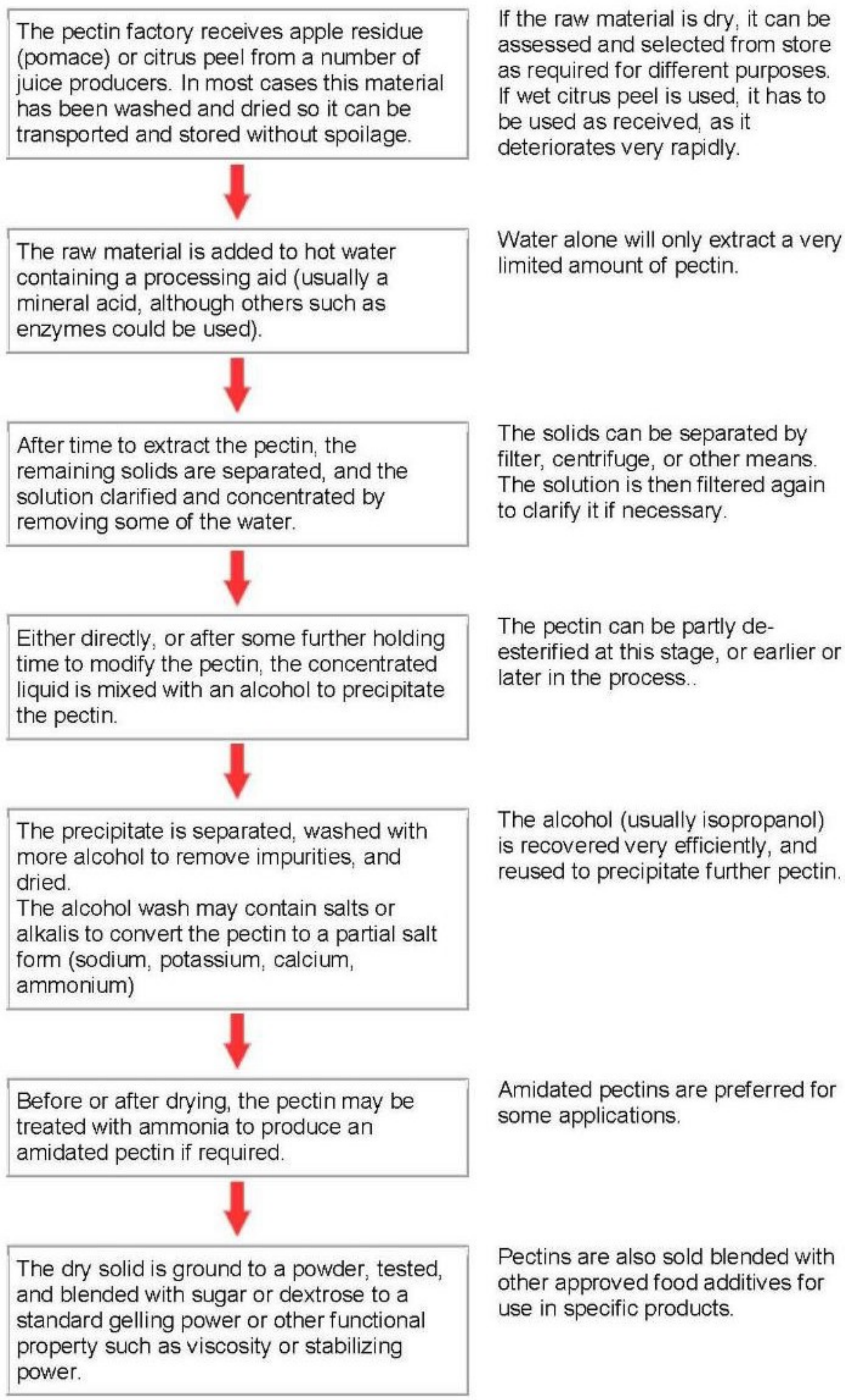


Fructose

Lab 20: Jelly and Jam Making and Pectin

Introduction to Pectin

Process details vary between different companies, but the general process is as follows:



Applications of Pectins

Pectin is one of the most versatile stabilizers available. Its gelling, thickening and stabilizing attributes makes is an essential additive in the production of many food products.

Traditionally, pectin was primarily used in the production of jams and fruit jellies - industrially as well as domestically and in low as well as high sugar products. It secures the desired texture, limits the creation of water/juice on top of the surface as well as an even distribution of fruit in the product. With the change in lifestyle pectin is primarily sold for industrial use. In some European markets it is still sold to the consumers as an integrated component in gelling sugar, though.

Product and application development by the major pectin producers has over the years resulted in a large expansion of the opportunities and applicability of pectin. Pectin is a key stabilizer in many food products.

- Fruit applications:
  - Jams, jellies, and desserts
- Bakery fillings and toppings:
  - Fruit preparations for dairy applications
- Dairy applications:
  - Acidified milk and protein drinks
  - Yoghurts (thickening)
- Confectionery:
  - Fruit jellies
  - Neutral jellies
- Beverages
- Nutritional and Health Products
- Pharmaceutical and Medical Applications

Over the years the positive public connotation of pectin has proven helpful in its widespread use, and this may be a contributing factor to the growing interest in investigating pectin for possible direct health benefits and thus applications in regulated non-food segment as well as in functional foods and nutraceuticals. Pectins also find medical and pharmaceutical applications.

This wide range of applications explains the need for many different types of commercial pectins, which are sold according to their application, for example:

- Rapid Set pectin - traditionally used for jams and marmalades
- Slow Set Pectin - used for jellies and for some jams and preserves, especially using vacuum cooking at lower temperatures. Also, important for higher sugar products like bakery and biscuit jams, sugar confectionery, etc.
- Stabilizing Pectins - used for stabilizing acidic protein products such as yoghurts, whey and soya drinks against heat processing.
- Low methyl ester and amidated pectins - used in a wide range of lower sugar products, reduced sugar preserves, fruit preparations for yoghurts, dessert gels and toppings, and savory applications such as sauces and marinades. Can also be used in low acid high sugar products such as preserves containing low acid fruits (figs, bananas) and confectionery.

Information on pectin was obtained from the International Pectin Producers Association's website: http://www.ippa.info/index.htm.

Making Jams and Jellies

Several recipes for jams and jellies follow. The class will make several of these as directed by the instructor.

Apple Jelly

Materials and Methods

- 1 container (11 1⁄2 ounce) apple juice concentrate (frozen) mixed with 3 cups of water
- 4 1⁄2 cups sugar
- 1 package MCP pectin
- 2 to 3 cinnamon sticks (optional)

Bottle Preparation

Bring boiling-water canner, half full of water, to simmer. Wash jars and screw bands in hot soapy water; rinse with warm water. Pour boiling water over flat lids in saucepan off the heat. Let stand in hot water until ready to use. Drain well before filling. (Recipe makes about 4 pints.)

Jelly Preparation

1. Place mixed apple juice into saucepot.
2. Stir pectin into apple juice mixture in saucepot.
3. Bring mixture to full rolling boil (a boil that doesn't stop bubbling when stirred) on high heat, stirring constantly.
4. Stir in sugar. (If making apple cinnamon jelly break each cinnamon stick into three pieces and add to mixture now.)
5. Return to full rolling boil and boil exactly 3 minutes, stirring constantly.
6. Remove from heat; skim off any foam with metal spoon. Also, if added, remove the cinnamon stick pieces now and discard.
7. Ladle immediately into prepared jars, filling to within 1/4 inch of tops.
8. Wipe jar rims and threads. Cover with two-piece lids. Screw bands tightly. Place jars into steam canner. Cover; bring water to a boil. Process 10 min. Remove jars and place upright on towel to cool completely. After jars cool, check seals by pressing middles of lids with finger. (If lids spring back, lids are not sealed, and refrigeration is necessary.)

