FOOD FIGHT!

Product Development in the Science Classroom

Authors:

Amy Rowley

Jeremy Peacock

NSF Graduate Teaching Fellows
Department of Food Science and Technology
The University of Georgia
Athens, Georgia

June 2005

FOOD FIGHT! was developed as part of *The Science Behind Our Food* NSF GK-12 program at the University of Georgia in collaboration with the College of Agricultural and Environmental Sciences and the Department of Food Science and Technology.

This material is based upon work supported by the National Science Foundation under Grant Award No. DGE0229577. Any opinions, findings, and conclusions or

recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the National Science Foundation.

Contributors

Contributing Author:

Chris Wildman
NSF Graduate Teaching Fellow
Department of Animal and Dairy Science
The University of Georgia
Tifton, Georgia

Collaborating Teachers:

Danielle Armstrong
Science Teacher
Columbia High School
Decatur, Georgia

Paul Blais
Science Teacher
Cedar Shoals High School
Athens, Georgia

Reviewers:

David Knauft, Ph.D.
Professor
Department of Horticulture
The University of Georgia
Athens, Georgia

Steve Oliver, Ph.D.
Associate Professor
Department of Science Education
The University of Georgia
Athens, Georgia

Robert Shewfelt, Ph.D.
Professor
Department of Food Science and Technology
The University of Georgia
Athens, Georgia

Welcome to FOOD FIGHT!

An Introduction for Teachers

The most effective approaches to science instruction present scientific concepts in terms that are relevant and meaningful in students' lives. As food is one of our most basic interests in life and a top priority in teenagers' lives, the science behind our food is a natural perspective from which to approach high school science instruction.

Food science is the application of science and engineering to the production, processing, distribution, preparation, evaluation, and utilization of food. Food science is a multidisciplinary field, utilizing such subjects as biology, chemistry, physics, engineering, and mathematics. Food scientists work in government, academia, and industry in areas such as…

…food chemistry – Food chemists are interested in the composition and properties of food components and the chemical changes that occur during handling, processing, and storage. For example, a food chemist might study the effects of processing on the nutritional quality, color, or flavor of foods.

…**food processing** – Food processing engineers are responsible for the design of processes and equipment that transform raw ingredients into finished food products.

…**food packaging** – Food packaging engineers are responsible for the development of materials and packages that contain and protect products, while also fulfilling consumer needs for convenience and communication.

…**food microbiology** – Food microbiologists are interested in the microorganisms that cause food spoilage, cause food-borne illness, or improve the quality of foods. For example, molds are microorganisms that can lead to food spoilage, *E. coli* is a disease-causing microorganism, and *Lactobacillus spp.* is the microorganism responsible for transforming milk into yogurt.

…**quality control –** Quality control is a system by which a desired standard of quality in a product or process is maintained. Through regular product testing, quality control scientists ensure that consumers receive consistent, high-quality food products.

…**product development** – Product development is the process through which food scientists transform new food ideas into marketable products. When developing a new food product, product developers must decide what product will be produced, discover who will buy the product and how to make it unique, define what is in the product, develop all aspects of the product, and deploy the product into the marketplace. Product development is one of the most popular and exciting areas of food science.

The food industry, comprising food processing, handling, preparing, and serving, is the largest industry in the United States and the world, employing tens of millions of people. Further, the United States food industry grosses hundreds of billions of dollars annually.

The *FOOD FIGHT!* activity series uses food product development to incorporate food science into the high school science classroom with the goals of increasing student interest and engagement in science and introducing students to the countless academic and career opportunities in food science. By bringing *FOOD FIGHT!* into your classroom, you and your students will become food scientists as you develop a new food product. *FOOD FIGHT!* will introduce you to key concepts in food product development and guide you through the product development process.

Thank you for your interest in the *FOOD FIGHT!* activity series. We hope that you and your students will find the activities to be engaging and beneficial. If you are interested in additional food science-based classroom activities, please visit our website (www.uga.edu/discover/sbof) or contact us directly.

Thank you,

Amy Rowley
NSF Graduate Teaching Fellow
Dept. of Food Science and Technology
The University of Georgia
Athens, Georgia 30602
(706) 369-9799
arowley@uga.edu

Jeremy Peacock
NSF Graduate Teaching Fellow
Dept. of Food Science and Technology
The University of Georgia
Athens, Georgia 30602
(706) 248-7745
jpeacock@uga.edu

FOOD FIGHT! Contents

FOOD FIGHT!

An Introduction to Product Development

What do Lipton Brisk Lemonade®, Chick-fil-A Cool Wraps®, and the McDonald's McSalad Shaker® have in common? These and many other new food products were developed with the help of University of Georgia Department of Food Science and Technology students and faculty.

Food scientists develop new products through a process that combines biology, chemistry, microbiology, biotechnology, nutrition, psychology, physics, and engineering with business and marketing to identify and satisfy ever-changing consumer needs. In fact, food scientists working in industry and university laboratories develop more than 100,000 new products each year. Of these new products, only about 10,000 actually make it onto store shelves or restaurant menus. What's more, about 9,000 of those products that make it into the market fail. In the end, only one out of every 100 new food products is successfully marketed. In order to increase the chances of success in the face of these odds, food scientists have developed a process for product development that allows the product development team to address the many complex issues involved in developing a new product in a manageable way.

In order to develop a new food product, the product development team must…

…DECIDE what product will be produced,

…DISCOVER who will buy the product and how to make it unique,

…DEFINE what is in the product,

…DEVELOP all aspects of the product, and

…DEPLOY the product into the marketplace.

DECIDE

The product development team must first decide what product will be produced. The team should brainstorm a list of possible ideas, discuss the requirements for each of the ideas, and determine the feasibility of each idea.

DISCOVER

The product development team should keep in mind that any successful product must meet a perceived consumer need. Therefore, the team must discover who will buy the product and how to make it unique. To do this, the team might use individual interviews, focus groups, or surveys to identify consumer needs, to determine how the new product will meet these needs, and to identify ways to make the new product stand out from the competition.

DEFINE

Once a product has been selected, the product development team must define the key elements of the product, including product formulation, processing, packaging, and storage. Definition enables the product development team to establish a starting point for consumer testing of the product.

DEVELOP

With a clear definition of the product in hand, the product development team must develop all aspects of the new product, including its formulation, processing, packaging, and storage. The team should first assemble a prototype of the product to see what is necessary to transform the idea into a reality. A technique often used at this stage of the process is "benchmarking," in which food scientists analyze competing products in order to identify key ingredients and characteristics. Once the prototype has been developed, the team must conduct intensive consumer testing and sensory analyses, which allows them to determine consumer acceptability of the product and to make any necessary adjustments.

DEPLOY

Before a new product can be deployed to grocery store shelves or local restaurants, the product development team must finalize the package appearance to address marketing information and labeling requirements; determine a profitable pricing structure for the product; and plan the schedule of production, distribution, and promotion. With these plans in place, the product is produced on a large scale, deployed to the marketplace, and hopefully purchased by consumers who see the new product as the perfect solution to their daily needs.

After all that work, it might seem like it is time for a break. However, the product development team must turn its attention to the future of the product, including line extensions and follow-up products. The job of a food scientist, especially a product development team member, is never boring. Keeping up with ever-changing consumer demands and remaining one step ahead of the competition requires flexibility, dedication, creativity, and teamwork, not to mention scientific expertise.

Reference:

The following video provides an introduction to the product development process and served as the basis for this article.

- *From Concept to Consumer: Food Product Development*, 21:40 min., Institute of Food Technologists (IFT)

FOOD FIGHT!

Product Development Project – Teacher's Guide

Annotation:
The *FOOD FIGHT!* project challenges students to become food scientists as they apply physical science, biology, chemistry, and physics concepts to the development of a new food product. Through a series of laboratory exercises, classroom activities, and assignments, students will learn the stages of product development and apply this knowledge to the development of an original food item.

The University of Georgia Food Science Club sponsors a New Product Fair held at the Food Science and Technology Building on the University of Georgia campus each semester. Winning teams from each class are invited to participate.

Primary Learning Outcomes:
Students will apply physical science, biology, chemistry, and physics concepts to the development of a new food product.

Students will acquire knowledge of food product development, food quality, food safety, food processing and preparation, packaging, product storage, and the marketing of new food products.

Students will develop an understanding of and appreciation for food science and the food industry.

Students will communicate clearly and effectively by oral and written means.

Students will develop and demonstrate leadership, team working, and creative thinking skills.

Georgia Performance Standards:
SCSh1. Students will evaluate the importance of curiosity, honesty, openness, and skepticism in science.

SCSh2. Students will use standard safety practices for all classroom laboratory and field investigations.

SCSh3. Students will identify and investigate problems scientifically.

SCSh4. Students use tools and instruments for observing, measuring, and manipulating scientific equipment and materials.

SCSh5. Students will demonstrate the computation and estimation skills necessary for analyzing data and developing reasonable scientific explanations.

SCSh6. Students will communicate scientific investigations and information clearly.

SCSh7. Students analyze how scientific knowledge is developed.

SCSh8. Students will understand important features of the process of scientific inquiry.

Duration:
FOOD FIGHT! consists of eleven sessions that can be adapted to fit within the normal class schedule. In order to maximize the effectiveness of the project, it is anticipated that roughly one class period every one to two weeks be dedicated to *FOOD FIGHT!* activities.

Procedures:
The *FOOD FIGHT!* lesson plans included in this book can be used to guide you and your students through the product development process. Students will develop an original food item, complete a written product proposal, and orally present their product and proposal to the class. Students should work in groups of two to four members. A suggested project schedule can be found on page 6.

Product Theme:
A new product theme for competition in the UGA Food Science Club New Product Fair is selected each semester. For the current theme, please contact Amy Rowley (arowley@uga.edu) or Jeremy Peacock (jpeacock@uga.edu). If you do not plan to have students compete in the New Product Fair, you and your students may select your own product theme. Examples might include: a healthy snack item, a school lunch item, or a chocolate item.

Project Requirements:
1. Each team must prepare a product proposal that follows the outline below.
    a. Name of New Food Product
    b. Product Description (~1 paragraph)
    c. Target Market (~1 paragraph)
    d. Product Recipe (Abbreviations and brand names should not be used in the recipe.)
        i. *List of Ingredients and Ingredient Functions*
        ii. *Instructions for Preparation*
    e. Package Design (~2-3 paragraphs)
    f. Storage and Display Plan (~1-2 paragraphs)
    g. Marketing Plan

2. Each team must give a brief oral presentation to introduce and describe the new product to the class. Students must provide the product package (or a detailed drawing of the package design) and enough product sample for a class evaluation of the product. *Note: Intent to purchase evaluation scorecards are provided on page 7.*

Assessment:
Class Competition:
Each participating class should hold a new product competition. Class competitions should be judged by the teacher and students and should be scored based on the *FOOD FIGHT!* Scoring Rubric provided on page 8.

Food Science Club New Product Fair:
The University of Georgia Food Science Club sponsors a New Product Fair held at the Food Science and Technology Building on the University of Georgia campus each semester.

Eligibility:
Winning teams from any participating high school science class in Georgia are invited to compete. Project teams must consist of a minimum of 2 students and a maximum of 4 students. To compete, each

participating teacher should notify Amy Rowley (arowley@uga.edu) or Jeremy Peacock (jpeacock@uga.edu) of their participation at the beginning of the semester.

