Candy Bites
The Science of Sweets

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We would like to dedicate this book to wife and mother, Paula McMahon. Thanks especially for your patience with us as we wrote this.

Preface

The impetus behind Candy Bites is the candy course taught at the University of Wisconsin-Madison. Every summer since 1963, when the course was initiated in conjunction with the National Confectioner's Association, candy technologists in companies around the world have congregated in Madison for several weeks to learn about candy. From hard candy to chocolate, they learn about ingredients, formulations, and manufacturing methods from experts in the field. They then come down to the candy lab and make numerous batches to understand how formulation and processing conditions influence the quality attributes of each candy.

For example, in the caramel lab, small groups of students make about 15 different caramel varieties. Some use sweetened condensed milk while others use powdered milk, some use butter while others use vegetable fat, and some cook to 238 °F while others cook to 260 °F. At the end, the instructor provides input and evaluation on how and why the observed differences come about.

This long-standing expertise in candy science is also available to the undergraduate Food Science majors at UW-Madison through a senior elective course, Candy Science. From understanding how the boiling point elevation curve influences moisture content in sugar confections, to how the principles of glass transition and the state diagram allow control over candy quality, to controlling the polymorphic crystallization of cocoa butter during tempering of chocolate, the students learn to apply scientific principles to candy making. In this way, candy making becomes more of a science than an art (see Chap. 3).

In this book, we've teamed up to provide a unique product. Most of the chapters were written by Dr. Rich, a Professor of Food Science and lead instructor for both candy courses, with input from AnnaKate, who has degrees in English and Writing. A few chapters were written by AnnaKate, which are indicated as such in the text. It was written so that people with all levels of science education and expertise can enjoy this book. We hope you enjoy learning a little science along with trivia, history, and social insights related to candy

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Through A Candy Store Window

While on vacation in Provincetown, Massachusetts, a small resort town on the tip of Cape Cod, we took a visit to a local candy shop. The proprietor was making fudge in the window and had a fan blowing the fumes out onto the street as the tourists walked by. Sugar and cream cooked together gives off a wonderful smell reminiscent of caramel and fudge, so many people when they first got a whiff of the exhaust fumes raised their heads to see where the smell was coming from. Nearly everyone, except perhaps for those strict parents who frown on sweets and were intent on getting their kids past a candy store without major incident, looked into the window of the shop to see the candy maker at his fudge kettle.

What a great marketing strategy, blowing your candy smells out onto the street to intrigue the passers-by into coming into your shop. Odor is one of the strongest ties to our deeper emotions and this candy maker was hoping that the smell of cooking fudge would bring out childhood memories and induce people to step into his shop. The fresh candy smell was a better advertisement than a huge banner on the storefront proclaiming a deep discounted sale.

So, of course we went in to look around, see what candies were available, watch the customers searching the shelves for their favorite candies, and to observe the proprietor at his art.

Once inside the shop, we saw that the candy maker was teaching a new employee how to make fudge. It was the start of the summer tourist season and the proprietor was training this young man in the details of making their special brand of fudge. He was showing the employee the proper way to stir as the mixture of sugar, corn syrup, condensed milk and butter cooked in a large

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copper kettle on an open flame. Ensuring that all the ingredients are well-mixed, with the butter properly emulsified, while preventing the milk proteins from scorching on the hot surface requires constant attention and vigorous agitation. The proprietor was teaching the apprentice how to execute a figure-eight mixing pattern with the large wooden paddle to make sure the entire kettle surface was periodically scraped clean without causing a vortex in the middle. I watched with approval since this is exactly the technique we teach in our candy courses.

As the fudge batch cooked on the flame, the proprietor wondered aloud about the hot and humid weather expected for the next few days. "Hmm, it's going to be hot and humid for the next few days" he said. As an experienced candy maker, he knew that the outside conditions could have an impact on the characteristics of his candy—how it would feel and taste, and how long it would last. On a normal day, he would have cooked the batch to a pre-set temperature, defined by the candy thermometer (see Chap. 8), to obtain a smooth, creamy fudge that was firm, but still soft to bite through. The hot, humid weather he knew would make his fudge unacceptably sticky and soft, so he proclaimed to the employee "Let's cook the batch to one or two degrees higher temperature than normal. That'll make it hold better." Without really knowing it, he was applying science to his art.