Tips

To get exact level cup measures of sugar, spoon sugar into dry metal or plastic measuring cup, then level by scraping excess sugar from top of cup with a straight-edged knife.

At altitudes above 1,000 feet, increase processing time as indicated: 1,001 to 3,000 feet - increase processing time by 5 min.; 3,001 to 6,000 feet - increase processing time by 10 min.; 6,001 to 8,000 feet - increase processing time by 15 min.; 8,001 to 10,000 feet - increase processing time by 20 min.

Grape Jelly from Frozen Concentrate

Materials

- 3-3/4 cups prepared juice
- 1 box MCP Pectin
- 5-1/3 cups sugar, measured into separate bowl

Methods

1. Bring boiling-water canner, half full of water, to simmer. Wash jars and screw bands in hot soapy water; rinse with warm water. Pour boiling water over flat lids in saucepan off the heat. Let stand in hot water until ready to use. Drain well before filling.
2. Mix the thawed grape concentrate with water according to instructions.
3. Measure exactly 3-3/4 cups of the prepared grape juice.
4. Place this into a 6- or 8-qt. saucepot.
5. Stir pectin into prepared juice in saucepot. Bring mixture to full rolling boil (a boil that doesn't stop bubbling when stirred) on high heat, stirring constantly.
6. Stir in sugar. Return to full rolling boil and boil exactly 2 min., stirring constantly. Remove from heat. Skim off any foam with metal spoon.
7. Ladle immediately into prepared jars, filling to within 1/4 inch of tops. Wipe jar rims and threads. Cover with two-piece lids. Screw bands tightly. Place jars into steam canner. Cover; bring water to a boil. Process 10 min. Remove jars and place upright on towel to cool completely. After jars cool, check seals by pressing middles of lids with finger. (If lids spring back, lids are not sealed, refrigeration is necessary.)

Tips

To get exact level cup measures of sugar, spoon sugar into dry metal or plastic measuring cup, then level by scraping excess sugar from top of cup with a straight-edged knife.

At altitudes above 1,000 feet, increase processing time as indicated: 1,001 to 3,000 feet-increase processing time by 5 min.; 3,001 to 6,000 feet-increase processing time by 10 min.; 6,001 to 8,000 feet-increase processing time by 15 min.; 8,001 to 10,000 feet-increase processing time by 20 min.

Mixed Berry Jam

Materials

- 6 cups prepared mixed berry fruit
- 1/4 cup lemon juice (optional)
- 1 box MCP Pectin
- 8-1/2 cups sugar, measured into separate bowl

Methods

1. Bring boiling-water canner, half full of water, to simmer. Wash jars and screw bands in hot soapy water; rinse with warm water. Pour boiling water over flat lids in saucepan off the heat. Let stand in hot water until ready to use. Drain well before filling.

2. Crush berries or briefly place in blender. Measure 6 cup of prepared fruit. Stir in lemon juice. Add to cooking pan.
3. Stir pectin into fruit mixture in saucepot. Bring mixture to full rolling boil (a boil that doesn't stop bubbling when stirred) on high heat, stirring constantly. Stir in sugar. Return to full rolling boil and boil exactly 4 min., stirring constantly. Remove from heat; skim off any foam with metal spoon.
4. Ladle immediately into prepared jars, filling to within 1/4 inch of tops. Wipe jar rims and threads. Cover with two-piece lids. Screw bands tightly. Place jars into steam canner. Cover; bring water to a boil. Process 10 min. Remove jars and place upright on towel to cool completely. After jars cool, check seals by pressing middles of lids with finger. (If lids spring back, lids are not sealed, and refrigeration is necessary.)

Tips

To get exact level cup measures of sugar, spoon sugar into dry metal or plastic measuring cup, then level by scraping excess sugar from top of cup with a straight-edged knife.

At altitudes above 1,000 feet, increase processing time as indicated: 1,001 to 3,000 feet - increase processing time by 5 min.; 3,001 to 6,000 feet - increase processing time by 10 min.; 6,001 to 8,000 feet -increase processing time by 15 min.; 8,001 to 10,000 feet - increase processing time by 20 min.

<u>Peach Jam</u>

Materials

- 4 cups of finely chopped or mashed peaches
- 1/4 cup lemon juice (optional)
- 1 box MCP Pectin
- 6 cups sugar, measured into separate bowl

Methods

1. Bring boiling-water canner, half full of water, to simmer. Wash jars and screw bands in hot soapy water; rinse with warm water. Pour boiling water over flat lids in saucepan off the heat. Let stand in hot water until ready to use. Drain well before filling.
2. Chop the peaches in briefly in blender or use masher. Measure 4 cups of prepared fruit. Stir in lemon juice (optional). Add to cooking pan.
3. Stir pectin into fruit mixture in saucepot. Bring mixture to full rolling boil (a boil that doesn't stop bubbling when stirred) on high heat, stirring constantly. Stir in sugar. Return to full rolling boil and boil exactly 4 min., stirring constantly. Remove from heat; skim off any foam with metal spoon.
4. Ladle immediately into prepared jars, filling to within 1/4 inch of tops. Wipe jar rims and threads. Cover with two-piece lids. Screw bands tightly. Place jars into steam canner. Cover; bring water to a boil. Process 10 min. Remove jars and place upright on towel to cool completely. After jars cool, check seals by pressing middles of lids with finger. (If lids spring back, lids are not sealed, and refrigeration is necessary.)

Tips

To get exact level cup measures of sugar, spoon sugar into dry metal or plastic measuring cup, then level by scraping excess sugar from top of cup with a straight-edged knife.

At altitudes above 1,000 feet, increase processing time as indicated: 1,001 to 3,000 feet - increase processing time by 5 min.; 3,001 to 6,000 feet - increase processing time by 10 min.; 6,001 to 8,000 feet - increase processing time by 15 min.; 8,001 to 10,000 feet - increase processing time by 20 min.

<u>Raspberry Jam</u>

Materials

- 6 cups prepared fruit (crushed and ready to add pectin)
- 1 box MCP Pectin
- 8-1/2 cups sugar, measured into separate bowl

Methods

1. Bring boiling-water canner, half full of water, to simmer. Wash jars and screw bands in hot soapy water; rinse with warm water. Pour boiling water over flat lids in saucepan off the heat. Let stand in hot water until ready to use. Drain well before filling.
2. Raspberry preparation: If using fresh berries, wash and crush raspberries. Measure exactly 6 cups prepared raspberries into 6- or 8-qt. saucepot.
3. Stir pectin into prepared fruit mixture in saucepot. Bring mixture to full rolling boil (a boil that doesn't stop bubbling when stirred) on high heat, stirring constantly. Stir in sugar. <u>If desired, add ½ teaspoon of butter to reduce foaming</u>. Return to full rolling boil and boil exactly 4 min., stirring constantly. Remove from heat. Skim off any foam with metal spoon. Makes about 10 cups.
4. Ladle immediately into prepared jars, filling to within 1/4 inch of tops. Wipe jar rims and threads. Cover with two-piece lids. Screw bands tightly. Place jars into steam canner. Cover; bring water to a boil. Process 10 min. Remove jars and place upright on towel to cool completely. After jars cool, check seals by pressing middles of lids with finger. (If lids spring back, lids are not sealed, and refrigeration is necessary.)

Tips

To get exact level cup measure of sugar, spoon sugar into dry metal or plastic measuring cup, then level by scraping excess sugar from top of cup with a straight-edged knife.