Awards:
The New Product Fair selects one winning product. Each member of the winning team is awarded a New Product Fair certificate and a $50 savings bond.

Judging:
Teams must give a 15 minute oral presentation. In addition to the product name, description, recipe, target market, storage and display plan, and marketing plan, the presentation must also include the actual product and product package (or a detailed drawing of the package design). Product proposals and presentations will be judged by students and faculty of the University of Georgia Department of Food Science and Technology. Projects at the New Product Fair will be scored similarly to the classroom judging. Teams registering with the fair will be provided with a New Product Fair competition rubric.

Resources:
The following video provides an introduction to the product development process.

- *From Concept to Consumer: Food Product Development*, 21:40 min., Institute of Food Technologists (IFT)

The following websites may be useful during the product development process.

- IFT – http://www.ift.org
- Institute of Food Technologists Student Association (IFTSA) Product Development Competition – http://www.ift.org/iftsa/competitions/pdc.html
- *Food Product Design* Editorial Library – http://www.foodproductdesign.com/archive/editorial.html
- The Department of Food Science and Technology - http://www.uga.edu/fst/
- The Extension Food Science and Food Safety – http://fsext-outreach.ces.uga.edu/

FOOD FIGHT!

Product Development Project – Suggested Project Schedule

	In-Class Activity	Assignment		Teacher
		Assign	Collect	
1	Introduction; Announce Product Theme; Group Selection ***Resources Needed:*** *FOOD FIGHT! An Introduction to Product Development; FOOD FIGHT! Product Development Project – Teacher's Guide & Student Handouts*	Individual Product Idea	NA	NA
2	Team Meeting to Share & Rank Product Ideas	Team Rankings	Individual Product Ideas & Team Rankings	Provide Feedback on Product Ideas & Rankings
3	Team Meeting to Review Feedback & Select Final Product Idea	Final Product Idea; Product Name, Description, & Target Market	Final Product Idea	NA
4	Ingredient Functionality ***Resources Needed:*** *How Sweet It Is! Lesson Plan & Student Handouts*	List of Ingredients & Functions	Product Name, Description, & Target Market	Provide Feedback on Product Name, Description & Target Market
5	Formulation ***Resources Needed:*** *The Chemist's Cookbook Lesson Plan & Student Handouts*	Instructions for Preparation	List of Ingredients & Functions	Provide Feedback on List of Ingredients & Functions
6	Sensory Evaluation ***Resources Needed:*** *One of These Things Is Not Like The Other Lesson Plan & Student Handouts; The Tomato…Flavorful or Flavorless Lesson Plan & Student Handouts*	Product Sample	Instructions for Preparation	Provide Feedback on Instructions for Preparation
7	Product Sampling & Intent to Purchase Evaluation ***Resources Needed:*** *Intent to Purchase Evaluation Scorecards*	Analyze Intent to Purchase Data & Calculate Score	Product Sample	Provide Feedback on Product Sample
8	Packaging ***Resources Needed:*** *The Perfect Package Lesson Plan & Student Handouts*	Package Design & Explanation; Storage & Display Plan; & Review Product Suggestions	Intent to Purchase Score	NA
9	Marketing ***Resources Needed:*** *Can You Believe Everything You See? Lesson Plan & Student Handouts*	Marketing Plan	Package Design & Explanation; Storage & Display Plan	Provide Feedback on Package Design & Explanation; Storage & Display Plan
10	Final Preparation	Final Proposal, Presentation, Product Sample, & Package	Marketing Plan	Provide Feedback on Marketing Plan
11	*FOOD FIGHT!* Competition		Final Proposal, Presentation, Product Sample, & Package	Judge Projects, Compile Scores, & Select Winning Team

FOOD FIGHT!

Product Development Project – Intent to Purchase Evaluation Scorecards

Note: Copy and cut for use in peer judging of products.

Peer Intent to Purchase Evaluation:

Product Name: ___________________

On a scale of 1 to 5 (1 being least likely and 5 being most likely), indicate with an "X" the likelihood that you would purchase this product if it were available for purchase.

1 _____

2 _____

3 _____

4 _____

5 _____

Peer Intent to Purchase Evaluation:

Product Name: ___________________

On a scale of 1 to 5 (1 being least likely and 5 being most likely), indicate with an "X" the likelihood that you would purchase this product if it were available for purchase.

1 _____

2 _____

3 _____

4 _____

5 _____

Peer Intent to Purchase Evaluation:

Product Name: ___________________

On a scale of 1 to 5 (1 being least likely and 5 being most likely), indicate with an "X" the likelihood that you would purchase this product if it were available for purchase.

1 _____

2 _____

3 _____

4 _____

5 _____

Peer Intent to Purchase Evaluation:

Product Name: ___________________

On a scale of 1 to 5 (1 being least likely and 5 being most likely), indicate with an "X" the likelihood that you would purchase this product if it were available for purchase.

1 _____

2 _____

3 _____

4 _____

5 _____

FOOD FIGHT!

Product Development Project – Scoring Rubric

CRITERIA	10	9-8	7-5	4-0	
Product Name and Description	Product name is original, descriptive, and marketable. Product description provides a clear and detailed explanation of what the product is, how it is unique, and how it meets a specific consumer need. Product idea is congruent with assigned product theme. Explanation of how product addresses assigned theme is provided.	Product name is descriptive. Product description provides a clear explanation of what the product is but an unclear or incomplete explanation of how the product is unique, and how it meets a specific consumer need. Product idea is congruent with assigned product theme.	Product name is not descriptive. Product description provides an unclear explanation of what the product is. Product idea is somewhat congruent with assigned product theme.	Product name or prod description is missing shows little effort. Pr idea is unrelated to as product theme.	
Originality of Product	Product is completely original. There is no other product like it on the market.	Product is mostly original but based on modifications of an existing product.	Product represents only minor modifications of an existing product.	Product is a copy of a existing product.	
Target Market	Target market is clearly defined and an explanation is provided as to why the particular audience was chosen. Target market is congruent with product theme.	Target market is broadly defined and is congruent with the product theme.	Target market is defined but is only somewhat congruent with the product theme.	Target market is missi shows little effort.	
Product Recipe	Product recipe clearly lists, in order of use, all ingredients used in the product, accurate explanations of the specific functions (based on physical, chemical, or biological properties) of all product ingredients, and detailed procedures for preparation.	Product recipe clearly lists all ingredients used in the product, reasonable, but general, explanations of the functions (based on physical, chemical, or biological properties) of all ingredients, and procedures for preparation.	Product recipe provides an incomplete list of the ingredients used in the product, incomplete or incorrect explanations of the ingredient functions, or incomplete or unclear procedures for preparation.	The list of ingredients explanations of ingred functions, or instructi preparation are missin show little effort.	

Package Design	Package (or detailed drawing) contains an original design feature and is made (or drawn) to scale. Visual design is professional, appeals to the target market, and provides required product information (product name, ingredients, nutritional information, etc.). A clear, detailed explanation of the selection of package materials and design (based on the physical, chemical, and biological properties of the product and package) is provided.	Package (or detailed drawing) is made (or drawn) to scale. Visual design is professional, appeals to the target market, and provides required product information (product name, ingredients, nutritional information, etc.). A general, but accurate explanation of the selection of package materials and design (based on the physical, chemical, and biological properties of the product and package) is provided.	Package (or detailed drawing) is not made (or drawn) to scale. Visual design is professional and appeals to target market, but required product information (product name, ingredients, nutritional information, etc.) is incomplete. An incomplete explanation of the selection of package materials and design is provided.	Package or package d missing or shows little	
Storage and Display Plan	Specific storage conditions (based on physical, chemical, and biological properties of product and package) are specified. A reasonable estimate of product shelf-life and a specific description of food safety concerns are provided. Display plan is appropriate for target market.	General storage conditions (based on physical, chemical, and biological properties of product and package) are specified. An estimate of product shelf-life is provided, as well as a general description food safety concerns. Display plan is appropriate for target market.	General storage conditions are specified. An inaccurate estimate of product shelf-life is provided. Display plan is appropriate for target market.	Storage or display pla missing or shows little	
Marketing Plan	Marketing plan is appropriate for target audience, provides detailed explanation of marketing techniques to be used, provides multiple examples of marketing tools, and displays professionalism and creativity.	Marketing plan is appropriate for target audience, provides an explanation of marketing techniques to be used, provides one sample marketing tool, and displays professionalism and creativity.	Marketing plan is inappropriate for target audience, provides an incomplete explanation of marketing techniques to be used, does not provide an example of a marketing tool, and/or lacks professionalism and creativity.	Marketing plan is mis shows little effort.	
Written Communication	Written proposal follows assigned outline and is written in paragraph form. Writing is clear and free of grammar, spelling, and typographical errors.	Written proposal follows assigned outline and is written in paragraph form. Writing is clear and contains no more than 5 grammar, spelling, or typographical errors.	Written proposal follows assigned outline and is written in paragraph form. Writing is unclear and/or contains 5 or more grammar, spelling, or typographical errors.	Written proposal does follow assigned outlin not written in paragra Writing is unclear and contains many gramm spelling, or typograph errors.	

Oral Communication	Students are well prepared, and oral presentation is complete. Students speak clearly and professionally and show a full understanding of the information presented. Students are able to answer accurately almost all questions posed by classmates or instructor.	Students are prepared, and oral presentation is complete. Students speak clearly and professionally and show an understanding of the information presented. Students are able to answer accurately most questions posed by classmates or instructor.	Students are somewhat prepared, and oral presentation is complete. Students speak clearly and professionally but show little understanding of the information presented. Students are able to answer accurately few questions posed by classmates or instructor.	Students are not prepa oral presentation is incomplete. Students speak clearly or professionally. Studen not show an understar the information preser Students are unable to accurately questions p classmates or instructo	
Product			Mean class intent to purchase score _____		
				Total Score (out c	

Additional Teacher Comments:

FOOD FIGHT!

Product Development Project – Student Handout

Introduction:
The *FOOD FIGHT!* project will challenge you to become a food scientist as you apply physical science, biology, chemistry, and physics concepts to the development of a new food product. Through a series of laboratory exercises, classroom activities, and assignments, you will learn the stages of product development and develop an original food item.

The University of Georgia Food Science Club sponsors a New Product Fair held at the Food Science and Technology Building on the University of Georgia campus each semester. The winning team from your class is invited to participate.

Procedures:
You will develop an original food item, complete a written product proposal, and orally present your product and proposal to the class. You will work in groups of two to four members. All assignments must be typed in paragraph form. All activities and assignments will be completed according to the schedule below.

Product Theme: _____

Schedule:

Assignment	**Due Date**	**Complete**
Individually develop an *original product idea* congruent with the product theme.		
Meet with your *team* and *rank* your product ideas.		
Select the *final product idea* for your team.		
Develop a *name for your product* and provide a brief *product description.*		
Provide a description of the specific *target market* for which your product is designed (*e.g.* young children, teenagers, college students, or young adults)		
Provide a *list of ingredients* that will be used to make your product. For each ingredient listed, provide a description of the *ingredient's function* based on its physical, chemical, or biological properties (*e.g.* sugar used as a sweetener or flour used as thickener).		
Provide detailed *instructions for preparation* of your product.		