What was funny was that he then looked over at me, since he knew I was watching, and said "It's not rocket science". I laughed and said, "No, it's candy science." He didn't know who I was. As a scientist (Physics and Engineering) who studies candy making and teaches candy science to anyone who'll come near my lab, I have an appreciation for the science that goes into making a high quality confection (although I often wish I was better at the art of it).

The aroma of fudge cooking on an open flame is wonderfully appealing, so it's not surprising that candy often elicits strong emotions since it's generally tied to childhood experiences. A walk through an old-time candy shop, fudge aroma and all, is often a walk through our childhood. Perhaps for you it's seeing the colored candy dots on the strand of paper or the box of candy

cigarettes that brings the memories rushing back. Each one of us has our own buried memories and emotions, just waiting to rush back to mind with the proper stimulus. Candy is one of those stimuli that often create a strong bridge to our childhood memories.

In the following chapters, we hope to build on this image of walking through an old-time candy store to pique your interest about the history, sociology, and especially, the science behind your favorite candies. We hope to provide an entertaining and enjoyable trip back through the candy store memories of your childhood to develop a greater appreciation for the science behind the art of confectionery.

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All Candy Expo

Like a kid in a candy shop, she flitted from booth to booth. On her left there's a new candy bar to taste (nougat and caramel roll laid on a chocolate wafer) and on her right she's being asked to sample the new Jelly Belly flavors (Dog Food, Dirt, and Centipede). Every way she turns, there's something new and exciting to taste and investigate. It's fun walking through the All Candy Expo, no matter what your age.

The National Confectioners Association (NCA), a corporate sponsored trade group responsible for overseeing the interests of the confectionery industry, holds an enormous annual exposition of all things new in the candy world (now called the Sweets and Snacks Expo). Every year, candy manufacturers and distributors put on their prettiest faces (or hire the prettiest models) to hawk their products to the nation's retailers. Thousands of people come to walk the aisles of the Expo to see what's new.

Unfortunately, not just anyone can attend. Without an invitation, you can't get in. If you own a shop that sells candy, you're invited to this Expo as a buyer. Other than that, everyone else is excluded, except for a candy scientist and his wife. Even the deepest love for candy isn't enough to get you in. You have to be a buyer to go crazy at the All Candy Expo—and there's a good reason for that.

Everyone would love to go crazy in a candy expo!

And many people do. It's almost sad how some people lose it when exposed to such choices. Over the years, the people at NCA have had to change their policies regarding who could attend the Expo and what they could take away because of people's behavior. Children under 16 are no longer allowed in—their behavior,

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goggle-eyed crazy in a candy shop, took away from the intended purpose.

It wasn't just kids, though, that caused problems. Many adults would also go nuts around so much candy. People would roll in luggage carts to fill up with free stuff. Exhibitors often have bowls of candy out for people to sample and these people would completely wipe out the bowl, pouring the contents into their travel bag. How rude—no consideration either for the exhibitor or the next person to come along. Supposedly, one person filled his bag up enough times to fill his station wagon—he took the candy back to his convenience store to sell. Not a bad profit, but at what expense.

To control the greedy nature of people, NCA then limited what bags were allowed into the Expo and, for a while, created a Candy Room to appease people's desires for free candy. Attendees would receive a standard bag as they entered the Candy Room and be allowed to fill it up once. You'd think a free bag of candy would satisfy people, but one bag full wasn't enough for some. Although it was only a few people who found ways to circumvent the rules, for example by building up the walls of the bag with cardboard so it would hold more, NCA finally had enough of people's greed and discontinued the Candy Room.

Expo attendees are now limited to one designated bag to collect samples and brochures and no wheelies allowed—the free candy grab is over.

Too many people just lose it when faced with free candy. They lack control. Or rather, they lose control.