At altitudes above 1,000 feet, increase processing time as indicated: 1,001 to 3,000 feet-increase processing time by 5 min.; 3,001 to 6,000 feet-increase processing time by 10 min.; 6,001 to 8,000 feet-increase processing time by 15 min.; 8,001 to 10,000 feet-increase processing time by 20 min.

Strawberry Jam

Materials

- 5-3/4 cups prepared fruit (crushed and ready to add pectin)
- 1/4 cup fresh lemon juice (optional)
- 1 box MCP Pectin
- 8-1/2 cups sugar, measured into separate bowl

Methods

1. Bring boiling-water canner, half full of water, to simmer. Wash jars and screw bands in hot soapy water; rinse with warm water. Pour boiling water over flat lids in saucepan off the heat. Let stand in hot water until ready to use. Drain well before filling.
2. Strawberry preparation: Wash, stem and crush strawberries thoroughly, one layer at a time or use blender. Measure exactly 5-3/4 cups prepared strawberries into 6- or 8-qt. saucepot.
3. Stir pectin into prepared fruit mixture in saucepot. Bring mixture to full rolling boil (a boil that doesn't stop bubbling when stirred) on high heat, stirring constantly. Stir in sugar. Return to full rolling boil and boil exactly 4 min., stirring constantly. Remove from heat. Skim off any foam with metal spoon. Makes about 11 cups.
4. Ladle immediately into prepared jars, filling to within 1/4 inch of tops. Wipe jar rims and threads. Cover with two-piece lids. Screw bands tightly. Place jars into steam canner. Cover; bring water to a boil. Process 10 min. Remove jars and place upright on towel to cool completely. After jars cool, check seals by pressing middles of lids with finger. (If lids spring back, lids are not sealed, and refrigeration is necessary.)

Tips

How to Measure Precisely

To get exact level cup measure of sugar, spoon sugar into dry metal or plastic measuring cup, then level by scraping excess sugar from top of cup with a straight-edged knife.

At altitudes above 1,000 feet, increase processing time as indicated: 1,001 to 3,000 feet-increase processing time by 5 min.; 3,001 to 6,000 feet-increase processing time by 10 min.; 6,001 to 8,000 feet-increase processing time by 15 min.; 8,001 to 10,000 feet-increase processing time by 20 min.

Describe the common unit operations of food processing used. Clean up!

Requirements for Lab Report

When you write your lab, report follow the standard lab report format and be sure that you discuss or answer the following:

- Identify any failures in your product?
- The taste of your product.
- Describe the value-added concept of your product
- How could (or is) the process be automated?
- How does the pectin cause the juice to form a jelly?
- What are some other uses of pectin?
- How does inverting the bottle seal it?

- Why is it important to have a seal on the bottles?
- Where does pectin come from?
- What is the role of the sugar in the preservation process and in candy-making?
- Where does cinnamon come from?
- What is the nature of the cinnamon flavor and how can the flavor be extracted?
- Taste-test your final product and describe.

Lab 21: The Scientific Method & Taste Test

Introduction

Now that you have had some experiences in the lab for the food system class, the time has come to put your experience to work, or more precisely to put the scientific method to work. But first you need some more introductory material and some background about the scientific method.

First and foremost, agriculture is a science. In fact, it encompasses many sciences. Science can be distinguished from other fields of intellectual endeavor by two main features.

1. It differs in its content or the type of organized knowledge with which it is concerned.
2. It differs in its strictly empirical (practical or experimental) approach to problems.

Science deals only with rational beliefs which can be verified or disproved by observation or experiment.

"Experimental science has one great prerogative...that it investigates its conclusions by experience." ---Roger Bacon (1210-1292)

Often people think of science consisting of collecting and organizing fact. This is only one aspect of science. Far more important is what scientists do with the facts they have. The way in which scientists draw conclusions, generalize, and test predictions form the scientific method. For those seeking to understand science, they need to make a distinction between the content and procedure in science.

Scientific content is the subject matter of science or the generalizations that the scientific community currently recognizes as valid. For example, the Mendelian laws of inheritance, the concepts of natural selection and mutation, hormonal regulation of the estrous cycle represent scientific content. The methods by which such concepts were obtained represent the scientific method.

Learning Objectives

- List six steps in the scientific method
- Form a hypothesis based on observation
- Develop a test for a hypothesis-design an experiment
- Explain the reason for random sampling
- Define: replication, variable and statistics
- Report on the results of an experiment designed to test a hypothesis

Background

The Scientific Method

The popular person-on-the-street concept of scientists and their methods is a poor one. This concept seems to be that the scientist is a person with secret means of obtaining knowledge to benefit humankind. Explanations put forth by research scientists may be wrong as often as they are right. And not all their discoveries directly benefit humans. Indeed, some seem completely useless or detrimental.

The scientific method is a series of six or seven steps. How rigorous scientists follow these steps varies. Here is one list of steps:

1. Observe the problem situation.
2. Form a hypothesis to explain the observed relationships.
3. Build an experiment to test the hypothesis.
4. Accept or reject the hypothesis
5. Develop the general knowledge from accepting or rejecting the hypothesis
6. Apply the general knowledge for decision making and continue to make observations.

Figure 1

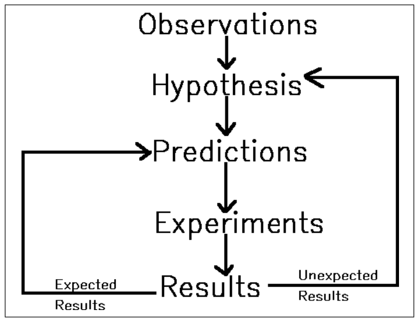


Figure 1 shows the steps and the process in the scientific method. Experimental results are used, when necessary, to modify a hypothesis and to test predictions, but the cycle of testing shown in Figure 1 really never ends.

Some take another view of the scientific method. They say that "science is simply doing one's damnedest with one's mind with no holds barred." This view indicates that the means used by scientists in solving problems are not unique to science. In fact, the scientific method can be used by anyone to solve a variety of problems.

A Hypothesis

Science proceeds by proposing and testing a hypothesis. A hypothesis is simply a tentative explanation---a guess---put forth to account for a set of observations. Sometime hypotheses have been called “educated guesses.”

A hypothesis is a tentative statement or assumption which is made to be tested. To formulate a hypothesis is to make a testable prediction about the relationship between variables. A hypothesis is usually stated before any sensible investigation or experiment is performed because the hypothesis provides guidance to an investigator about the data to collect.

A hypothesis is an expression of what the investigator thinks will be the effect of the manipulated (independent) variable on the responding (dependent) variable. A workable hypothesis is stated in such a way that, upon testing, its credibility can be established or refuted. Hypotheses can usually be formed as an "if...then" statement.

Because it is not possible to prove a hypothesis scientifically, a theorem, scientists frequently phrase their hypothesis as a null hypothesis (H: O), in opposition to an alternative hypothesis (H: A). A null hypothesis is simply a statement of "no difference" between the experimental and control. If there is a difference, we must reject the null hypothesis and accept the alternative. The concept of hypothesis testing is basic to all of science; it is also the most misunderstood by the public. The word "prove" should not exist in the scientist's vocabulary, an infinite number of examples are needed to prove a hypothesis.

No matter how much evidence we gather to support a specific hypothesis, we can never be certain that the same data would not equally support any number of unknown alternative hypotheses. On the other hand, only one piece of evidence is necessary to disprove, and thus reject, a null hypothesis. If we demonstrate that the null hypothesis is invalid, then the alternative must be true.