Provide a *sample of your product*. Students must provide enough product sample for a class evaluation of intent to purchase.		
Analyze the Intent to Purchase data compiled for your product and calculate the *Intent to Purchase score*. Review any product suggestions.		
Provide a *detailed drawing and description of your product package*. Provide an explanation of why the design is the best package for your product. This explanation should be based on the physical and chemical properties of the product and package.		
Devise a *plan for storing and displaying* the product in the store, including an estimate of how long the product can be safely stored.		
Devise a *marketing plan* to promote and advertise your new product. Examples of advertising methods that may be used are a television commercial video or skit, a magazine or newspaper ad, a billboard design, or a radio ad or jingle.		
Prepare a *product proposal* for your product, as well as a brief *oral presentation* to introduce and briefly describe your new product to the class. You must provide the *product package* (or a detailed drawing of the package design) and enough *product sample* for a class evaluation of product intent to purchase.		

Project Requirements:

1. Each team must prepare a product proposal that follows the outline below.
    a. Name of New Food Product
    b. Product Description (~1 paragraph)
    c. Target Market (~1 paragraph)
    d. Product Recipe (Abbreviations and brand names should not be used in the recipe.)
        i. *List of Ingredients and Ingredient Functions*
        ii. *Instructions for Preparation*
    e. Package Design (~2-3 paragraphs)
    f. Storage and Display Plan (~1-2 paragraphs)
    g. Marketing Plan

2. Each team must give a brief oral presentation to introduce and describe the new product to the class. Students must provide the product package (or a detailed drawing of the package design) and enough product sample for a class evaluation of the product.

Class Competition:

You will compete with your classmates in a new product development competition. Your product, package, written proposal, and oral presentation will be scored according to the *FOOD FIGHT!* Scoring Rubric.

Food Science Club New Product Fair:
The University of Georgia Food Science Club sponsors a New Product Fair held at the Food Science and Technology Building on the University of Georgia campus. The winning team from your class will be invited to compete against other Georgia high school students. The New Product Fair will select one winning product. Each member of the winning team will be awarded a New Product Fair certificate and a $50 savings bond.

Teams must give a 15 minute oral presentation. In addition to the product name, description, recipe, target market, storage and display plan, and marketing plan, the presentation must also include the actual product and product package (or a detailed drawing of the package design). Product proposals and presentations will be judged by students and faculty of the University of Georgia Department of Food Science and Technology. Projects at the New Product Fair will be scored similarly to the classroom judging. Teams registering with the fair will be provided with a New Product Fair competition rubric.

How Sweet It Is!

Ingredient Functionality – Lesson Plan

Annotation:
In this classroom activity, students will explore the relationship of chemical structure to the functional properties of food ingredients as they compare natural and artificial sweeteners.

Primary Learning Outcomes:
Students will be able to name common sweeteners found in food products.

Students will be able to classify sweeteners as organic compounds.

Students will be able to identify the chemical structures of sucrose, saccharin, and sucralose.

Students will be able to describe the relationship between the chemical structure and functional properties of food ingredients.

Students will be able to explain the role of ingredient selection in the development of food products.

Georgia Performance Standards:
SCSh3. Students will identify and investigate problems scientifically.

SPS2. Students will explore the nature of matter, its classifications, and its system for naming types of matter.

SC1 Students will analyze the nature of matter and its classifications.

Related Topics:
Structure and Properties of Matter
Organic Compounds

Duration:
Preparation: 45 minutes
Introduction: 20 minutes
Student Activity: 15 minutes
Conclusion: 15 minutes
Total Class Time: 50 minutes

Materials and Equipment:
For Teacher Preparation:
(Per class of 30 students)

1. ½ Cup sucrose (table sugar)
2. ½ Cup sucralose (Splenda®)
3. ½ Cup saccharin (Sweet'N Low®)
4. 120, 5-oz. Plastic cups
5. 4 Gallons of drinking water
6. Saltine® crackers
7. Napkins

Per Student:

1. *How Sweet It Is!* student handout
2. 5-oz. Cup of Solution A
3. 5-oz. Cup of Solution B
4. 5-oz. Cup of Solution C
5. 5-oz. Cup of water
6. 2 Saltine® crackers
7. Napkin

Safety:
Because students will be allowed to eat during the activity, precautions should be taken to prevent materials from coming into contact with laboratory equipment or surfaces. Materials should remain in cups or on clean napkins at all times.

Technology Connection:
Not applicable

Procedures:
Teacher Preparation:
Use the attached template to prepare the *How Sweet It Is!* student handout for each student. To one gallon of drinking water, add ½ cup of sucrose (table sugar) and mix thoroughly. Label this "Solution A." To a second gallon of drinking water, add ½ cup of sucralose (Splenda®) and mix thoroughly. Label this "Solution B." To a third gallon of drinking water, add ½ cup of saccharin (Sweet'N Low®) and mix thoroughly. Label this "Solution C." For each student, label 4 cups "A," "B," "C," and "water," respectively. Fill each cup with the appropriate sample. *Note: Although this procedure will not provide solutions of equivalent molar concentrations, the relative concentrations are such that students will obtain the desired results. Because saccharin and sucralose are significantly sweeter than sucrose, they are packaged along with filler materials such as dextrose. For example, a one-gram packet of Sweet'N Low® contains only 36 mg of saccharin along with 964 mg of filler and other ingredients. Thus in order to create molar-equivalent solutions of sucrose and saccharin using materials found at the grocery store, it would be necessary to adjust for the presence of filler in the commercially available saccharin product.*

Estimated Time:
45 minutes

Introduction:
Everything we see, touch, smell, and taste is chemical, whether it is the neon lights at your favorite restaurant, the napkin you place in your lap, the aroma of fresh garlic, or the food that you eat.

During the development of a new food product, each ingredient (*i.e.* chemical) is selected because of its specific function within the food. Sugar sweetens. Vanilla flavors. Flour thickens. Potassium sorbate preserves. The specific function of an ingredient is a result of its chemical structure, and therefore, any changes in the chemical structure alter the function of the ingredient. For example, L-carvone and D-carvone are enantiomers, or isomers whose structures are mirror images of one another. In this case, L-carvone exhibits a spearmint aroma; whereas, D-carvone exhibits a caraway, or rye cracker-like, aroma. Structural changes in ingredients can result indirectly from heating, processing, and storage or can result directly from the efforts of food scientists to manipulate specific functional properties of an ingredient. Therefore, knowledge of the relationship between the structure and function of ingredients is critical in food science.

Explain to students that they will be sampling sucrose, saccharin, and sucralose. Each of these is an organic compound that is used as a sweetener in food and beverage products. Organic compounds are often simplified to include those compounds that contain the element carbon. For example, aspirin, $C_9H_8O_4$, is an organic compound. Organic compounds do contain carbon, and most organic compounds also contain hydrogen. Those compounds that consist solely of carbon and hydrogen are called hydrocarbons. Butane, C_4H_{10}, is an example of a hydrocarbon. Other organic compounds may contain oxygen, nitrogen, sulfur, phosphorus, or one of the halogens. These groups of atoms containing elements other than carbon and hydrogen constitute functional groups. Each functional group is important because it provides the compound with unique chemical properties. Furthermore, organic compounds are commonly classified by the functional groups they contain.

As with any ingredient function, it is the chemical structure of sweeteners that allows them to function as such. Food scientists have determined that a specific arrangement of organic functional groups allows a compound to interact with taste bud receptors to register a sweet sensation. A compound must contain an –OH or –NH group, a basic N or C atom, and a hydrophobic group such as $–CH_3$ in a triangle with specific angles and distances in order to act as a sweetener. Among the more than 50 sweeteners known to food scientists, the natural sugars, such as sucrose and fructose, are the best known.

Sucrose (Figure 1), or common table sugar, is a carbohydrate and is a major source of calories and energy in the human diet. Sucrose is actually a disaccharide that is composed of the two monosaccharides glucose and fructose. Table sugar is refined from sugarcane and sugar beets and is considered the standard when measuring the sweetness of compounds.

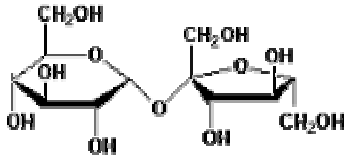


Figure 1: Sucrose

Because of the interest in low-calorie and low-sugar foods that has developed over the last few decades, interest has grown in using low-calorie or no-calorie sweeteners. These sweeteners, such as sucralose, saccharin, cyclamate, and aspartame, are either not metabolized or are so intensely sweet that very small quantities can be used.

Sucralose (Figure 2) is the newest artificial sweetener to enter the market and is known by the trade name Splenda®. Sucralose is made through a process that converts sucrose to a non-caloric, non-carbohydrate sweetener by replacing three –OH groups on the sucrose molecule with three Cl atoms. The result is a stable compound, 600-times sweeter than sucrose, that is not metabolized by the body and is stable at high temperatures. Aside from its use in manufactured products and as a tabletop sweetener, Splenda® is sold as a sucrose-sucralose blend for baking, as sucrose can have important functions in the texture and appearance of baked foods.

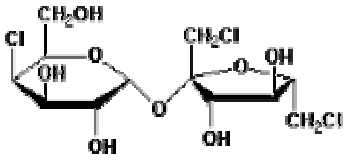


Figure 2: Sucralose

Saccharin (Figure 3), the world's oldest low-calorie sweetener, was discovered accidentally in 1879 when a researcher at Johns Hopkins University spilled the compound on his hand and later noticed his hand to have a sweet taste. Saccharin is a heterocyclic compound that is derived from toluene or methyl anthranilate and is 300-times sweeter than sucrose. It is not metabolized by the body, and although there has been much controversy concerning its health effects, saccharin has been shown to be a safe alternative to sugar. Today, saccharin is sold as a tabletop sweetener under the trade name Sweet'N Low® and is used in such products as baked goods, gum, candy, and salad dressings.

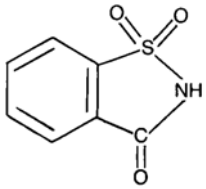


Figure 3: Saccharin

Estimated Time:
20 minutes

Activity:
Provide each student with the materials listed above. Ask students to sample the solutions and rank the relative sweetness intensities according to the instructions given on the *How Sweet It Is!* student handout. Before sampling each solution, students should use the water and crackers to cleanse their palates.

Estimated Time:
15 minutes

Conclusion:
On the board, note the consensus of student rankings. Confirm the correct rankings and discuss any differences observed by the students. Have students individually answer the post-laboratory questions found on the *How Sweet It Is!* student handout.

Estimated Time:
15 minutes

Assessment:
Assessment should be based on completion of the *How Sweet It Is!* student handout.

References:

- Christen, G.L. and J.S. Smith (Eds.). 2000. *Food Chemistry: Principles and Applications*. Science Technology System, West Sacramento, California.
- Emsley, J. 1988. *Artificial Sweeteners*. ChemMatters. February: 4-8.
- Gilman, V. 1988. *Artificial Sweeteners: No-calorie sugar substitutes provide options for enjoying the sweet life.*. Chemical and Engineering News. 82(25): 43.
- http://www.saccharin.org/
- http://www.splenda.com/
- http://www.sweetnlow.com/

Deleted: <#>http://www.aspartame.org/ ¶

How Sweet It Is!

