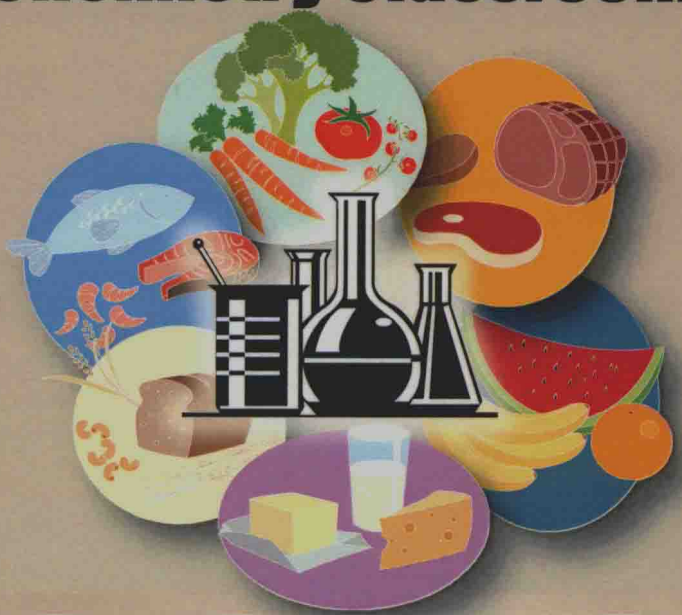
S SYMPOSIUM SERIES 1130

Using Food To Stimulate Interest in the Chemistry Classroom



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Using Food To Stimulate Interest in the Chemistry Classroom

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Using Food To Stimulate Interest in the Chemistry Classroom

Foreword

The ACS Symposium Series was first published in 1974 to provide a mechanism for publishing symposia quickly in book form. The purpose of the series is to publish timely, comprehensive books developed from the ACS sponsored symposia based on current scientific research. Occasionally, books are developed from symposia sponsored by other organizations when the topic is of keen interest to the chemistry audience.

Before agreeing to publish a book, the proposed table of contents is reviewed for appropriate and comprehensive coverage and for interest to the audience. Some papers may be excluded to better focus the book; others may be added to provide comprehensiveness. When appropriate, overview or introductory chapters are added. Drafts of chapters are peer-reviewed prior to final acceptance or rejection, and manuscripts are prepared in camera-ready format.

As a rule, only original research papers and original review papers are included in the volumes. Verbatim reproductions of previous published papers are not accepted.

ACS Books Department

Preface

Our survival as a species depends upon our ability to discriminate between things that are nutritious and those that are poisonous. As omnivores, we must make many more food decisions than either an herbivore or a carnivore. Our brains are configured so that the pleasure centers are activated when we eat foods that will provide safe calories, and so that the flight reflexes are triggered when we eat foods that are poisonous (*1*). But how do our bodies recognize which chemical entities are nutritious and which should be avoided? How do humans make these food choices? These are questions that are fundamental to the idea of life, and so relevant to any student, no matter what their major in college. As anyone who has taught a class knows, showing students the relevance of the material you are trying to teach is a crucial step to student learning.

There are many factors that go into the acceptance of a food: its color, texture, smell, taste, and even your past associations with the food. People are, in general, quite conservative in their food choices; and we tend to reject foods that don't meet our preconceptions about food or are an unexpected color or texture (*2*). Think about the experiment a couple of years ago with purple catsup, or our reaction to uncolored (white) margarine. Both the catsup and the margarine taste just fine and are safe to eat, but we reject them because their colors do not fit our preconceptions of what butter and catsup ought to look like. Once again, these textures and colors are a direct result of the chemistry taking place in the food warring with our cultural expectations of what nutritious food should look and feel like. While there are chemical reasons why a food has the color and texture that it does, the associations of rejection or acceptance are mostly a matter for the psychologist. The final two factors involved in food acceptance, taste and smell, are directly tied to how our senses react to the chemistry in the environment around us.