After forming a hypothesis, a scientist proceeds by designing and performing experiments. The primary purpose of scientific experimentation is to test hypotheses. So, any hypothesis selected by a scientist to explain a natural phenomenon must meet a very important requirement: It must be testable.

Testing Hypotheses

Experiments test hypotheses by testing the correctness of the predictions that can be derived from them. After the hypothesis is formed the prediction can be made in form of an If-then statement. For example: If a bull is homozygous for the polled gene then all his offspring will be polled.

A true hypothesis leads to a true prediction or conclusion. But a false hypothesis may lead to a true or a false conclusion or prediction. Unfortunately, true predictions do not constitute proof of the truth of a hypothesis. The agricultural scientist can never be absolutely certain that the experiment has eliminated all of the variables that might influence the results. A major problem in agricultural research becomes one of experimental design. The agricultural scientist recognizes the impossibility of eliminating all of the variables which might affect the experimental results. Still, scientists try to design experiments to decrease the likelihood that these variables will occur. Statistics are another tool scientist use to deal with the variables that are encountered in an experimental design.

False Hypotheses

In the past, many false hypotheses have been held by scientists and people in general, simply because accurate predictions could be made from these hypotheses despite their falseness. A true hypothesis always gives rise to true predictions so can false hypotheses. For example, acceptance of the belief that the sun orbits the earth lead people to predict that the sun rises on one horizon crosses the sky and sets on the other horizon. And so, it does. The prediction is correct, but this does not mean that the sun orbits the earth! To demonstrate that this hypothesis is false other tests must be devised to show that it gives false predictions.

Agricultural scientists rarely deal with cases in which every prediction made by a hypothesis turns out to be correct. The question then becomes: How many or what proportion of a given number of predictions must be verified to make the hypothesis a useful one? For this reason, experimental data are subjected to a statistical analysis. Here mathematics is used to determine whether deviations from the pattern that is predicted by the hypothesis are significant.

Applied versus Pure Research

In applied research, scientists may use the scientific method for the purpose of developing products to improve human comfort and welfare. In pure or basic research, the scientist searches for knowledge---knowledge for its own sake---regardless of whether the discoveries will benefit humankind. Still, the results of basic research have contributed as much or more than those of applied research. Science by its very nature is productive.

Experimental Design

Experimental design deals with selection of variables to be studied and the choice of a sampling program. It does not deal with experimental techniques used to gather data. The most commonly used experimental design is the two-sample comparison. To do this you select two situations in which all conditions, but one is the same. One situation, usually more "normal" serves as the control and is the basis for comparison. The other situation is the experimental in which you vary the factor of interest. By comparing data obtained from the experimental situation with the control, you can make some conclusions about the effect of the variable you altered on the organism being studied. Be careful, though, to consider other possible explanations.

Bias

A bias is a preconception which can influence your ability to make observations or to interpret data. Try to recognize what your biases might be when designing an experiment, then design your experiment in such a way as to avoid as many biases as possible.

Control

When designing an experiment, you want something to compare your results against - this is the control. When designing your experiment, be sure to keep all variables constant, except the one you are interested in examining**.**

Error

This term has a common usage which is equally applicable in agriculture---making a mistake. In science, however, there are other, more specific definitions. When analyzing the results of an experiment, we are interested in the experimental error--that error due to the specific design of the experiment or the equipment used. For instance, if we are using a thermometer to record temperatures during an experiment, and the instrument was out of calibration, our results will be consistently in error. Another example of experimental error would arise if different members of a group make successive readings of an instrument and they do not read consistently. For instance, one person may misread the meter by not viewing it direct on while another person may round off readings. A third person may interpolate (estimate a fraction between two numbers on the scale) to one additional significant figure, while a fourth may interpolate two additional significant figures. When the data from this group is pooled, there will be an inherent experimental error due to the different instrument reading techniques of the individual group members. Additional errors commonly encountered in biology have to do with statistical testing.

We use statistical tests to help us determine if observed results are sufficiently close to the expected results to be accepted or sufficiently different to be rejected. A type I error is when we reject a null hypothesis when it is true. The probability of making a type I error is the level of significance of a statistical test. A type II error is when we accept a null hypothesis when, in fact, the alternative is true. We can avoid a type I error by making our statistical test more rigorous. But of course, that increases the likelihood of making a type II error!

Precision

Results which are predictable and repeatable are precise, but precise results may or may not be accurate. For instance, if your measuring instrument is not calibrated properly you may get the same result on ten successive measurements, which would be extremely precise, but your results would be inaccurate to the degree that the instrument was out of calibration.

Random

Random means without definite aim, direction, intention, or method; of equal probabilities—in other words, without bias. Random selection is a key assumption of statistical analysis, and as such, is critically important in designing scientific experiments and analyzing data. If one cannot be reasonably certain that samples were obtained in a randomized manner, the results obtained will be questionable. Experimental treatments must be randomized.

In sampling, it is important to decide where, how much and how many samples should be made ahead of time so as not to bias samples, like subconsciously choosing the largest steers for a test. One way to do this is to select steers with a random numbers table.

Sampling

A scientist can rarely collect all of the data about which she wants to draw conclusions. For example, it may be of interest to draw conclusions about the body weight of all 18-year-old males in the United States. The only way to make statements about body weight of these men, with 100% confidence is to weigh each individual - an impossible task. Instead, only some of the total number of 18-year-old males are weighed and we infer from the results the total weights of all the individuals of interest. The men who are weighed are a statistical sample of the population.

The key to having a sample accurately represent the population is to obtain a random sample. Random sampling implies that each individual in the population has an equal chance of being selects as part of the sample, that is, there is no bias for or against any individuals being sampled. If samples are taken at random from a population, valid conclusions may be drawn about that population from a small sample - with a known chance of error. We can control the amount of error by varying the size of the sample. In general, it is understood that the smaller the sample the larger the chance of error; and the larger the sample the smaller the chance of error.

A random number table is useful in obtaining random samples. Decide ahead of time how you will use the table, for example, read the last three digits down a row or the first three digits across line, etc., then enter the table at a random point and begin to sample. A randomly selected number could represent an individual in a row of plantings, number of feet from a starting point, number of measurements taken of a dimension, and so on.

Replication

A single measurement is not adequate to draw conclusions about a population. This is because it is not possible to know how reliably a character was measured. Repeated measurements may vary greatly, especially if made by different people. Therefore, a series of repeated measurements, or replicate measurements, should be taken. From the collection of replicates, the mean and standard deviation will provide an estimate for the whole population. There are techniques to determine how many replicates are needed to achieve a certain level of reliability. Generally, three is a minimum number.

Statistics

Statistics are important to scientists for three reasons:

1. Allow data to be quantitatively described and summarized
2. Allow generalized conclusions to be drawn based on relatively small sets of data
3. Differences and relationships between sets of data can be objectively analyzed

Variable

A variable is any factor in a situation that may change or vary. Investigators in science and other disciplines try to determine what variables influence the behavior of a system by manipulating one variable, called the independent variable and measuring its effect on another variable, called the dependent variable. As this is done, all other variables are held constant. If there is a change in only one variable and an effect is produced on another variable, then you can conclude that the effect has been brought about by the changes in the manipulated (independent) variable. If more than one variable changes, there can be no certainly at all about which of the changing variables causes the effect on the responding variable.

In a scientific investigation, measurements of the variables are made; however, you, the investigator, must decide how to measure each variable. An operational definition of a variable is a definition you determine for the purpose of measuring the variable during an investigation. Thus, different operational definitions of the same variable may be used by different investigators.