Ingredient Functionality – Student Handout

Introduction:
Sucrose (Figure 1), or common table sugar, is a carbohydrate and is a major source of calories and energy in the human diet. Because of the interest in low-calorie and low-sugar foods that has developed over the last few decades, interest has grown in using low-calorie or no-calorie sweeteners. Sucralose (Figure 2) is the newest artificial sweetener to enter the market and is known by the trade name Splenda®. Sucralose is made through a process that converts sucrose to a non-caloric, non-carbohydrate sweetener by replacing three –OH groups on the sucrose molecule with three Cl atoms. Saccharin (Figure 3), the world's oldest low-calorie sweetener, is known by the trade name Sweet'N Low®. Saccharin is a synthetic compound derived from toluene.

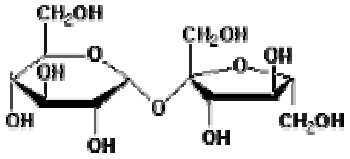


Figure 1: Sucrose

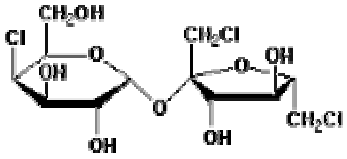


Figure 2: Sucralose

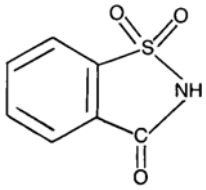


Figure 3: Saccharin

Table sugar is refined from sugarcane and sugar beets and is considered the standard when measuring the sweetness of compounds. Compared to sucrose, artificial sweeteners exhibit much more intense sweetness. Saccharin is 300-times sweeter than sucrose, while sucralose is 600-times sweeter than sucrose.

Purpose:
To identify common food sweeteners, sucrose, saccharin, and sucralose, by comparing sweetness intensity rankings of solutions of each compound.

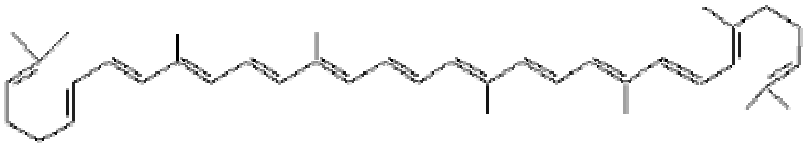
Materials:
1. 3 Sweetener solutions (A, B and C)
2. Cup of water
3. Saltine® crackers
4. Napkin

Intensity Ranking:
Sample each solution, from A to C. Rank (1 being least intense and 3 being most intense) the sweetness of each solution.

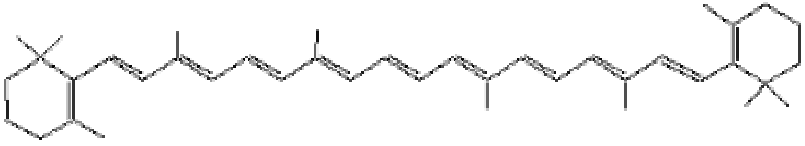
Sample	Sweetness Intensity Ranking	Comments
A	_____	_____
B	_____	_____
C	_____	_____

Post-Laboratory Questions:

1. Identify solutions A, B, and C as sucrose, saccharin, or sucralose based on your sweetness intensity rankings.
2. Other than sweetness intensity, what differences did you detect among the samples?
3. Sucralose is stable at high temperatures. However, for baking applications, Splenda® is sold as a sucrose-sucralose blend. Identify two functions, other than sweetening, that sucrose might have in baked food products that sucralose does not fulfill.
4. Carotenoids are a class of compounds responsible for many of the red, orange, and yellow hues of plant leaves, fruits, and flowers, as well as the colors of some birds, insects, fish, and crustaceans. Examine and compare the chemical structures found below. Lycopene is a carotenoid found in tomatoes. Based on your comparison, would you expect β-carotene to exhibit the properties of a carotenoid? Why or why not?



Lycopene ($C_{40}H_{56}$)



β-carotene ($C_{40}H_{56}$)

The Chemist's Cookbook

Formulation – Lesson Plan

Annotation:
In this laboratory exercise, students will explore product formulation and quality control, perform metric conversions, and evaluate accuracy and precision as they follow a scientific protocol to prepare cookies.

Primary Learning Outcomes:
Students will be able to convert metric measurements to standard measurements.

Students will be able to define the terms ***accuracy*** and ***precision***.

Students will be able to calculate the arithmetic mean and relative standard deviation of a dataset.

Students will be able to use relative standard deviation to describe the precision of a set of measurements.

Students will be able to calculate the mean percent difference between an observed mean and a given, standard value.

Students will be able to use mean percent difference to describe the accuracy of a set of measurements.

Students will be able to define the term ***quality control*** and describe its importance in the production of a food product.

Students will be able to explain the importance of product formulation in the design of a new food product.

Georgia Performance Standards:
SCSh2. Students will use standard safety practices for all classroom laboratory and field investigations.

SCSh3. Students will identify and investigate problems scientifically.

SCSh4. Students will use tools and instruments for observing, measuring, and manipulating scientific equipment and materials.

SCSh5. Students will demonstrate the computation and estimation skills necessary for analyzing data and developing reasonable scientific explanations.

SCSh6. Students will communicate scientific investigations and information clearly.

Related Topics:
Metric Conversions
Data Analysis

- Accuracy and Precision
- Standard Deviation

- Mean Percent Difference

Duration:
Preparation: 70 minutes
Introduction: 30 minutes
Student Activity: 90 minutes
Conclusion: 30 minutes
Total Class Time: 150 minutes

Materials and Equipment:

1. All-purpose flour
2. Baking soda
3. Salt
4. Butter
5. Granulated [white] sugar
6. Brown sugar
7. Imitation vanilla flavoring
8. Eggs
9. Semi-sweet chocolate chips
10. Measuring cup
11. Measuring spoons
12. Small mixing bowl
13. Large mixing Bowl
14. Mixing spoon
15. Hand mixer
16. 4 Non-stick baking sheets
17. Oven mitts
18. Oven
19. Balance
20. Metric ruler

Per Student:

1. *The Chemist's Cookbook* student handout

Safety:
The primary safety concern in this laboratory exercise is the heat produced during cooking. Ensure that students wear dry oven mitts and use caution when handling hot objects. Because students will consume the product of this activity, be sure to prepare the cookies outside the laboratory (*e.g.* in a home economics classroom or the school cafeteria). Use ingredients and equipment that are not used or stored in the laboratory.

Technology Connection:
At the teacher's discretion, students may use calculators or computer spreadsheet software to complete required calculations.

Procedures:
This laboratory exercise is organized in three sessions as outlined below.

SESSION ONE:

- Introduce the activity to students by reviewing the introduction provided below.
- Provide students with *The Chemist's Cookbook* student handout and review the overall assignment.
- Instruct students to complete, as homework, the pre-laboratory assignment found on *The Chemist's Cookbook* student handout.

SESSION TWO:

- Have students complete the laboratory assignment and post-laboratory questions found on *The Chemist's Cookbook* student handout.

SESSION THREE:

- Conclude the activity as described in the conclusion below.

Teacher Preparation:

SESSION ONE:

Use the attached template to prepare a copy of *The Chemist's Cookbook* student handout for each student.

Estimated Time:

10 minutes

SESSION TWO:

Teacher Preparation:

The standard chocolate chip cookie recipe follows.

1. 2 ¼ c. All-purpose flour
2. 1 tsp. Baking soda
3. 1 tsp. Salt
4. 1 c. Butter, softened
5. ¾ c. Granulated [white] sugar
6. ¾ c. Packed brown sugar
7. 1 tsp. Vanilla extract
8. 2 Eggs
9. 12 oz. Semi-sweet chocolate chips

Following the procedures given on *The Chemist's Cookbook* student handout, this recipe will make approximately 36 cookies. Obtain enough of the above materials to allow each group to complete the full recipe. Arrange for access to the equipment listed above and arrange to complete the activity outside of the laboratory. Ideally, the activity can be completed in a home economics classroom that is stocked with the required measuring and cooking equipment. Prepare student stations by placing necessary materials and equipment at each station. *Note: This exercise may also be completed using store-bought cookies. Cookies purchased from a bakery generally exhibit greater variability and are preferable to commercially produced, brand-name cookies.*

Estimated Time:

60 minutes

Introduction:

Stop and think about opening a new bag of Chips Ahoy® chocolate chip cookies. Each cookie seems to be exactly the same shape, size, and color. Every cookie has just the right number of chocolate chips, and as you bite into each cookie, you get the same perfect crunch.

We have all come to expect perfection in our foods. That means that food manufacturers must dedicate more and more resources to delivering consistently high quality foods with no mistakes and no excuses. All food companies employ some form of ***quality control***, *i.e.* a system by which a desired standard of quality in a product or process is maintained. No matter what form a quality control system takes, the foundation is formed by solid, science-based product formulation. When developing a new food product, the product formulation provides a standardized recipe and protocol for production of a high-quality product. In order to maintain product consistency, samples of the product are regularly evaluated against standards for size, shape, color, flavor, texture, and nutrient content. Any products

found that do not meet these standards are never allowed to reach the consumer. Thus, a well-tested product formulation is the basis for any successful new product.

Explain to students that in this activity, they will perform their own quality control as they follow a standard formulation to make chocolate chip cookies and then evaluate their cookies against product standards. In particular, students will compare the average mass and average diameter of their cookies to standard values. Any time we wish to evaluate observed values against a standard, there are two critical concepts to keep in mind: accuracy and precision. ***Accuracy*** refers to the extent to which a measurement agrees with the true value or standard. To use a classic example, if a marksman takes several shots at a bulls-eye, accuracy describes how close those shots are to hitting the bulls-eye. In this activity, accuracy will refer to how close students' cookies are to matching product standards. ***Precision***, on the other hand, refers to the extent to which individual measurements of the same quantity agree. In our classic example, precision refers to how close the marksman's shots are to one another. In this activity, precision will refer to the consistency of students' cookies (*i.e. H*ow much do mass and diameter vary between individual cookies?).

Note: In order to evaluate the accuracy and precision of their cookie production, students will use the statistical concepts of arithmetic mean, mean percent difference, and relative standard deviation. Students will also use the concept of mean percent difference. Before assigning these calculations, review or introduce these concepts to your students. For the purposes of this activity, *mean* $(\overline{X})$ is taken to be the average value of a set of numbers and is calculated using the following equation,

$$\overline{x} = \frac{(x_1 + x_2 ::: + x_n)}{n}$$

where $x_1;\ x_2;:::;\ x_n$ are the individual observations and *n* is the total number of observations.

Accuracy of students' cookie production will be evaluated by comparing the mean values of mass and diameter to the respective standards by calculating the *mean percent difference (MPD)*, which is calculated using the following equation,

$$MPD = \frac{\overline{x}_{obs} à x_{Std}}{x_{Std}} â 100\%$$

where $\overline{x}_{obs}$ is the observed mean and x_{Std} is the standard value.

The precision of students' cookie production will be evaluated by calculating the standard deviation of the data sets for mass and diameter, respectively. *Standard deviation (s)* is a measure of how a set of data varies from its mean and is given by the equation

$$s = \sqrt{\frac{(x_1^2 + ::: + x_n^2) à \frac{(x_1 + ::: + x_n)^2}{n}}{n à 1}}$$

where $x_1;\ x_2;:::;\ x_n$ are the individual observations and *n* is the total number of observations.