For the most part, we learn to control our urges through the process of growing up. It's not unusual for a young kid to yell "Mine" when another kid tries to play with his toy, but parents generally teach their kids to share and control their selfish urges. Parents also teach their kids not to be gluttons, particularly with sweets and candy. In private, a kid may binge on candy until he gets sick, but at least in public, we grow up being taught to control our inner urges. And those urges for sweets seem to be one of the stronger temptations we face.

But each person is different and we each fall prey to our own temptations. Take, for example, a box of chocolates. Some people can restrict themselves to one piece per night. These people can enjoy the taste of a chocolate and then put the rest of the box aside, knowing it will be there the next night. Seriously, there really are such people—saints. Most of us would go back for another (and maybe even another). Once the taste is in your mouth, it's difficult to stop. Some people have so little control, they'd eat the entire box at one sitting, and then usually regret it.

For what it's worth, if you really want to stop at one chocolate, consider brushing your teeth immediately after that first one. Removing the chocolate taste in your mouth removes the temptation to take another one. Besides, chocolates (and many other things) taste terrible with a toothpaste mouth.

Consider the Marshmallow Experiment. An experimenter and a four-year-old are together in a room. The experimenter says, "You can either have one marshmallow right away or, if you wait 15 minutes, you can have two." He then leaves the room, leaving the four-year-old alone with the marshmallow (and a camera). Imagine the agony. Not surprisingly, some kids succumbed—better one marshmallow now than two later. Others found ways to pretend it wasn't there or had enough self-control to delay gratification for a larger reward. The research found that those children who have the patience to wait are often happier and healthier adults (lower body weight, higher SAT scores, and, in general, significantly more confident) than those who ate the marshmallow right away. The marshmallow test was even a better indicator of future success than socio-economic factors. Marshmallows can tell the future.

As a kid, I'm not sure if I could have waited 15 minutes for a second marshmallow. I was the typical candy fiend, saving money to buy candy, always trying to get the best value for my money (3 Musketeers are really big for their weight and appeared to go a lot farther than the more dense Snickers Bar). Still, it was only a marshmallow; I think I could probably have lasted 15 minutes.

Nowadays, with candy all around me, I can afford to be extremely picky and eat candy sparingly (which, along with lots of cycling miles, helps keep the spare tire at bay as well). People marvel at how I can have candy all around without craving it, but it's probably like anything—you get saturated with it and no longer feel the need all the time.

Still, there's a sense of wonder walking around the All Candy Expo, looking at all the new candies appearing on the market. Although I don't have that same amazement as my wife, there's something really cool about being inside the candy industry and being exposed to all the new sweets.

3

Art or Science: A Brief History of Candy

Numerous articles, blogs and even books have been written about the history of candy. Many of them start with natural sweeteners, like honey and maple syrup, and then move on to refined sugar, which is a relatively modern development. We'll focus here on the history of candy science, since this provides a unique perspective to how candy developed and where we are now.

Is candy-making an art or a science? More than 50 years ago, candy maker Jimmy King of the American Molasses Co. was asked by his peers in the candy industry to give his insight into the difference between art and science in candy making. He suggested that candy making developed over the years as an empirical or "non-rational" art. That is, early candy makers took whatever ingredients were available and experimented with their different attributes until they made something that looked and tasted good. No science was used; it was all trial and error.

Have things changed since then? Candy makers still argue, or at least discuss, this; well at least some candy makers do. In the University of Wisconsin summer candy school, it's not uncommon to hear industry instructors, people with substantial experience in the manufacturing industry, raise the art versus science debate.

Perhaps a brief look at the history of candy development can help shed some light on the art versus science question. The first "candies" were probably fruits and nuts rolled in honey, or something like that. And they were eaten almost immediately, so there were no worries about how long they would last. Not much science in that.

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Even centuries later, most candy making was still done without a clue about the science (actually, many things are like this, from food to paint, and even babies). We didn't even know what molecules were until the early 1800s, so how could we understand the details of the candy-making process? Yet our ancestors could still make delicious confections (as they could still make strapping babies without knowing genetics).

The history of candy is intertwined with the development of refined sugar (see Chap. 5). It wasn't until sugar became cheaper and easier to get that candy making really took off. Before that, it was only kings and other wealthy types who could afford to have confections made for them. It's quite probable that the precursors of many of our current candies were developed in king's kitchens around the world.