Descriptive Statistics

Living things are, by their nature, variable; a single individual, population, community etc. will not be the same as any other. To describe any group of living things, statistics, descriptive measures derived from sample data, must be computed. One of the most common descriptive statistics is the mean, or average. The magnitude of the variation between means is inversely proportional to the sample size. That is, the larger the sample size, the more precise the estimate of the population mean. Large samples generally give better results than small samples!

Note: You can learn more about the mean, mode, median, standard error and standard deviation in the “Introduction to Statistics” laboratory handout.

Comparing Two Means

Frequently two means of two samples need to be compared to draw conclusions about similarities or differences. For instance, are the results of a particular experimental treatment significantly different from the control? In some cases, the difference may be very large and obvious, but in other cases the means and variances may be quite similar, and an objective method is required to determine the degree of difference or similarity.

Student's t-test is commonly used to compare two means where the null hypothesis is that the means are the same.

Limitations of Science

Science is one of humankind's most productive ways of exploring, exploiting, and trying to understand the environment. It is by no means the only way. Historians have their way, theologians their way and philosophers have their way. Despite the many contributions science has made to human's intellectual growth, as well as to health and general welfare, science does have limitations.

Oddly, one limitation comes from one of its greatest attributes. As the philosopher George Boas points out---

"...what science wants is a rational universe, by which I mean a universe in which the reason has supremacy over both our perceptions and our emotions."

Science deals only with that set of phenomena which can be directly or indirectly be experienced through human's senses and placed into an experimental situation. This excludes from that set of phenomena which do not have these qualifications. Experimental science can only attempt to explain how a natural phenomenon may occur, and hypothesize its causes.
Scientists can only speculate why these phenomena occur.

The unemotional basis of science is another strength and weakness. Science is necessarily objective and detached from emotional prejudice. To keep its basic nature and succeed in dealing with contemporary problems, experimental science must remain objective and detached.

Despite the logical basis of science, it would wrong to give the impression that scientists are never wrong. Nothing could be further from the truth. The astronomer Johannes Kepler once wrote---

"How many detours I had to make, along how many walls I had to grope in the darkness of my ignorance until I found the door which lets in the light of truth."

Scientists do not always reason correctly. In fact, scientists are known for "going off the deep end," particularly when writing in areas other than their own specialty. True too, if scientists can be wrong so too can science. The strength of science does not lie in its infallibility. Nor does it lie in its logical basis, for the conclusions of a perfectly logical argument can be pure nonsense.

Science is a tradition of beliefs that have rational foundations, subject to continual review and discussion. Science is separate from the scientists. As an individual the scientist is only a human being, with all the emotions and weaknesses that come with being human.

In science, truth is a well-supported hypothesis. *Hypotheses are supported by experimentation but not proved.*

Materials

- Team members (3 to 4 class members)
- Paper and pencils for notes
- Time to brainstorm
- Other materials will be determined by the experiment you design

Procedures

1. Meet as a group and brainstorm ideas for conducting a scientific investigation of the food system; for example, list observations or ideas that are popular in the press or some concepts that seem to be cultural observations.
2. Develop a hypothesis and state it as a null hypothesis
3. Design an experiment (keep it simple) to test your hypothesis
4. Decide what items you will need to conduct your experiment
5. Determine the data you will collect and how you will present/analyze the data
6. Have your experiment approved by the instructor
7. Determine a timeline for conducting your experiment
8. Submit the timeline to your instructor and have it approved

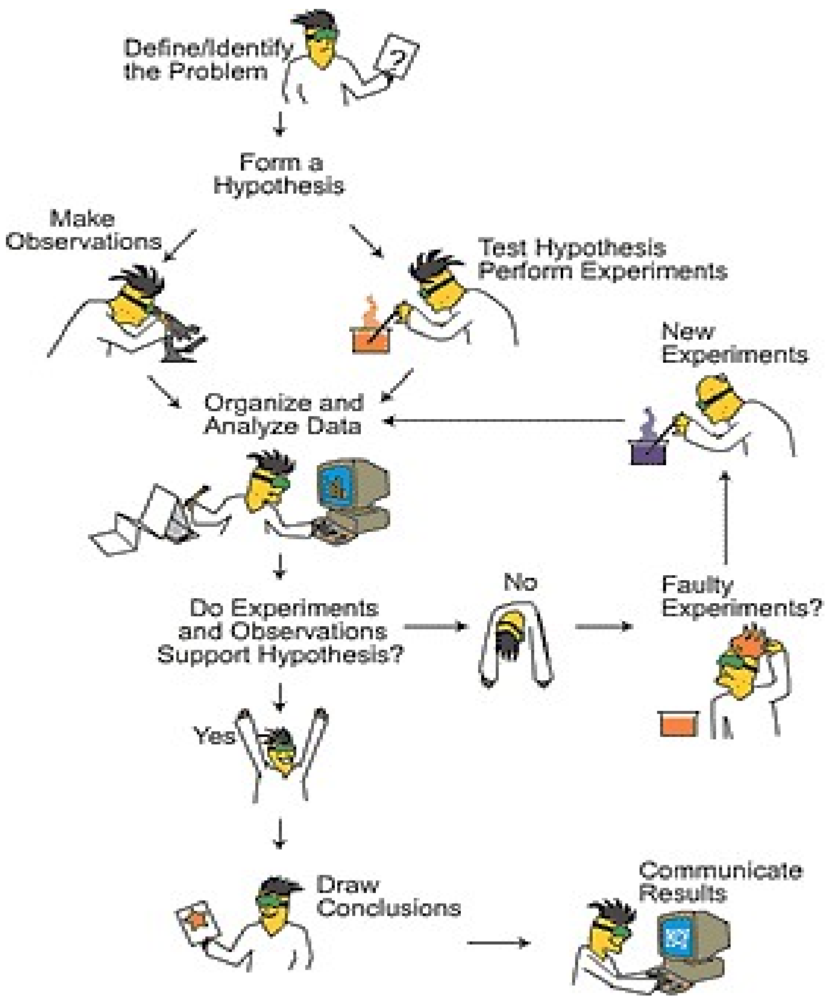
9. Conduct your experiment keeping in mind randomizing your experiment and the importance of replication
10. Decide whether to accept or reject your hypothesis
11. Report on your experiment and the results in your lab report

Results and Discussion

Write up you the results of your taste test in a lab report. Use the information you developed during the Procedures part of this lab and answer these questions in your lab report:

1. What is a hypothesis?
2. What control measures did youtake?
3. Why is randomness important in an experiment?
4. How manyreplications did you do?
5. What descriptive statistics did you use to summarize your results? What errors occurred during your experiment? Remember: Read this entire laboratory handout. The ideas and information will help you write a better lab report and will expand your understanding of the scientific method.

<u>Summary of Scientific Method</u>



Lab 22: Surveying Consumer Concerns

Introduction

In this laboratory exercise you will collect data using a questionnaire, and then you will summarize the data. You will draw conclusions as to how people feel about a controversial topic in the food system.

Before the end of the nineteenth century, the vast majority of people in the United States lived in rural areas and produced and processed most of the food they ate. The only product that most people see is the finished product in the grocery store. Most consumers have no idea how their food was processed or what ingredients went into the product.

U.S. consumers want a food product that safe, high quality and relatively inexpensive. However, most modern techniques are not understood by the public. As technology increases and new discoveries help growers produce more efficiently, concerns are raised among consumers as to the safety and wholesomeness of theirfood.

For some reason foods produced with a more advanced technology are less desirable to the consumer. The genetically modified (GM) foods appear to fall into this category, at least for some consumers. Genetically modified organisms (GMOs) have been developed from advanced biotechnology to achieve certain desirable traits in agricultural production such as weed and pest resistance. Unfortunately, without direct tangible benefits to the consumer, the foods produced with GMO ingredients may be perceived as being inferior or unsafe to their non-GM counterparts. There have been concerns about the consumer's acceptance of GM foods in many countries of the world such as those in the European Union (EU) and Japan, as no food manufacturers have dared to test the markets with specifically labeled GM foods under the mandatory labeling regulations.