In order to obtain a more meaningful value for precision, standard deviation can be adjusted by calculating the *relative standard deviation (RSD)*. RSD expresses standard deviation as a percentage of the mean and is given by the following equation.

$$RSD = \frac{s}{\bar{x}} \times 100\%$$

Estimated Time:
30 minutes

Student Activity:
Pre-Laboratory Assignment:
Students should…

1. Familiarize themselves with the laboratory procedures.
2. Write in their laboratory notebooks an introduction summarizing the information presented to them during the introductory lecture.
3. Write in their laboratory notebooks the purpose, materials, procedures provided on *The Chemist's Cookbook* student handout.
4. Review the list of reagents and identify and record in a table in their laboratory notebooks the common name of each ingredient.
5. Convert all metric values found in the reagent list and procedures to their standard equivalents and record in a table in their laboratory notebooks. *(Show all calculations.)*

Laboratory Assignment:
Students should follow the laboratory procedures set forth in *The Chemist's Cookbook* student handout and prepare a laboratory report communicating their results.

Estimated Time:
90 minutes

Conclusion:
Compile class data on the board. Discuss with students their accuracy and precision in making cookies. Also discuss measures taken by the food industry to ensure the quality and consistency of their products.

Estimated Time:
30 minutes

Assessment:
Assessment should be based on *The Chemist's Cookbook* Scoring Rubric provided on page 28.

References:

- Christen, G.L. and J.S. Smith (Eds.). 2000. *Food Chemistry: Principles and Applications*. Science Technology System, West Sacramento, California.

The Chemist's Cookbook

Formulation – Scoring Rubric

CRITERIA	10	9-8	7-5	4-0	
Introduction	Introduction is a clear, concise, and thoughtful description of the laboratory exercise. It reflectively shows how the laboratory exercise fits into the curriculum.	Introduction is a brief description of the background of the laboratory exercise.	Introduction is too brief, unrelated to the laboratory exercise, or provides little or no background information.	Introduction is a copy of material provided or is missing.	
Purpose	Purpose of the laboratory exercise is clearly identified and stated.	Purpose of the laboratory exercise is identified, but is stated in a somewhat unclear manner.	Purpose of the laboratory exercise is partially identified, and is stated in a somewhat unclear manner.	Purpose of the laboratory exercise is erroneous or missing.	
Materials	All materials and equipment used in the laboratory exercise are clearly and accurately described.	Almost all materials and equipment used in the laboratory exercise are clearly and accurately described.	Most of the materials and equipment used in the laboratory exercise are accurately described.	Many materials or equipment used in this laboratory exercise are described inaccurately or not described at all or are missing.	
Procedures	All procedures are listed in clear steps. Each step is numbered and is a complete sentence.	All procedures are listed in a logical order, but steps are not numbered and/or are not in complete sentences.	All procedures are listed but are not in a logical order or are difficult to follow.	Procedures do not accura list the steps of the experiment or are missin	
Data Collection	Data is accurate and is presented in a professional manner. Data is recorded with appropriate precision. Graphs and tables are correctly labeled and titled.	Data is accurate and recorded with the appropriate precision. Graphs and tables are labeled and titled.	Data is accurate and recorded with the appropriate precision. Graphs and tables are not used or are incorrectly labeled and titled.	Data are not shown or ar inaccurate.	

Data Analysis	All calculations are shown and the results are correct and labeled appropriately.	Some calculations are shown and the results are correct and labeled appropriately.	Some calculations are shown and the results labeled appropriately.	No calculations are show results are inaccurate or mislabeled.	
Results	MPD $\leq$ 10% RSD $\leq$ 10%	10% < MPD $\leq$ 25% 10% < RSD $\leq$ 25%	25% < MPD $\leq$ 50% 25% < RSD $\leq$ 50%	MPD > 50% RSD > 50%	
Discussion	Discussion is a clear, complete, and thoughtful response to the post-laboratory questions. Discussion is written in paragraph form and is free of grammar and spelling errors.	Discussion is a sufficient but brief response to the post-laboratory questions. Discussion is written in paragraph form but is somewhat unclear.	Discussion is unclear or a superficial or inaccurate response to the post-laboratory questions. Discussion may not be written in paragraph form or may contain many grammar and spelling errors.	Discussion disregards po laboratory questions, shc little effort, or is missing	
Safety	Laboratory exercise is carried out with full attention to relevant safety procedures. No part of the laboratory exercise posed a safety threat to any individual.	Laboratory exercise is generally carried out with attention to relevant safety procedures. No part of the laboratory exercise posed a safety threat to any individual, but at least one safety procedure was not followed.	Laboratory exercise is carried out with some attention to relevant safety procedures. No part of the laboratory exercise posed a safety threat to any individual, but several safety procedures were not followed.	Safety procedures were ignored and/or some asp of the laboratory exercis posed a threat to the safe of the student or others.	
Participation	Student used time well in the laboratory and focused attention on the exercise. Student cleaned and returned all equipment to its proper location.	Student used time pretty well in the laboratory and stayed focused on the exercise most of the time. Student cleaned and returned all equipment to its proper location.	Student did the laboratory exercise but did not appear very interested. Focus was lost on several occasions. Student cleaned and returned all equipment to its proper location.	Student participation wa minimal, or student did r clean and return all equipment to its proper location.	
				Total Score (out of 1	

The Chemist's Cookbook

Formulation – Student Handout

Introduction:
Stop and think about opening a new bag of Chips Ahoy® chocolate chip cookies. Each cookie seems to be exactly the same shape, size, and color. Every cookie has just the right number of chocolate chips, and as you bite into each cookie, you get the same perfect crunch.

Because we have all come to expect perfection in our foods, food companies must employ strict quality control measures in order to maintain product consistency. Product samples are regularly evaluated against standards for size, shape, color, flavor, texture, and nutrient content. Thus, a well-tested product formulation is the basis for any successful new product.

In this activity, you will perform quality control as you follow a standard formulation to make chocolate chip cookies and then evaluate your cookies against product standards. You will compare the average mass and average diameter of your cookies to standard values.

Purpose:
To follow a standard formulation to produce a consistent, high-quality food product—chocolate chip cookies.

Pre-Laboratory Assignment:
1. Familiarize yourself with the laboratory procedures.
2. Write in your laboratory notebook an introduction summarizing the information presented to you during the introductory lecture.
3. Write in your laboratory notebook the purpose, materials, procedures provided.
4. Review the list of reagents below. Identify and record on the student handout the common name of each ingredient.
5. Convert all metric values found in the reagent list and procedures to their standard equivalents and record on the student handout.

Useful Conversions:
1 cup = 8 fl. oz. = 16 tbsp. = 48 tsp. = 237 mL
Density of butter = 0.954 g/mL
1 lb. = 454 g = 16 oz.

Materials and Equipment:
Equipment:
1. Measuring cup
2. Measuring spoons
3. Small mixing bowl
4. Large mixing Bowl
5. Mixing spoon
6. Hand mixer
7. 4 Non-stick baking sheets
8. Oven mitts
9. Oven
10. Balance
11. Metric ruler

Reagents:

Metric Value	Description	Standard Value	Common Name
533.25 mL	Finely milled wheat grains		
5 mL	$NaHCO_3$		
5 mL	Iodized, granular NaCl		
226 g	80% Milkfat, water-in-oil emulsion		
177.75 mL	Granular, crystalline sucrose		
177.75 mL	Sucrose-molasses mixture		
5 mL	Vanillin-ethanol solution		
2	Unfertilized reproductive bodies of *Gallus domesticum*		
340 g	Semi-sweet *Theobroma cacao* chips		

Procedure:

1. Preheat oven to 191°C (_____°F).
2. Combine reagents 1, 2, and 3 in a small mixing bowl and set aside.
3. Soften reagent 4 by heating in a microwave oven for 60 seconds (_____min.).
4. Thoroughly mix reagents 4, 5, 6, and 7 in a large mixing bowl.
5. Add reagent 8, one at a time, to the large mixing bowl, mixing thoroughly after each addition.
6. Gradually add mixture from step 2 to the large mixing bowl and continue mixing.
7. Gently stir reagent 9 into the large mixing bowl.
8. Place 30-mL (_____tbl.) portions of cookie dough onto ungreased baking sheet.
9. Bake in 191°C (_____°F) oven for 600 seconds (_____min.) or until golden brown.
10. Let stand to cool completely.

Data Collection:

1. Record below the total number of cookies made by your group.
2. Select a sample of 10 cookies and set aside for quality control evaluation.
3. Measure the mass (to the nearest gram) and the diameter (to the nearest 0.1 cm) of each of the 10 sample cookies and record values in a table (Table 3) in your laboratory notebook.

Data Analysis:
(Show all calculations.)

1. Calculate and record the mean (average), standard deviation, and relative standard deviation of your sample masses.
2. The standard mass value for this chocolate chip cookie protocol is 31 g. Calculate and record the mean percent difference between the mean mass of your cookies and the standard mass value.
3. Calculate and record the mean (average), standard deviation, and relative standard deviation of your sample diameters.
4. The standard diameter value for this chocolate chip cookie protocol is 9.7 cm. Calculate and record the mean percent difference between the mean diameter of your cookies and the standard diameter value.

Post-Laboratory Discussion:
Write in your laboratory notebook a discussion of your findings and conclusions. Be sure to answer in your discussion the following questions.

1. Define quality control.
2. Why is quality control important in food production?
    a. Define accuracy and precision as they relate to food quality control.
3. Using the mean percent differences calculated for mass and diameter, respectively, describe your accuracy in making cookies.
4. Using the relative standard deviations calculated for mass and diameter, respectively, describe your precision in making cookies.
5. How might you improve the accuracy and precision of your cookie-making process?
6. How do you think food scientists at Nabisco®, the makers of Chips Ahoy® cookies, ensure the quality and consistency (*i.e.* accuracy and precision) of their products?
7. Name another area in which quality control is very important and explain why.

One of These Things is Not Like the Other

Sensory Evaluation – Lesson Plan

Annotation
In this classroom activity, students will explore the principles of sensory evaluation as they conduct and analyze a cola triangle test—a test used to determine whether there is a sensory difference between two products.

Primary Learning Outcomes:
Students will be able to define the term ***triangle test*** and explain its use.

Students will be able to calculate percentages based on a data set.

Students will be able to explain the importance of sensory evaluation in food science.

Assessed Georgia Performance Standards:
SCSh1. Students will evaluate the importance of curiosity, honesty, openness, and skepticism in science.

SCSh3. Students will identify and investigate problems scientifically.

SCSh5. Students will demonstrate the computation and estimation skills necessary for analyzing data and developing reasonable scientific explanations.

Related Topics:
Taste & Sensory Perception
Data Analysis

Duration:
Preparation: 30 minutes
Introduction: 15 minutes
Student Activity: 10 minutes
Conclusion: 15 minutes
Total Class Time: 40 minutes

Materials and Equipment:
For Teacher Preparation:
(Per class of 30 students)

1. 120, 5-oz. Plastic cups
2. 2-L Bottle of Pepsi®
3. 2, 2-L Bottles of Coca-Cola®
4. Gallon of drinking water
5. Saltine® crackers
6. Napkins
7. 12-oz. Can of Sprite® *(For Optional Extension)*
8. Blindfold *(For Optional Extension)*

Per Student:

1. *One of These Things is Not Like the Other* student handout
2. 5-oz. Cup of Sample A
3. 5-oz. Cup of Sample B
4. 5-oz. Cup of Sample C
5. 5-oz. Cup of water
6. 2 Saltine® crackers
7. Napkin

Safety:
Because students will be allowed to drink during the activity, precautions should be taken to prevent materials from coming into contact with laboratory equipment or surfaces. Materials should remain in cups or on clean napkins at all times.