The 1800s through about the mid-1900s was a time period of intense candy development. Most of our modern candies were either developed or perfected during that time period. While there are numerous new candy introductions each year—the candy industry is continually looking for new ideas—most of the top ten candies have been around for close to 100 years.

Another important development in the candy industry over the past century or so has been technology and automation. Candy used to be made by hand in small batches by artisan candy makers. They had the "feel" of the candy and could often tell when a candy was done by their sensory evaluation (visual, feel, smell, etc.). One of the most amazing tricks used by old-time candy makers was to dip their fingers into the hot cooking mass. They would dip their fingers into cold water, then directly into the boiling sugar syrup (yikes, just thinking about it makes me flinch), and then back out into the cold water, just to tell whether the cooking sugar syrup was ready or not. No science, or thermometer, needed.

Now, most commercial candy is made on large and mostly automated processing lines. Imagine an army of naked Snickers bars on a conveyor passing through a chocolate-fall (a waterfall of melted chocolate). Hundreds of finished candy bars come off the line every minute. Instead of an old-time candy maker to dip his

fingers into the syrup to decide if it's done, the most modern technology is used to control every aspect of the operation. This requires a very sophisticated understanding of the science underlying candy manufacture.

Scientifically, as our understanding of the world around us, both macroscopically and microscopically, developed over recent centuries, our understanding of candy making improved as well. From molecules to microbial growth, scientists applied the latest findings to all aspects of our lives, including sweets.

In recent history, the scientific understanding of candy and candy making has grown exponentially. Some of the earliest candy scientists, in the 1940s, 1950s and 1960s, knew an incredible amount about what went on beneath the surface, so to speak. That development continues to this day, with all the latest advances in physics, chemistry, microbiology and even biology being applied to advance our understanding. Many commercial candy companies hire PhDs in a variety of disciplines to help keep them competitive in the modern candy universe.

With this history in mind, is candy-making an art or a science? As with most things, continuous improvements in our understanding of what happens to the ingredients during candy making to make a quality candy is turning candy making into much more of a science-based process.

However, there are still plenty of opportunities for the artistic and creative aspects of confectionery, especially as practiced by artisan candy makers. In fact, one can see a resurgence of artisan candy makers, but perhaps with a difference from past times. They also want to understand the basics of what they're doing in hopes that they can enhance their offerings. Combining the technical knowledge of a science degree with culinary training allows them to develop new and unique offerings.

As one instructor used to say when talking about hard panning (see Chap. 45), it's not an art or a science. . ..—it's a sport. The more you practice, the better you get, whether you understand the science or not. That pretty much sums it up, although as a scientist,

I hope that adding science to candy making helps improve the sport.

4

Candy Companies Big and Small

A long time ago, confectioners had to do everything themselves in their own shop. Candy making started out as small individually run businesses and, although some candy makers still hold to this tradition, we now find huge international conglomerates dominating the commercial market.

At the beginning, confectioners would make their candy products fresh every day for people to purchase. Down in the alleys of the big cities, along with the signs for blacksmiths, bakers and butchers, would be the shingle for the confectioner, attracting business to his shop. Now, whole towns, like Hershey, PA, have hung out their candy shingle, to attract people from around the world. In Hershey, even the light fixtures are decorated like candy, Kisses to Peanut Butter cups.

One hundred years ago, there were hundreds of candy companies. The late nineteenth and early twentieth century were the heyday of candy development, with many of our national brands developed prior to 1950. Later in the 1900s, however, companies started to grow by buying up others. Like Pac-man gobbling up everything in his way, large candy companies get bigger by gobbling up other candy companies.

Look at the Hershey Company. Known primarily for chocolate, Hershey's has become one of the largest candy companies, primarily by buying out other brands. Twizzlers, Mounds, Almond Joy, York, Kit Kat, Jolly Rancher, PayDay, Zagnut, Zero, Good and Plenty, and the list goes on and on. All brand acquisitions, a business term for buy-out. Mars, Nestle and now the largest candy maker, Ferrara Candy, also have grown by mergers and acquisitions.

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