Regardless of science behind GM foods and GMO's they have become very political, social, and emotional issues. Be aware of this as you survey people. Don't let your feelings and opinion affect the person you are interviewing.

Learning Objectives

- Describe how organizations determine consumer concerns with various phases of the food system.
- Describe the use of survey techniques to determine public opinion.
- Demonstrate the use of research data to draw conclusions by using statistics to summarize the results of a survey

Materials

No special equipment is necessary for this laboratory exercise.

Table 1. Survey of Attitudes Surrounding Genetically Modified Organisms (GMO) Data Sheet

Note: A hard copy of the data collection sheet will be provided by the instructor.

Table 1. **Survey of Attitudes Surrounding Genetically Modified Organisms (GMO) Data Sheet**

Question	Individual Survey				
	#1	#2	#3	#4	#5
1. Genetic engineering will greatly improve the health of animals and humans.					
2. Genetically Modified Organisms (GMOs) are generally safe for humans.					
3. Use of genetic engineering and biotechnology should create a new type of agriculture.					
4. I am willing to consume GM foods.					
5. GM foods do not pose a health risk.					
6. GM foods must be labeled as such.					
7. GM crops should be developed if they reduce the use of pesticides.					
8. By eating GM foods, a person's genes could be altered.					
9. I consider myself well-informed on the issues of GM crops, animals and foods.					
10. The creation of GM crops and livestock can help solve world hunger.					
11. GM crops pose a potential environmental hazard.					
12. Genetic engineering of our foods represents large corporations' attempt to "own" and control the genetic code for crops.					
13. I understand the science of GMOs.					
14. Concerns about GM products represent media hype.					
15. I have eaten a genetically modified food.					
16. I eat organically produced food because it is safer and healthier.					

Procedures

1. Review the questionnaire in Table 1. Make sure you understand each question.
2. Ask 15 members of the community to participate in a survey using the questions in Table 1. Tell them that it will take no more than five minutes. (Remember the importance of randomness and non-bias in yourselection.)
3. Read each question aloud to the participants and ask them to rank the item on a continuum of 1 through 5 as to whether they strongly disagree (1) or strongly agree (5). Specifically-
   1 = strongly disagree
   2 = disagree
   3 = no opinion
   4 = agree
   5 = strongly agree
4. Record their responses in the boxes on Table 1.
5. As you conduct the survey frequently remind people of the meaning of the 1 through 5 scales. Often people confuse 1 and 5 so this could drastically affect your results.
6. For each row (each question) calculate the mean, mode and standard deviation (SD). Your instructor will help you with the standard deviation.
7. As you survey people make notes of any of their comments that might also reflect their attitude. Summarize these notes in your laboratory report.
8. Complete the items in the Results and Discussion section.

Results and Discussion

Use these questions to develop your lab report:

1. Follow the guidelines provided for all laboratory reports.
2. Briefly outline what you learned about the consumer and the acceptance of GM food, livestock, and crops based on the results of your survey.
3. You will add your data to a common spreadsheet in “the cloud” and it will be analyzed as a class. The link to this spreadsheet will be emailed to you.
4. After adding your data to the common spreadsheet, you will turn in your handwritten data collection sheet with a brief summary of your interview sample; for example: all co-workers; mix of students of varying ages and those in my art class, or family members ages x to x and co-workers.
5. Use the mean (average), mode and SD of the responses to draw conclusions about how consumers feel about GM foods. Write a paragraph about your conclusions in your lab report. Include any comments or observations you made while conducting the survey.
6. Present summarized data in a graph, chart, or table form in your laboratory report. You decide which type of chart or graph to use.
7. Remember to make notes of comments made by those you survey.

Lab 23: HACCP Activity

Introduction

The Hazard Analysis and Critical Control Point (HACCP) system, which is science based and systematic, identifies specific hazards and measures for their control to ensure the safety of food (and quality). HACCP is a tool to assess hazards and establish control systems that focus on prevention rather than relying mainly on end-product testing. Any HACCP system is capable of accommodating change, such as advances in equipment design, processing procedures or technological developments.

HACCP can be applied throughout the food chain from primary production to final consumption and its implementation should be guided by scientific evidence of risks to human health. As well as enhancing food safety, implementation of HACCP can provide other significant benefits. In addition, the application of HACCP systems can aid inspection by regulatory authorities and promote international trade by increasing confidence in food safety.

The successful application of HACCP requires the full commitment and involvement of management and the work force. It also requires a multidisciplinary approach; this multidisciplinary approach should include, when appropriate, expertise in agronomy, veterinary health, production, microbiology, medicine, public health, food technology, environmental health, chemistry and engineering, according to the particular study. The application of HACCP is compatible with the implementation of quality management systems. While the application of HACCP to food safety was considered here, the concept can be applied to other aspects of food quality.

Objectives

Working in teams, complete the Process Steps and the Critical Control Points (CCPs) for one of the food products developed in this class.

Methods

1. Select the food product: ______________________
2. List team members:

   ____

   ____
3. Use the tables on pages 2 and 3 to guide the development of this activity.

Definitions

Control measure: Any action and activity that can be used to prevent or eliminate a food safety hazard or reduce it to an acceptable level.

Corrective action: Any action to be taken when the results of monitoring at the CCP indicate a loss of control.

Critical Control Point (CCP): A step at which control can be applied and is essential to prevent or eliminate a food safety hazard or reduce it to an acceptable level.

Critical limit: A criterion which separates acceptability from unacceptability.

Hazard: A biological, chemical or physical agent in, or condition of, food with the potential to cause an adverse health effect or product quality.

Validation: Obtaining evidence that the elements of the HACCP plan are effective.

Verification: The application of methods, procedures, tests and other evaluations, in addition to monitoring to determine compliance with the HACCP plan.

Hazard Analysis Table

Process Step					
Processing steps	**Potential hazard: (C) chemical (P) physical (B) biological**	**Is this potential Food safety hazard significant?**	**Justification of decision**	**Preventative measures**	**Is this step a Critical Control Point (CCP)?**

Reminder of the Seven Principles of HACCP

- **PRINCIPLE 1**: Conduct a hazard analysis.
- **PRINCIPLE 2**: Determine the Critical Control Points (CCPs).
- **PRINCIPLE 3**: Establish critical limit(s).
- **PRINCIPLE 4**: Establish a system to monitor control of the CCP.
- **PRINCIPLE 5**: Establish the corrective action to be taken when monitoring indicates that a particular CCP is not under control.
- **PRINCIPLE 6**: Establish procedures for verification to confirm that the HACCP system is working effectively.
- **PRINCIPLE 7**: Establish documentation concerning all procedures and records appropriate to these principles and their application.

Critical Control Points (CCP)

CCP	Hazard description	Critical limits for each control measure	Monitoring				Corrective action	Verification activities	Record-keeping procedures
			What	How	Frequency	Who			

The remainder of HACCP is to develop a record-keeping system of logs and corrective actions that verify and track the Critical Control Points during the processing steps. Images of sample logs are on the next pages.