Technology Connection:
Not applicable

Procedures:
Teacher Preparation:
Use the attached template to prepare a *One of These Things is Not Like the Other* student handout for each student. For each student, label 4 cups "A," "B," "C," and "water," respectively. Remove all labels and markings from the soft drink bottle. Label the 2-L bottle of Pepsi® "A." Label one 2-L bottle of Coca-Cola® "B" and the second "C." Fill each cup roughly half full with the appropriate sample.

Estimated Time:
30 minutes

Introduction:
Sensory evaluation, an important area of food science, is a tool used to analyze and interpret human sensory responses to food products based on the five senses: sight, sound, smell, taste, and touch. Sensory evaluation is used to improve existing food products or to determine consumer acceptability of new food products. Several types of sensory tests are used. A triangle test is a difference test that is used to determine whether there is a sensory difference between two products. For example, do consumers detect a difference between generic and name-brand food items? During a triangle test, panelists are presented with three samples and asked to identify the sample they believe to be different from the other two. Data is compiled from a number of panelists and analyzed to determine whether there is a detectable difference between the products. A detectable difference is often considered to be one in which fifty percent or more of panelists are able to correctly distinguish the odd sample from the other two. However, food companies and researchers may adjust these levels according to their particular interests or needs.

Explain to students that they will be sampling three cola beverages: two are the same and one is different. Their task is to identify the odd cola sample.

Estimated Time:
15 minutes

Activity:
Provide each student with the materials listed above. Ask students to sample each of the three colas. Advise them to pay close attention to the color and flavor of each sample. Ask students to indicate the odd sample on the *One of These Things is Not Like the Other* student handout. Students should use the water and crackers to cleanse their palates between samples.

Estimated Time:
10 minutes

Optional Extension: Ask one or two students to step out of the classroom. As the class watches, pour, for each student sent out of the room, two cups of Coca-Cola® and one cup of Sprite®. Appoint a student to escort each student, one at a time, back into the classroom, blindfolded. Ask the student(s) to sample each of the three samples and identify the odd sample. In a blind sensory test, many individuals find it difficult to detect a difference between Coca-Cola® and Sprite®.

Conclusion:
Reveal to students the odd sample. As a class, compile the following data on the board: the number of students that were able to detect the odd sample, the number of male students that were able to detect the odd sample, and the number of female students that were able to detect the odd sample. Discuss with students any difficulties experienced in determining the odd sample. Have students answer the post-laboratory questions found on the *One of These Things is Not Like the Other* student handout.

Estimated Time:
15 minutes

Assessment:
Assessment should be based on completion of the *One of These Things is Not Like the Other* student handout.

Reference:

- Meilgaard, M., Civille G.V., and Carr B.T. 1991. *Sensory Evaluation Techniques.* CRC Press. Boca Raton, Florida.

One of These Things is Not Like the Other

Sensory Evaluation – Student Handout

Introduction:
Sensory evaluation, an important area of food science, is a tool used to analyze and interpret human sensory responses to food products based on the five senses: sight, sound, smell, taste, and touch. Sensory evaluation is used to improve existing food products or to determine consumer acceptability of new food products.

A triangle test is a difference test that is used to determine whether there is a sensory difference between two products. For example, do consumers detect a difference between generic and name- brand food items? During a triangle test, panelists are presented with three samples and asked to identify the sample they believe to be different from the other two. Data is compiled from a number of panelists and analyzed to determine whether there is a detectable difference between the products. In this assignment, a detectable difference is assumed to be one in which fifty percent or more of panelists are able to correctly distinguish the odd sample from the other two.

In this activity, you will be sampling three cola beverages: two are the same and one is different. Your task is to identify the odd cola sample.

Purpose:
To use triangle testing to determine the odd cola sample from a set of three cola samples.

Materials:
1. 3 Cola samples (A, B, and C)
2. Cup of water
3. Saltine® crackers
4. Napkin

Cola Triangle Test:
Sample each of the three cola beverages from A to C. Two samples are identical; one is different. Select the odd/different sample and indicate by placing an "X" next to the letter of the odd sample.

Sample	Indicate Odd Sample	Comments
A	_____	_____
B	_____	_____
C	_____	_____

Calculations:

(Show all calculations on a separate sheet of paper.)

1. What percentage of students in the class was able to distinguish the odd sample?
2. What percentage of male students was able to distinguish the odd sample?
3. What percentage of female students was able to distinguish the odd sample?

Post-Laboratory Questions:

1. Assume that in this sensory evaluation a detectable difference among samples is one in which thirty-five percent or more panelists are able to distinguish the odd sample from the other two. Based on the class data, is there a detectable difference among the samples?
2. Describe three factors that might account for the differences detected between the cola samples?
3. Why can some students detect differences between the samples while other students cannot?
4. During actual sensory evaluation, measures must be taken to reduce panelist bias towards food products. Describe three measures that could have been taken in this experiment to improve the reliability of the results?

The Tomato . . . Flavorful or Flavorless?!?

Sensory Evaluation – Lesson Plan

Annotation
In this classroom activity, students will explore the principles of sensory evaluation as they conduct and analyze an intent to purchase evaluation—a type of consumer acceptability test that is used to determine the likelihood that consumers would purchase a particular product.

Primary Learning Outcomes:
Students will be able to define the term ***intent to purchase evaluation*** and explain its use.

Students will be able to analyze data by calculating and interpreting arithmetic means and numerical ranges.

Students will be able to explain the importance of sensory evaluation in food science.

Assessed Georgia Performance Standards:
SCSh1. Students will evaluate the importance of curiosity, honesty, openness, and skepticism in science.

SCSh3. Students will identify and investigate problems scientifically.

SCSh5. Students will demonstrate the computation and estimation skills necessary for analyzing data and developing reasonable scientific explanations.

SC1 Students will analyze the nature of matter and its classifications.

SPS2. Students will explore the nature of matter, its classifications, and its system for naming types of matter.

Related Topics:
Data Analysis
Organic Compounds

Duration:
Preparation: 15 minutes
Introduction: 20 minutes
Student Activity: 10 minutes
Conclusion: 15 minutes
Total Class Time: 45 minutes

Materials and Equipment:
<u>For Teacher Preparation</u>:
(Per class of 30 students)

1. 4 Supermarket tomatoes
2. Cutting board
3. Knife

4. 30 Paper plates
5. 30, 5-oz. Plastic cups
6. Gallon of drinking water
7. Saltine® crackers
8. Napkins
9. 4 Vine-ripened tomatoes (*For Optional Extension*)

Per Student:

1. *The Tomato…Flavorful or Flavorless* student handout
2. Tomato sample
3. 5-oz. Cup of water
4. 2 Saltine® crackers
5. Napkin

Safety:
Because students will be allowed to eat during the activity, precautions should be taken to prevent materials from coming into contact with laboratory equipment or surfaces. Materials should remain in cups or on clean napkins at all times.

Technology Connection:
Not applicable

Procedures:
Teacher Preparation:
Use the attached template to prepare *The Tomato…Flavorful or Flavorless* student handout for each student. Slice each tomato into eight sections. For each student, place one section onto a plate.

Estimated Time:
15 minutes

Introduction:
Sensory evaluation, an important area of food science, is a tool used to analyze and interpret human sensory responses to food products based on the five senses: sight, sound, smell, taste, and touch. Sensory evaluation is used to improve existing food products or to determine consumer acceptability of new food products. Several types of sensory tests are used. Consumer acceptability tests measure the acceptability of a product to the consumer. An ***intent to purchase evaluation*** is a type of consumer acceptability test that is used to determine the likelihood that consumers would purchase a particular product. During an intent to purchase evaluation, panelists are presented with a sample and asked to rate, most often on a scale of 1 to 5 (1 being least likely and 5 most likely), the likelihood that they would purchase the item if it were available for purchase. Data is compiled from the panelists and analyzed to determine the overall likelihood that consumers would purchase the product (the mean response), and thus, consumer acceptability of that product.

Do you eat tomatoes? Most Americans do. In fact, Americans consume more than 12 million tons of tomatoes annually, averaging per person roughly 18 pounds of fresh tomatoes and nearly 70 pounds in processed forms such as ketchup and tomato sauce.

Explain to students that they will be sampling tomato, *Lycopersicon esculentum*. Botanically a berry fruit, the tomato was domesticated in Mexico and is consumed as a vegetable. The tomato is among the

most popular fruits and vegetables consumed in the world; however, that was not always the case. Upon introduction, Americans were reluctant to consume the tomato for fear that it was poisonous. This fear was based on the tomato's place in the Solanaceae family, a family that also includes poisonous nightshades. Not until September of 1820, when Robert Gibbon Johnson ate the fearful fruit and survived, did Americans begin to confront their tomato phobia. Today the tomato is the second-largest vegetable crop in dollar value consumed in the United States.

Although the tomato is a popular fresh produce item, consumers often complain that supermarket tomatoes lack the characteristic flavor of the "garden-grown" variety. Flavor is defined as the combination of taste, perceived on the tongue, and aroma, perceived in the nose. Fresh tomato flavor results from a combination of non-volatile taste compounds, such as sugars (glucose and fructose) and organic acids (citric and malic acids) and approximately thirty volatile aromatic compounds, including hexanal, *cis*-3-hexenal, and *trans*-2-hexenal. These compounds or their precursors are formed during ripening of the fruit.

Tomatoes are either allowed to ripen on the vine (vine-ripened) or are picked green and artificially ripened. The method of ripening greatly impacts tomato flavor. In contrast to vine-ripened tomatoes, most supermarket tomatoes are artificially ripened. Artificially ripened tomatoes are harvested while they are still green and ripened with ethylene (C_2H_4; Figure 1) to enhance yield, fruit size, lack of defects, and disease resistance. During this artificial ripening process, ethylene, a naturally occurring plant hormone that is responsible for plant ripening, is applied to fruit in the form of ethylene gas. Early harvest and gas treatment of supermarket tomatoes blocks the production of many important tomato flavor compounds, thus greatly decreasing the overall flavor of the fruit. In addition, artificial ripening greatly impacts the color and texture of the fruit.

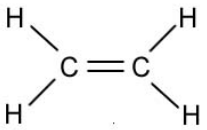


Figure 1: Ethylene

After harvest, tomatoes are often transported long distances before reaching the consumer. Green, unripened tomatoes have a firmer flesh that softens during ripening. Thus, picking tomatoes early and shipping while still firm prevents physical damage to the fruit. This however, provides consumers with a less flavorful product. In 1994, the Flavr Savr tomato, the world's first genetically modified fruit or vegetable approved by the FDA, was introduced in the United States. The Flavr Savr tomato, developed using antisense technology, was designed to provide supermarket shoppers with a genuine vine-ripened product. The tomato was modified to block the gene that produces polygalacturonase, an enzyme that degrades pectin and softens fruit. This allowed the tomato to ripen longer on the vine, thus enhancing the flavor, while also maintaining firmness of the fruit and preventing damage to the fruit during transport. The Flavr Savr tomato was removed from the market after only three years due to business complications and lack of consumer interest.