This is just one facet of the fascinating chemistry of food systems. While they are usually complex and often not well understood, they are immediately relevant and almost universally interesting to the students. Because of the complexity of the systems, the opportunities to provide insight into other disciplines are available to the instructors of these courses. This volume comes about as a result of the efforts of the authors to enhance student interest in chemistry based upon their presentations at the 22nd Biennial Conference on Chemical Education, held at Pennsylvania State University from July 29 to August 2, 2012.

This volume is divided into two sections. In the first section, we describe the efforts by the authors to design entire courses around the concept of food chemistry. These courses range from short courses for non-majors, to specialty courses on specialty topics such as beer production, to senior level capstone courses for majors that seek to tie together the undergraduate curriculum. They range from courses

that focus completely on the chemistry of the system, to those which explore the cultural, psychological, sociological, or political facets of food chemistry and the food systems that support our civilization. The commonality of these courses is the observation by the instructors that student interest and learning is enhanced. Even when presenting material that in other contexts would be considered difficult or "dry," the student interest and enthusiasm is unabated.

In the second section, we deal with authors who have used food chemistry to enhance specific activities that will make a course more interesting. Whether these are novel experiments, new activities, or opportunities for enhancement of the education of the instructor, these authors show us how to implement the ideas behind food chemistry in a way that will make any course better and enhance student interest in chemistry.

We hope that you enjoy this book and can find material here that will make whatever course that you teach a better experience for both you and your students. Bon Appetit!

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Chapter 1

The Chemistry of Food: A First-Year Three-Week Seminar Course

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At a small liberal arts institution, chemists are continually seeking methods to excite students about chemistry. Students need to understand that chemistry is an essential aspect in their everyday life. What could be more relevant than food consumption and production? Moreover, why do certain food taste good while others are repugnant? The Chemistry of Food first-year seminar course is designed to engage students in the basic concepts of chemistry while exploring a variety of topics related to food. The course also fosters educational skills such as logical thinking and effective communication. The 16-day course was taught for three hours a day during January term.

Introduction

In a first-year seminar course without any prerequisite courses, students explored several questions. Why are some foods better than others? How do individual food components contribute to the quality of the food? What chemical changes take place when a food is treated with an acid or heat? The course was divided into three themes: the biochemistry of food, flavor, and food ethics. All first-year students enroll in first-year seminar courses during the January term of their first-year. Therefore, the course described here is designed for a three-week term. The students met in the classroom for three hours a day for 16 days. In addition, the first-year seminar courses is part of our general education requirement; so, the course goals align with the first-year seminar goals of the college:

1. To provide a small-group learning situation that will engage students and faculty in an intensive intellectual experience
2. To introduce students in an innovative fashion to a discipline's basic concepts, modes of thought, or procedures
3. To foster basic educational skills--how to read critically, think logically, and communicate effectively (*1*).

By the end of the course, students will describe how chemistry plays a role in food and cooking and intelligently communicate their knowledge with their peers about chemistry, food, and cooking. Moreover, students will have developed their skills with the scientific method. A final goal of the course is to consider the ethical issues surrounding food production. On the first day of class, the goals were outlined, and students were informed that this is a science class not a cooking class.

To foster the college and course goals, students read *The Inquisitive Cook* by Anne Gardiner (*2*). The text was our main resource; however, additional articles and multimedia materials were provided. *The Inquisitive Cook* is an easy to read book written for the non-scientist; it explored most of the topics discussed in the course. While it does not go into the depth that other texts do, students obtained enough background to the material before class discussions. Students also presented their experimental results to the class several times. To help facilitate recreating a course on Chemistry and Food this chapter discusses the topics discussed during the term. In addition, the experiments and presentation assignments are also described. The final project was a video showcasing both cooking and chemistry.

As a logistical note, students had access to kitchens in their living spaces; however, we did not have access to a kitchen as a class. All cooking experiments performed as a class were done in a standard classroom. Therefore, the experiments described here do not cover all the topics we discussed in class. Students did address additional topics in the videos produced.