Sample Logs and Record-Keeping

5. Corrective Action Log

Corrective Action Log	
Product:	**Lot ID:**
Date / Time	Designated Food Worker:
Deviation:	
Cause of Deviation:	
Cause of Deviation Eliminated By:	
CCP Under Control After Corrective Actions Taken:	
Preventative Measures:	
Product Disposition:	

Verification (Records Review) by and Date: ______________________

4. Thermometer Calibration Log

Date	Time	Test Thermometer ID#	Reference Thermometer Reading	Test Thermometer Reading	Adjustments Required (Yes / No)	Corrective Action	Initials

Verification (Records Review) by and Date: ______________________

Instructions: Foodservice workers will record the calibration temperature and corrective action taken each time thermometer is calibrated. The supervisor of the food operation will verify that foodservice employees are using and calibrating thermometers properly by making visual observations of employee activities during all hours of operation. The supervisor of the operation will review and initial the log daily. This log should be maintained for a minimum of 90 days after the food has been consumed.
Thermometers intended for measuring hot temperature items, such as cooked product, will be calibrated in hot water, while those used for taking lower temperatures will be calibrated in ice water. All thermometers will be calibrated within + or – 2 degrees F.

10. Damaged or Discarded Product Log

Damaged or Discarded Product Log							
Date	Time	Vendor or Supplier	Product Name	Temperature	Corrective Action Taken	Initials/Date	Manager Initials/Date

Instructions: Designated food worker will record product name, quantity, action taken, reason, initials, and date each time a food or food product is damaged and/or will be discarded. The supervisor the food operation will verify that food workers are discarding damaged food properly by visually monitoring foodservice workers during the shift and reviewing, initialing, and dating this log daily. The Damaged or Discarded Product Log should be maintained for a minimum of 90 days after the food has been consumed.

9. Cooling Temperature Log

Cooling Temperature Log										
Date	Food Item	Time / Temp	Time / Temp	Time / Temp	Time / Temp	Time / Temp	Time / Temp	Corrective Actions Taken	Initials	Verified By / Date

Instructions: Record temperatures every hour during the cooling cycle. Record corrective actions, if applicable. If no foods are cooled on any working day, indicate "No Foods Cooled" in the Food Item column. The supervisor of the food operation will verify that the designated food worker is cooling food properly by visually monitoring the food worker during the shift and reviewing, initialing, and dating the log daily. The Cooling Log should be kept for a minimum of 1 year.

8. Receiving Log

Receiving Log (Transporting)							
Date	Time	Vendor or Supplier	Product Name	Temperature (°F)	Corrective Action Taken	Initials/Date	Manager Initials/Date

Instructions: Use this Log for deliveries or receiving foods from suppliers. Record any temperatures and corrective action taken on the Receiving Log. The supervisor of the food operation will verify that foodservice workers are receiving products using the proper procedure by visually monitoring foodservice workers during the shift and reviewing the log daily. The Receiving log should be maintained for a minimum of 90 days after the food has been consumed.

Lab 24: Food Packaging and Labels Laboratory Activity

Requirements for Packaging

A modern food package has many functions, its main purpose being to physically protect the product during transport. The package also acts as a barrier against potential spoilage agents, which vary with the food product. Milk is sensitive to light, so a package that provides a light barrier is necessary. Other foods like potato chips are sensitive to air because the oxygen in the air causes rancidity. The bags containing potato chips are made of materials with oxygen-barrier properties. Practically all foods should be protected from filth, microorganisms, moisture, and objectionable odors. Consumers rely on the package to offer that protection.

Aside from protecting the food, the package serves as a vehicle through which the manufacturer can communicate with the consumer. Nutritional information, ingredients and often recipes are found on a food label. The package is also used as a marketing tool designed to attract your attention. This makes printability an important property of a package.

Types of Containers

Food packaging can be divided into three general types:

1. Primary
2. Secondary
3. Tertiary

Primary containers come in direct contact with the food. A secondary container is an outer box or wrap that holds several primary containers together. Tertiary containers group several secondary holders together into shipping units.

Many containers used in the food industry are part of form-fill-seal packaging. Containers may be pre-formed at another site and then filled at the processing plant. Or, containers may be formed in the production line just ahead of the filling operation. This is called form-fill-seal and it is one of the most efficient ways to package food.

To protect the food against exchange of gases and vapors, and contamination from bacteria, yeasts, molds, and dirt, containers are hermetically sealed. The most common hermetic containers are cans and glass bottles.

Packaging Materials

The food industry uses four basic packaging materials: metal, plant matter (paper and wood), glass, and plastic. Many basic packaging materials are often combined to give a suitable package. The fruit drink box is another case in point where plastic, paper, and metal are combined in a laminate to give an ideal package;

Environmental Considerations

Packaging waste can adversely affect the environment. Recycling is a sound approach. However, the problem often lies in feasibility of collection, separation, and purification of the consumer's disposed food packages. This mode of recycling is called post-consumer recycling. While it offers a logistic challenge, recycling is gaining in popularity, and the packaging industry is cooperating in that effort. Aluminum cans are the most recycled container at this time. Plastic recycling is increasing, yet most plastic is recycled during manufacturing of the containers—not as post-consumer recycling. Trimmings from plastic bottles are re-ground and reprocessed into new ones.

The plastics industry facilitates consumer recycling by identifying the type of plastic from which the container is made. A number from 1 to 7 is placed within the recycling logo on the container's bottom. One (1) refers to PET (Polyethylene Terephthalate), the plastic used for the large 2-liter soft drink bottles. Plastics have the advantage of being light. This helps to conserve fuel during transport and also reduces the am ount of package waste. For a description of the plastic types refer to Table 1.

Table 1. Plastic Resin Codes

No.	Image	Unicode	Alternate images	Abbr.	Polymer Name	Uses	Recycling
1		U+2673		PETE or PET	Polyethylene terephthalate	Polyester fibers (Polar Fleece), thermoformed sheet, strapping, soft drink bottles, tote bags, furniture, carpet, paneling and (occasionally) new containers.	Picked up through most curbside recycling programs.
2		U+2674		HDPE	High-density polyethylene	Bottles, grocery bags, milk jugs, recycling bins, agricultural pipe, base cups, car stops, playground equipment, and plastic lumber	Picked up through most curbside recycling programs, although some allow only those containers with necks.
3		U+2675		PVC or V	Polyvinyl chloride	Pipe, fencing, shower curtains, lawn chairs, non-food bottles and children's toys.	Rarely recycled; accepted by some plastic lumber makers.
4		U+2676		LDPE	Low-density polyethylene	Plastic bags, 6 pack rings, various containers, dispensing bottles, wash bottles, tubing, and various molded laboratory equipment	LDPE is not often recycled through curbside programs, but some communities will accept it. Plastic shopping bags can be returned to many stores for recycling.
5		U+2677		PP	Polypropylene	Auto parts, industrial fibers, food containers, and dishware	Number 5 plastics can be recycled through some curbside programs.
6		U+2678		PS	Polystyrene	Desk accessories, cafeteria trays, plastic utensils, toys, video cassettes and cases, clamshell containers, packaging peanuts, and insulation board and other expanded polystyrene products (e.g., Styrofoam).	Number 6 plastics can be recycled through some curbside programs.
7		U+2679		OTHER or O	Other plastics, such as acrylic, nylon, poly carbonate, and polylactic acid (abioplastic), and multilayer combinations of different plastics	Bottles, plastic lumber applications, Headlight lenses, and safety shields/glasses.	Number 7 plastics have not been recycled, but some curbside programs now take them.

Class Activity

Using some of the food packaging available in the classroom, determine the following:

- The types of packaging – primary, secondary, tertiary
- Packaging material construction; “dissect” the packaging material and determine layers and linings
- For plastics, determine the type of plastic being used
- Purposes of the packaging material, including artwork
- What does the packaging say about recycling?
- Describe the nutritional information on the package – fats, sugars, carbohydrates, vitamins, minerals, etc.
- Describe the ingredients and their purpose; for example, which ones are preservatives, antioxidants, flavoring agents, sweeteners, emulsifiers, stabilizers, thickeners, leavening agents, anticaking agents, humectants, coloring agents, bleaches, acids, bases, buffers and nutrients?
- What health claims are made on the package?