Explain to students that their task is to sample the tomato and indicate the likelihood that they would purchase that particular tomato.

Estimated Time:

20 minutes

Activity:
Provide each student with the materials listed above. Ask students to sample the tomato and indicate on *The Tomato…Flavorful or Flavorless* student handout the likelihood that they would purchase that particular tomato. Students should use the water and crackers to cleanse their palates before sampling.

Estimated Time:
10 minutes

Optional Extension: If possible, obtain vine-ripened tomatoes from a local farmer's market or produce stand. Have students sample the vine-ripened tomatoes and indicate their likelihood of purchase. As a class, compile and compare results with those for the supermarket tomatoes.

Conclusion:
As a class, compile the data on the board. Discuss with students reasons for their selections. Have students individually answer the post-laboratory questions found on *The Tomato…Flavorful or Flavorless* student handout.

Estimated Time:
15 minutes

Assessment:
Assessment should be based on completion of *The Tomato…Flavorful or Flavorless* student handout.

References:

- Cardulla, F. 1999. Spoiled Produce – The Long and Short of It. *ChemMatters.* April: pp. 7-8.
- Meilgaard, M., Civille G.V., and Carr B.T. 1991. *Sensory Evaluation Techniques*. CRC Press. Boca Raton, Florida.
- Petro-Turza, M. 1987. Flavor of tomato and tomato products. *Food Reviews International*. 2(3): pp. 309-351.

The Tomato . . . Flavorful or Flavorless?!?

Sensory Evaluation – Student Handout

Introduction:
Sensory evaluation, an important area of food science, is a tool used to analyze and interpret human sensory responses to food products based on the five senses: sight, sound, smell, taste, and touch. Sensory evaluation is used to improve existing food products or to determine consumer acceptability of new food products.

An intent to purchase evaluation is a type of consumer acceptability test that is used to determine the likelihood that consumers would purchase a particular product. During an intent to purchase evaluation, panelists are presented with a sample and asked to rate, most often on a scale of 1 to 5 (1 being least likely and 5 most likely), the likelihood that they would purchase the item if it were available for. Data is compiled from the panelists and analyzed to determine the overall likelihood that the consumers would purchase the product (the mean response), and thus, consumer acceptability of the product.

In this activity, you will be sampling tomato. Your task is to determine the likelihood that you would purchase a particular tomato.

Purpose:
To use intent to purchase testing to determine the likelihood of purchase of a tomato sample.

Materials:
1. Tomato sample
2. Cup of water
3. 2 Saltine® crackers
4. Napkin

Tomato Intent to Purchase Evaluation:
On a scale of 1 to 5 (1 being least likely and 5 being most likely), indicate with an "X" the likelihood that you would purchase this product if it were available for purchase.

1 _____

2 _____

3 _____

4 _____

5 _____

Post-Laboratory Questions:
1. What is the average likelihood of students in the class to purchase the tomato? Include in your answer the mean score and range for the class data.
2. Based on the class data, how well do you think the tomato would sell in a local supermarket?

The Perfect Package

Packaging – Lesson Plan

Annotation
In this assignment, students will act as food packaging engineers as they evaluate an existing food package and propose improvements needed to make it the "perfect" package.

Primary Learning Outcomes:
Students will be able to define the term ***package*** and explain the basic functions of a food package.

Students will be able to name and describe commonly used packaging materials and package types.

Students will be able to apply physical, chemical, and biological principles to the evaluation of a food package.

Students will be able to communicate effectively scientific information through written means.

Students will be able to explain the importance of food packaging to the food industry.

Assessed Georgia Performance Standards:
SCSh3. Students will identify and investigate problems scientifically.

SCSh6. Students will communicate scientific investigations and information clearly.

Duration:
Preparation: 15 minutes
Introduction: 20 minutes
Student Assignment: Adaptable to class schedule
Conclusion: Adaptable to class schedule
Total Class Time: Adaptable to class schedule

Materials and Equipment:
Various food packages provided by students

Safety:
There are no significant safety concerns associated with this activity.

Technology Connection:
Students may use all available information resources (e.g. internet search, library research, online databases, books, and periodicals) to aid them in completing the assignment.

Procedures:
Teacher Preparation:
Use the attached template to prepare a copy of *The Perfect Package* student handout for each student.

Estimated Time:

15 minutes

Introduction:

Name any material that you can think of, and it was probably used at some time as a food packaging material. Did you know?

- The earliest food packaging was provided by nature in the form of gourds, shells, leaves, hollowed logs, woven grasses, and animal organs.
- The first commercial cardboard box was produced in England in 1817, more than two hundred years after the Chinese invented cardboard.
- The can opener was invented in 1875.
- The first glass bottle-making machines were invented in the United States in 1882.
- The polyethylene terephthalate (PET) bottle became available in 1977 for use in the beverage industry.

Food packaging is an extremely important area of food science. From the time a food product leaves the factory until it is consumed by the public, it is the package that is primarily responsible for maintaining the integrity of the product. Many definitions are used in the food industry to define the term package. However, the basic definition of a ***package*** is an enclosure of a food product that serves one or more of the following functions.

- *Containment* – Products must be contained in order to be moved from the factory to the grocery store to the pantry shelf.
- *Protection* – Products must be protected from physical damage (*e.g.* drops or falls), environmental effects (*e.g.* water, light, or oxygen), and contaminants (*e.g.* dust, microorganisms, or chemicals).
- *Communication* – The package must attract consumers for purchase. It also communicates product information such as nutritional content, ingredients, and net weight.
- *Convenience* – The package must conveniently fit into the consumer's lifestyle.

Food packaging dates back to the dawn of human civilization when food was contained in materials such as leaves, cloth, and pottery. Modern food packages consist of materials such as paper, metal, glass, and plastics. Recently, a number of different plastics are becoming increasingly important in new package development. As packaging materials, plastics provide visibility of the product, strength, flexibility, and a barrier to moisture and gases. Plastics are polymers, or long chains of repeating molecules. In addition to carbon, these chains may also contain elements such as oxygen, nitrogen, and sulfur. These additional elements, along with the length and shape of the carbon chains, determine the type of plastic produced. The plastics most commonly used in the packaging industry are polyethylene, polyvinyl chloride (PVC), and polyethylene terephthalate (PET). While there are a variety of packaging materials available, the material selected for a particular food product must be compatible with the product, thus protecting and maintaining product quality.

Explain to students that in this assignment they will evaluate a current product package and determine whether the package is best suited to meet the packaging needs of that product.

Estimated Time:

20 minutes

Student Assignment:
Students should select and provide a food package and follow the guidelines provided in *The Perfect Package* student handout to complete an evaluation of the product package. Students may work individually or in small groups.

Estimated Time:
Adaptable to class schedule

Conclusion:
Have students share with the class the findings of their package evaluations.

Estimated Time:
Adaptable to class schedule

Assessment:
Assessment should be based on *The Perfect Package* Scoring Rubric.

References:

- Kadoya, T., ed. 1990. *Food Packaging.* Academic Press, Inc. San Diego, California.
- Robertson, G.L. 1993. *Food Packaging: Principles and Practice*. Marcel Dekker, Inc. New York, New York.

The Perfect Package

Packaging – Scoring Rubric

CRITERIA	10	9-8	7-5	4-0	
Product Name & Description	Product name and a clear, detailed description of the product are provided.	Product name and a description of the product are provided.	Product name and a superficial or unclear description of the product are provided.	Product name or product description is missing or shows little effort.	
Package Description	Clear, detailed package description is provided, including package type, materials used, appearance, and size.	Basic package description is provided, including package type, materials used, appearance, and size.	Package description is incomplete or unclear.	Package description is missing or shows little effort.	
Containment	Clear, detailed explanation of how package achieves containment and why this is important is provided.	Basic explanation of how package achieves containment and why this is important is provided.	Basic explanation of how package achieves containment is provided.	Explanation of how pack achieves containment is missing or shows little effort.	
Protection	Clear, detailed explanation of how package achieves protection and why this is important is provided.	Basic explanation of how package achieves protection and why this is important is provided.	Basic explanation of how package achieves protection is provided.	Explanation of how pack achieves protection is missing or shows little effort.	
Communication	Clear, detailed explanation of how package achieves communication and why this is important is provided.	Basic explanation of how package achieves communication and why this is important is provided.	Basic explanation of how package achieves communication is provided.	Explanation of how pack achieves communication missing or shows little effort.	
Convenience	Clear, detailed explanation of how package achieves convenience and why this is important is provided.	Basic explanation of how package achieves convenience and why this is important is provided.	Basic explanation of how package achieves convenience is provided.	Explanation of how pack achieves convenience is missing or shows little effort.	

Package Evaluation	Detailed evaluation of the package is clearly based on the discussion of how the package achieves the four basic functions.	Somewhat detailed evaluation of the package is clearly based on the discussion of how the package achieves the four basic functions.	Evaluation of the package is somewhat based on the discussion of how the package achieves the four basic functions.	Package evaluation is missing or shows little effort.	
Package Improvements	Detailed and thoughtful explanation of two or more package improvements are given. Improvements are based on the four basic functions of a package.	Detailed and thoughtful explanation of one package improvement is given. Improvement is based on the four basic functions of a package.	Superficial explanation of one package improvement is given. Improvement may or may not be based on the four basic functions of a package.	Explanation of package improvements is missing shows little effort.	
Written Communication	Written proposal follows assigned outline and is written in paragraph form.	Written proposal follows assigned outline and is written in paragraph form.	Written proposal follows assigned outline and is written in paragraph form.	Written proposal does nc follow assigned outline c not written in paragraph form.	
Spelling, Punctuation and Grammar	One or fewer errors in spelling, punctuation and grammar in the report.	Two or three errors in spelling, punctuation and grammar in the report.	Four errors in spelling, punctuation and grammar in the report.	More than 4 errors in spelling, punctuation and grammar in the report.	
				Total Score (out of 1	

Additional Teacher Comments:

The Perfect Package

Packaging – Student Handout

Introduction:
Name any material that you can think of, and it was probably used at some time as a food packaging material. Did you know?

- The earliest food packaging was provided by nature in the form of gourds, shells, leaves, hollowed logs, woven grasses, and animal organs.
- The first commercial cardboard box was produced in England in 1817, more than two hundred years after the Chinese invented cardboard.
- The can opener was invented in 1875.
- The first glass bottle-making machines were invented in the United States in 1882.
- The polyethylene terephthalate (PET) bottle became available in 1977 for use in the beverage industry.

In this assignment, you will select a food product and evaluate its current package. Your task is to determine whether the package is a "perfect" fit for the product.

Purpose:
To evaluate a current product package and to determine whether the package is best suited to meet the packaging needs of that product.

Assignment:

1. Select and provide a food package for evaluation.
2. On separate paper, complete the following *Product Package Evaluation* for the package you have selected.

Product Package Evaluation:
Evaluate your product package and prepare a written report of your findings. Your report should follow the outline below.

1. Product Name & Description – Provide the name and a brief description of the product you have selected.
2. Package Description – Provide a detailed description of the product package, including package type, materials used, appearance, and size of the package.
3. Package Function
    a. Containment – Explain how the package achieves containment. Why is this important?
    b. Protection – Explain how the package achieves protection. Why is this important?
    c. Communication – Explain how the package achieves communication. Why is this important?
    d. Convenience – Explain how the package achieves convenience. Why is this important?
4. Package Evaluation – In your opinion, is the existing package the best-suited package for the product? If yes, why? If no, why not?
5. Package Improvements – Describe any improvements that could be made to enhance the function of the product package.