Course Topics

The Biochemistry of Food

To start the class, the students read a handout discussing basic physical and chemical principles. Next, the students were introduced to the major macromolecules in food. A lot of chemistry regarding why food looks the way it does was discussed during this segment of the course. For example, student investigated why some fats are solid while others are liquids. Students focused on four groups of food all outlined in *The Inquisitive Cook*: dairy, eggs, meat, and fruits and roots. Students learned about the composition of milk and how cheese is manufactured. The class examined the Maillard reaction and the effects temperature has on meat.

For each section, readings were assigned. Students completed a reading quiz prior to class. Often times a case study was used to illustrate the biochemical concepts. Students were assigned areas of food where they were the experts on that

particular topic. Experiments were performed for several topics. The experiments are outlined in the Experiments section below.

Students investigated different types and cut of meat. Moreover, the macromolecular composition of the meats was discussed. Moreover, a local chef and culinary professor visited the class to discuss the differences between corn fed and grass-fed livestock (*3*). Anecdotally, he discussed how the fat composition of bacon varied based on the diet of the hog.

Flavor

Students now had a keen interest in learning why certain food taste good together. We had spent a significant portion of the biochemistry and food section discussing the composition of food; yet, we had yet to discuss the actual flavors contained in each group. Groups of students were assigned one of the four basic tastes: sweet, salty, sour, and bitter. The groups then developed an expertise in their specialty. Each group was responsible for explaining why food taste sour, salty, etc.

Students explored the science of artificial flavoring. Students watched a multimedia presentation about the creation of flavor from organic compounds. Pair of students researched a specific compound for a class presentation. The class also investigated the taste difference between artificial flavors and their natural counterpart.

Flavor acquisition is an important aspect of cooking. Students explored the addition of spices, dressing, and acid in the deviled eggs experiment. In addition, we incorporated the discussion of genetically modified organisms with food production. In other words, do companies seek non-genetically modified foods? A large industry in Kentucky is bourbon. We toured Maker's Mark Distillery, where students learned that the corn is tested for various compounds that indicate if it is genetically modified corn. Only non-genetically modified corn is accepted by the distillery. The students were also exposed to the type of quality control that is necessary when producing a product even on a large scale. Fermentation and the distillation process is an important component of why different types of bourbons have different flavors. Although students could not taste test the product, the field trip was a very valuable experience for students to understand how much chemistry is necessary for bourbon production.

Food Ethics

In developing the course on chemistry and food, the idea of how food production affects the environment and human health became an important one to address in the course. At a small liberal arts college, we are often seeking to tackle issues in a wider social context. It was necessary to expose the students to both sides of the issue. Therefore, we did several cases studies where a variety of chemicals were found in food. Students had to decide whether or not they would continue to eat the food with the knowledge toxic chemical were either in the food or produced as a byproduct.

Additionally, farming practices for both livestock and produce were discussed. The local chef, previously mentioned, discussed the importance of the cliché—"You are what you eat." However, he took it another step: "You are what the animal eats." Students learned that the type of fat in bacon varies based on what the pig consumes. In addition, students read articles and watched documentaries where issues around factory farming and genetically modified food issues were in the forefront.

In addition to the guest speaker who spoke tangentially about food ethics, the students visited a local meat processing plant. It is a small facility that processes local livestock. All of the animals processed at the plant were treated well on the farm. The owners spent a great deal of time not only discussing the ways in which they seek to the make the animals more comfortable prior to slaughter but also the ways in which the animals were housed and treated at the farm.

As a note, these issues were discussed in the class because they allowed us to talk about ethical issues in the choices we make everyday. Perhaps more interesting though is the fact that students self-reported this portion of the course the most enlightening. Most of the students in the class had never thought about where their food comes from or why it might matter what the pig eats. Students also self-reported that this aspect of the course transformed the way they think about food.

Presentations and Projects

Experimental Notebook

The experimental notebook aspect of the course is a hybrid of a cookbook and a laboratory notebook. Students outlined the main sections of a laboratory notebook: purpose, procedure, observations, data, and discussion. Students were to record all data and observations for each cooking experiment performed; students were to also record data and results for the experiments in their video projects. Typically, prompts and questions were provided to guide the students through the process. Notebooks were collected once at mid-term and again at the end of the term. At the end of the term, students were asked to evaluate their own notebook for repeatability.