Food Labeling

Under regulations from the Food and Drug Administration of the Department of Health and Human Services and the Food Safety and Inspection Service of the U.S. Department of Agriculture, the food label offers more complete, useful, and accurate nutrition information than ever before.

The purpose of the food label reform was to clear up confusion that has prevailed on supermarket shelves for years, to help consumers choose more healthful diets, and to offer an incentive to food companies to improve the nutritional qualities of their products. Key features of the new regulations include:

- Nutrition labeling for almost all foods
- A distinctive, easy-to-read format
- Information on the amount per serving of saturated fat, cholesterol, dietary fiber, and other nutrients of major health concern to consumers
- Nutrient reference values, expressed as Percentage (%) Daily Values
- Uniform definitions for terms that describe a food's nutrient content-such as "light," "low-fat," and "high-fiber"
- Claims about the relationship between a nutrient or food and a disease or health-related condition
- Standardized serving sizes
- Declaration of total percentage of juice in juice drinks
- Voluntary nutrition information for many raw foods

These and other changes are part of final rules published in the Federal Register in 1992 and 1993. FDA's rules implement the provisions of the Nutrition Labeling and Education Act of 1990 (NLEA), which requires nutrition labeling for most foods (except meat and poultry) and authorizes the use of nutrient content claims and appropriate FDA-approved health claims. Meat and poultry products regulated by USDA are not covered by NLEA. However, USDA's regulations closely parallel FDA's rules.

Words Describing the Nutrient Content

The regulations also spell out what terms may be used to describe the level of a nutrient in a food and how they can be used. These are the core terms:

- Free Low (lo)
- Lean and extra lean
- High (hi)
- Good source
- Reduced less light
- Fresh Healthy

Health Claims

Claims for relationships between a nutrient or a food and the risk of a disease or health-related condition are now allowed. They can be made in several ways: through third-party references, such as the National Cancer Institute; statements; symbols, such as a heart; and vignettes or descriptions. The claim must meet the requirements for authorized health claims.

Notes

Lab 25: Diversity in the Food System

Introduction

U.S. cooking is as diverse as its population. Because the American cookpot contains a blend of cuisines from many countries, the term "American cooking" loosely defines a collection of traditional dishes that have gained popularity across the country.

There's no shared definition of traditional American cooking, but simple dishes like roast beef, fried chicken, grilled steak, stuffed turkey, meatloaf, corn on the cob, potato salad, apple pie, clam chowder, hamburgers, hotdogs and hot chicken wings would be on most lists.

Cuisine in different parts of the United States developed independently. Each region was influenced by the nationality of colonists that settled in the area and by the ingredients locally available.

New England, the northeastern part of the nation, is renowned for hearty dishes imported by British colonists and for its cold-water seafood harvested locally. This is the land of Yankee pot roast and Boston baked beans. When visiting New England, sample the seafood and be sure to try New England clam chowder and Maine lobster.

Southeastern states are home to "down home southern cooking," characterized by farm-style cooking with plenty of deep fried foods, heavy sauces and sweet desserts. Elvis Presley loved southern cooking, and it was reflected in his growing waistline. Deep-fried chicken, known as southern-fried chicken, and chicken-fried steak, a deep-fried beef cutlet, are often served with a thick white sauce called home-style gravy.

Southerners love barbeque, but unlike westerners, they do not favor sweet tomato-based sauces. Eastern barbeque usually means pork, especially pork ribs, well spiced or marinated and slowly cooked over glowing coals. Greens, black-eyed peas and corn bread are common side dishes. Pecan pie, peach cobbler, banana pudding and sweet potato pie are some favorite desserts.

New Orleans has a distinctly European culture with its own unique cuisine. This city at the mouth of the great Mississippi River was influenced by Spanish and French colonists and by the many African immigrants. It developed some of the finest cuisine in the USA.

The city's Creole and Cajun cuisine is a mixture of Spanish and French cooking spiced with African and West Indian flavors. Blackened fish and steaks are grilled with coatings of pepper and hot spices. Jambalaya and gumbo are flavored stews of meats, sausage and seafood. Much Cajun cooking is highly spiced with hot pepper and chili, but not all of the dishes are fiery. Traditional Spanish and French cooking and local variations of them are available in many fine restaurants throughout the city.

Cuisine in the southwestern states has been influenced by American Indians, early Spanish settlers and the United States' Mexican neighbors. Southwestern cuisine includes a wide variety of dishes prepared with local ingredients and liberally sprinkled with Mexican spices. Southwestern restaurants create some interesting variations of familiar dishes by the creative use of unfamiliar ingredients and exotic spices.

Tex-Mex is a variant of southwestern cooking that is most popular in Texas and along the Mexican border. It includes barbeque and chili. These cowboy-inspired dishes are so popular in the southwest and across the nation that many places have annual chili festivals and barbeque cook-offs with prizes for the best recipes. It is also the home of salsa, nachos, tacos and burritos.

California is blessed with a bountiful supply of fresh fruits, vegetables and seafood in all seasons. Its ethnically diverse population has developed a refreshingly healthy cuisine that uses fresh ingredients flavored with unusual combinations of spices.

Fresh green salads topped with avocados and citrus fruits might be served with Asian spiced peanut sauce. Fish could be lightly grilled in salsa and served with Chinese vegetables and Native American fry bread. Almost any combination of ethnic food styles can be combined in California cooking. This is the home of avant-garde, experimental cuisine.

Source: http://iipdigital.usembassy.gov/

Learning Objectives

- Recognize the diversity of the foods available in our food system.
- Identify uncommon foods in local food system
- Taste a newfood

Materials

- Five dollars for eachteam
- Plates or cups forsamples

Procedures

1. As a team go to a food market (regular or ethnic).
2. Use your team funds to purchase one item that represents a unique food item that most students have probably nevereaten.
3. Return to class with your food item
4. Describe it to theclass
5. Prepare samples for all of the class to taste
6. Taste samples from otherteams
7. Record the reactions to your food sample and your reactions to the other food samples.

Results and Discussion

1. Follow the guidelines provided for all laboratory reports.
2. Briefly outline what you learned about the consumers and new foods
3. Describe the reactions to new foods by classmates
4. Discuss some reasons that food is acceptable or not acceptable to individuals

Lab 26: Capstone Project and Presentation of the Science in Food Systems

Introduction

The final lab for Food Systems Science, is a capstone project to reinforce the knowledge gained during the semester. A capstone project is a multifaceted assignment that serves as a culminating educational experience. This will include the requirement for presentation that is described in your syllabus.

Supplies

- Samples of one of the food products made during one of the Food Systems Science labs
- Trays/plates and utensils fordisplaying and serving samples
- One-page printout of poster describing the science and technology to produce the product being displayed

Procedure

During the semester a number of food products have been made in lab. For the final lab you and another class member will choose one of the food products and prepare it for a "Taste of Food Systems Science" where samples of the product will be presented to invited guests. Samples of your food product will be on display and available for tasting by all who attend this event. (School administrators and some community members will be invited.)

During the "tasting" time, you and your teammate will use a poster that you have prepared to explain the science and the technology involved in the production of your food product. You will be given three minutes to explain your poster to the group. Your presentation and your poster will be graded using a rubric supplied to the class mid-semester.

WARNING: Photos will be taken, and community members will be in attendance – look your best!