Can You Believe Everything You See?

Marketing – Lesson Plan

Annotation
In this laboratory exercise, students will explore the allure of marketing as they use the scientific method to evaluate a popular food-related, science-based television, radio, or print marketing claim.

Primary Learning Outcomes:
Students will be able to identify a testable hypothesis and variables of interest.

Students will be able to develop appropriate procedures to test a hypothesis.

Students will be able to collect, organize, and record appropriate data.

Students will be able to analyze and draw appropriate conclusions from experimental data.

Students will be able to evaluate whether conclusions are reasonable by reviewing all available information.

Students will be able to use evidence to support or refute scientific arguments or claims.

Students will be able to communicate effectively scientific information through written and oral means.

Students will be able to recognize that scientific principles can be applied to everyday decisions.

Students will be able to identify likely faults in science-based or science-related claims.

Students will be able to explain the importance of marketing to the food industry.

Assessed Georgia Performance Standards:
SCSh1. Students will evaluate the importance of curiosity, honesty, openness, and skepticism in science.

SCSh2. Students will use standard safety practices for all classroom laboratory and field investigations.

SCSh3. Students will identify and investigate problems scientifically.

SCSh4. Students use tools and instruments for observing, measuring, and manipulating scientific equipment and materials.

SCSh5. Students will demonstrate the computation and estimation skills necessary for analyzing data and developing reasonable scientific explanations.

SCSh6. Students will communicate scientific investigations and information clearly.

SCSh7. Students analyze how scientific knowledge is developed.

SCSh8. Students will understand important features of the process of scientific inquiry. Students will apply the following to inquiry learning practices:

Duration:
Preparation: 10 minutes
Introduction: 20 minutes
Student Assignment: Adaptable to class schedule
Conclusion: Adaptable to class schedule
Total Class Time: Adaptable to class schedule

Materials and Equipment:
Materials and equipment needs will be determined by the experimental procedures developed by students.

Safety:
Safety concerns associated with this activity will be determined by the experimental procedures developed by students.

Technology Connection:
Students may use all available information resources (*e.g.* internet search, library research, online databases, books, and periodicals) to aid them in completing the assignment.

Procedures:
Teacher Preparation:
Use the attached template to prepare a copy of the *Can You Believe Everything You See?* student handout for each student.

Estimated Time:
10 minutes

Introduction:
Have you ever wondered whether all of the marketing claims you see and hear are true? They all sound so scientific that they must have research to back them up, right? Well, maybe.

- Bounty: "The quilted, quicker picker-upper"
- "Gatorade is thirst aid for that deep down body thirst."
- Coca-Cola C2: "½ The Carbs, ½ The Cals, All The Great Taste"

Marketing is an important area of food science, particularly in new product development. No matter how many hours or how much quality science goes into the development of a new product, the product cannot be successful without an effective marketing plan. Food marketing involves everything from the appearance of the package to pricing promotions to television, radio, and print advertising. Often, marketing involves the use of science-based product claims. Any science-based marketing claim must be backed by strong evidence because a false marketing claim exposed by a competitor could be fatal to a product or company.

Provide students with the *Can You Believe Everything You See?* student handout. Explain to them that in this activity they will use the scientific method to evaluate a popular television, radio, or print marketing claim. As a homework assignment, ask students to watch television, listen to the radio, read the newspaper or magazines, and pay special attention to advertisements that include a food-related, science-based marketing claim. Students should select three food-related, science-based marketing claims that they would be interested in testing. Students should record the names of the products, the manufacturers, and the marketing claims to be tested. Each claim may be a comparison of two or more products or a claim made only about the product of interest. The products selected by the students must be readily available consumer products that THEY can legally purchase. Also, the claims must be reasonable for testing within the classroom. **Food-related medical products can only be selected if the claim can be tested without consumption.**

Estimated Time:
20 minutes

Student Activity:
This activity may be completed as a class or in small groups. Students should follow the guidelines provided in the *Can You Believe Everything You See?* student handout to complete the activity. Provide continuous feedback to students and approve the completion of each step before allowing students to move to the next step. Space is provided on the *Can You Believe Everything You See?* student handout for recording due dates and teacher approval.

Estimated Time:
Adaptable to class schedule.

Conclusion:
Students should give an oral presentation to the class that describes the claim tested, experimental design and procedures, results, and conclusion. Students should conclude the presentation with a new, revised marketing claim or slogan based on the experimental results. At the conclusion of the presentations, discuss with students any interesting procedures or findings. In addition, discuss the roles of skepticism and evidence in science and their importance in consumer decision making.

Estimated Time:
Adaptable to class schedule

Assessment:
Assessment should be based on the *Can You Believe Everything You See?* Scoring Rubric.

Can You Believe Everything You See?

Marketing – Scoring Rubric

CRITERIA	10	9-8	7-5	4-0	
Introduction	Introduction is a clear, concise, and thoughtful explanation of the claim to be tested and any needed background information. The purpose of the experiment or the question to be answered during the experiment is clearly identified and stated.	Introduction is a brief explanation of the claim to be tested and any needed background information. The purpose of the experiment or the question to be answered during the experiment is identified, but is stated in a somewhat unclear manner.	Introduction is too brief, unrelated to the experiment, or provides little or no background information. The purpose of the experiment or the question to be answered during the experiment is partially identified, and is stated in a somewhat unclear manner.	Introduction is missing o shows little effort. The purpose of the experiment or the questi to be answered during th experiment is erroneous irrelevant.	
Materials & Procedures	All materials and equipment used in the experiment are clearly and accurately described. Procedures are listed in clear steps. Each step is numbered and is a complete sentence.	Almost all materials and equipment used in the experiment are clearly and accurately described. Procedures are listed in a logical order, but steps are not numbered and/or are not in complete sentences.	Most of the materials and equipment used in the experiment are accurately described. Procedures are listed but are not in a logical order or are difficult to follow.	Many materials are described inaccurately O are not described at all. Procedures do not accura list the steps of the experiment.	
Experimental Design	Experimental design is a well-constructed test of the stated hypothesis.	Experimental design is adequate to test the hypothesis, but leaves some unanswered questions.	Experimental design is relevant to the hypothesis, but is not a complete test.	Experimental design is n relevant to the hypothesi	
Replicability	Procedures appear to be replicable. Steps are outlined sequentially and are adequately detailed.	Procedures appear to be replicable. Steps are outlined and are adequately detailed.	All steps are outlined, but there is not enough detail to replicate procedures.	Several steps are not outlined AND there is nc enough detail to replicate procedures.	

Safety	Experiment is carried out with full attention to relevant safety procedures. The set-up, experiment, and tear-down posed no safety threat to any individual.	Experiment is carried out with attention to relevant safety procedures. The experiment posed no safety threat to any individual, but one safety procedure needs to be reviewed.	Experiment is carried out with some attention to relevant safety procedures. The experiment posed no safety threat to any individual, but several safety procedures need to be reviewed.	Safety procedures were ignored and/or some asp of the experiment posed threat to the safety of the student or others.	
Data	Professional looking and accurate representation of the data in tables and/or graphs. Graphs and tables are accurately labeled and titled.	Accurate representation of the data in tables and/or graphs. Graphs and tables are accurately labeled and titled.	Accurate representation of the data in written form, but no graphs or tables are presented.	Data are not shown OR a inaccurate.	
Analysis	The relationship between the variables is discussed and trends/patterns logically analyzed. Predictions are made about what might happen if part of the lab were changed or how the experimental design could be changed.	The relationship between the variables is discussed and trends/patterns logically analyzed.	The relationship between the variables is discussed but no patterns, trends or predictions are made based on the data.	The relationship betweer variables is not discusse	
Conclusion	Conclusion includes whether the findings supported the hypothesis, possible sources of error, and what was learned from the experiment. Conclusion illustrates an accurate and thorough understanding of scientific concepts underlying the experiment.	Conclusion includes whether the findings supported the hypothesis and what was learned from the experiment. Conclusion illustrates an accurate understanding of most scientific concepts underlying the experiment.	Conclusion includes what was learned from the experiment. Conclusion illustrates a limited understanding of scientific concepts underlying the experiment.	No conclusion was inclu in the report OR shows l effort and reflection. Conclusion illustrates inaccurate understanding scientific concepts underlying the experime	

Spelling, Punctuation and Grammar	One or fewer errors in spelling, punctuation and grammar in the report.	Two or three errors in spelling, punctuation and grammar in the report.	Four errors in spelling, punctuation and grammar in the report.	More than 4 errors in spelling, punctuation and grammar in the report.	
Participation	Used time well in lab and focused attention on the experiment.	Used time pretty well. Stayed focused on the experiment most of the time.	Did the lab but did not appear very interested. Focus was lost on several occasions.	Participation was minima OR student was hostile about participating.	
				Total Score (out of 1	

Additional Teacher Comments:

Can You Believe Everything You See?

Marketing – Student Handout

Introduction:
Have you ever wondered whether all of the marketing claims you see and hear are true? They all sound so scientific that they must have research to back them up, right? Well, maybe.

- Bounty: "The quilted, quicker picker-upper"
- "Gatorade is thirst aid for that deep down body thirst."
- Coca-Cola C2: "½ The Carbs, ½ The Cals, All The Great Taste"

Now is your opportunity to pick one popular, science-based marketing claim and put it to the test.

Purpose:
To use the scientific method to evaluate a popular food-related, science based television, radio, or print marketing claim.

Assignment:

Step	Due Date	Complete
1. Watch television, listen to the radio, read the newspaper or magazines, and pay special attention to advertisements that include a food-related, science-based marketing claim.		
2. Select three food-related, science-based marketing claims that you would be interested in testing. Record the names of the products, the manufacturers, and the marketing claims to be tested. Each claim may be either a comparison of two or more products or a claim made only about the product of interest. *(Note: The product you select must be a readily available consumer product that YOU could legally purchase. Also, the claim must be reasonable for testing within the classroom.* ***Food-related medical products can only be selected if the claim can be tested without consumption****.)*		
3. Meet with your laboratory group and select the one marketing claim that your group will test. Have your teacher approve your group's selection.		
4. Identify and record the hypothesis that will be tested.		
5. Meet with your group to develop an experimental procedure that will allow you to test your stated hypothesis. Write a brief outline of your proposed procedure and have it approved by your teacher. You should include in your outline the independent and dependent variables of interest, experimental controls, what data will be collected, and how you will analyze that data.		

6. Write a detailed experimental procedure and list of materials. Have these approved by your teacher.		
7. Set up and conduct your experiment.		
8. Compile and analyze your data. Construct tables or graphs as needed.		
9. Meet with your group to discuss and write up your findings and conclusions. Remember that all conclusions must be based on data collected during the experiment.		
10. Give an oral presentation to the class that describes the claim you tested, your experimental design and procedures, the results, and conclusion. Use visual aids to help in your explanation. Conclude your presentation with a new, revised marketing claim or slogan based on the experimental results you obtained.		

FOOD FIGHT!

Product Development in the Science Classroom

Amy Rowley

Jeremy Peacock

The University of Georgia
College of Agricultural and Environmental Sciences

College of Agricultural and Environmental Sciences