In-Class Oral Presentations

Developing a Recipe for Deviled Eggs

After discussing dairy products and introducing basic flavor concepts, a list of items from ketchup to pickles was provided to students. Students paired items on the list based on their knowledge of flavor. Students worked in pairs to develop a recipe for deviled eggs using the pair of ingredients chosen. For example, one group had the obvious pair of mayonnaise and mustard while another group had salad dressing and hot sauce. Students then prepared the deviled eggs outside of

class and presented their experimental research to the class. Students prepared a PowerPoint presentation outlining scientific method for recipe development. Then, students tasted the final products.

Flavor Additives

Pairs of students chose a flavor compound to investigate. The pair prepared a PowerPoint presentation on the flavor of interest. Presentations addressed three main questions. What flavor does the compound mimic and how? What types of food is your flavor compound found? Are there any known problems or benefits associated with the flavor compound? While the presentation was a group project, each student wrote a one-page summary of the findings. The flavor presentations were fascinating, and they exposed students to a variety of flavor compounds.

Food Ethics Reflections

Students wrote responses twice in the food ethics section of the course. The first assignment was a reflection on an article focusing on genetically modified food in *Vanity Fair* (*4*). The second was for a documentary we watched: *Food, Inc.* (*5*). Both articles were in preparation for the small-scale meat processing plant we visited at the end of the term.

Video Project

Throughout the term, students worked in groups of four to plan a meal and describe the science behind the meal. Students incorporated the knowledge gained with experimental design, food composition, and flavor combinations to produce a meal and a video showcasing a specific food. Each group focused on one of the main groups we discussed at the beginning of the course. On the last day of class, we hosted a public premiere with food from each video. The video and associated projects (storyboard and storyboard presentation) was worth almost one-third of the course grade.

Logistics

The video project was assigned on the first day of class. Students choose groups of cheese, eggs, fruits, and roots via the course management software prior to the first day of class. On the first day of the class, I gave an outline of the project and assigned various checkpoint dates. On the second day of class, an instructor from the Center for Teaching and Learning came to class to teach my students how to film, edit, and produce a video. On the fourth day of class, storyboards were due. The final video was due on the last day of class. Students were instructed to finalize the DVD the evening prior to class, as it can take an hour or more to burn a movie of this size to a DVD.

Storyboard Presentations

The storyboards were presented to the class, and we discussed the ideas each group presented. The storyboards are an important aspect of the video project assignment; they carried a significant amount of weight in the grading rubric for the project. The storyboards are necessary to keep the students on task and alert the students to how much detail will be necessary to produce a 30-45 minute movie.

Video Premiere

Each of the videos was premiered at a public event. The groups were encouraged to bring food showcased in the video production. Students ranked the videos, which was considered when evaluating the final product.

Experiments

As mentioned previously, the class did not have access to a kitchen to perform experiments. Therefore, we were limited as to what types of experiments we could perform. The three in-class experiments (ice cream, whipping cream, and flavor) were performed in a standard classroom. It is also important to note that the experimental notebook was less than 10% of the course grade.

Ice Cream Experiment

Utilizing the chemical principle of freezing-point depression, students performed a simple experiment to make ice cream (*6*). The students recorded data and observations in their experimental notebook.

Whipping Cream Experiment

As a topping for the ice cream, students prepared whipped cream. A variety of agents were added to the cream as students whipped it. In addition, one group used a copper bowl. Students analyzed which method produced the whipped cream most efficiently (*7*).

Deviled Eggs Experiment

Students were given basic instructions on making deviled eggs: boil eggs, shell eggs, mix yolk with specified ingredients until the final product is delicious. Students performed their own research via the Internet or a phone call to a relative. Each student pair was assigned a set of ingredients. For example, the best-deviled eggs were made with blue cheese dressing and hot sauce; they were named the Buffalo Deviled Egg. The student pair was assigned salad dressing and hot sauce.