Food Bites

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The Science of the Foods We Eat

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What Is Food Science?

If you don't finish your dinner, you'll go to bed hungry! Parents have it right, you have to eat. Even before our forefathers crawled out of the ocean, food was an important part of life. Back then, one of our daily battles was finding the food we needed to survive, at least that is when we weren't fending off bigger predators who, in turn, wanted to make a meal out of us. Like the fish in the proverbial food chain, we were looking for smaller fish to catch while the bigger ones were chasing our tails.

Finding food has always been like that, or at least until modern times.

Before civilization, or at least before TV dinners, the food chain was much different than it is now. Most of us were farmers, hunters, and gatherers. We planted wheat, corn, and other crops to harvest, and hunted for game and local produce (berries, nuts, etc.) to round out our diets. Everyone was directly involved in finding food for survival, in one way or another.

As towns formed and grew, more and more people became dependent on others for their food supply. In return for providing such needed skills as dentist and blacksmith, maybe even banker, lawyer, and used car salesman, city dwellers got the food they needed from local farmers.

As towns and cities grew into metropolises, the connection with the farmer decreased even more, to the point where most urbanites today probably would not even know a farmer if they ran one down in their sport-utility vehicle. Most of us have never even been to a real farm. The few remaining farmers, less than 1 percent of the population, must provide food for nearly the entire population, and

do it without thanks. Since the majority of us have become so accustomed to having everything we need at our fingertips, or at least at the grocery store, regardless of the season.

Our food dynamics have changed considerably in the past 100 years or so. From big cities to small towns, food is mostly purchased these days at grocery stores or supermarkets, unless we're in a hurry – then we stop at a convenience store. The biggest change in our food supply is the convenience. We expect everything to be there the minute we want it.

The foods available at grocery stores have changed significantly over the past 100 years or so too. Sure, we can still buy the basic raw materials to cook our own meals – flour to bake our own bread and whole vegetables to make our own salads. But most of us do not. When was the last time you had to slaughter, gut, and clean a turkey for Thanksgiving dinner? Mostly, we get foods that have been conveniently processed to make preparation as simple as possible.

Over the years, many of the steps in food preparation have moved from our kitchens to the processing plants. From sliced bread for sandwiches to shredded lettuce for salads, the processing industry has continually evolved to make our lives easier.

We generally take the abundance of a convenient, safe food supply for granted. But, how are the raw materials converted into the foods we eat and who is responsible for the foods we find in the store? The farmers only supply the raw materials – someone else has to turn those ingredients into convenient foods. Someone has to grind the flour and bake the bread. Someone has to shred the lettuce and make sure it is safe and that it lasts at least a week in your refrigerator.

Typically, it's people trained in Food Science who are responsible for supplying the abundance of safe and nutritious foods found on the store shelves. Food Scientists are the people who make sure our food supply is safe, convenient, and long-lasting, yet still as nutritious as possible.

Food Science is an applied field, where numerous disciplines like chemistry, physics, engineering, biochemistry, microbiology, and even psychology are applied to the production and preservation of

foods. In contrast to cooks and chefs, whose main interests are in the kitchen, Food Scientists are concerned with the large-scale production of high-quality nutritious foods that are safe for consumption, particularly after extended times of storage.

Like the Twinkie, which despite its dubious nutritional status has a shelf life of over two years.

Sure, you might question how a Twinkie fits into the grand scheme of food production. Actually, as opposed to our ancestors, some of whom ate bark to survive, we now eat for more than simply nutritional purposes. We also eat for psychological reasons. A cream-filled cake may be an important component of the diet for some of us. Other than the hard-core, most of us periodically eat decadent treats for psychological enjoyment rather than nutritional needs. Furthermore, in general, as long as we temper our enjoyment of these treats with healthy doses of nutritious foods, there is no harm in it.

In the following chapters, various aspects of our food production are explored. From food safety to Pop Rocks, we will delve into the science that goes into our food supply.

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Processed Foods: Good or Bad?

How much time is spent in your home on food preparation?

Over the years, the time spent on home food preparation has decreased as our lives have become more hectic. It used to be that someone, usually mom, would spend all day, or at least a few hours, preparing the family meal. Other than special occasions, no one spends that much time on food preparation these days. Many people spend less than 15 minutes a day on meals.

One recent study[1] on food preparation times showed that one third of women and two thirds of men reported that they spent no time at all preparing food at home! Of course, some of those men were lazy husbands relying on their wives to make their meals; still, that is a large percentage of the population that does not cook at home at all.

The trend of moving some of the food preparation time from the kitchen to the food manufacturing facility started a long time ago. The first cereals, developed in the mid-1850s, reduced the time for breakfast preparation. The TV dinner of the 1950s strengthened that trend, as the availability of frozen foods skyrocketed. That trend continues these days, for example, with microwavable frozen dinners and grocery store take-out counters.

The trade-offs for the time and convenience of transferring food preparation away from the kitchen are many. Taste, for example. A well-cooked meal prepared "from scratch" generally tastes better than a pre-made, microwave-heated dinner from the freezer. So far, no

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[1] http://www.atususers.umd.edu/papers/atusconference/posters/JabsPoster.ppt (retrieved 8/21/07)

one has come up with a replacement for mom's traditional holiday Turkey Dinner. For many of us, however, this loss in quality is worth the greater convenience.

However, prepared foods do not always mean lower nutritional value. Food processors use methods of preparation carefully designed to minimize nutritional losses while maximizing food safety. In some cases, processing methods may even lock in nutrition before the food can go bad. For example, frozen vegetable manufacturers claim that their products are frozen within a couple of hours of harvesting. The frozen peas in your freezer may have a vitamin content equivalent to that of the peas picked fresh from your garden.

Processed foods often cost more than the prepared food if we bought the ingredients and prepared the food ourselves, but not always. Large food processors get discounts for buying huge quantities and can pass this savings onto consumers. The cost of a boxed cake mix, where you just add eggs, water and oil, is probably less than what it would cost to purchase the individual ingredients. Especially since you cannot just buy the small amount of ingredients you need for one cake.

Furthermore, some foods are not edible in their native form and must be processed into something we can eat. No one nibbles on raw wheat kernels; yet, wheat is one of our food staples. After being milled into flour, wheat is turned into bread, cake, and numerous other products. Wheat is also one of the primary ingredients in cereals, which are probably one of the earliest examples of processed convenience foods.

The first commercial breakfast cereal supposedly was developed by William Kellogg at a sanitarium in Battle Creek, MI, US, as a healthy and convenient start to the day. Although the first trial batches were made in their kitchens, over the years, cereal manufacturing plants have gotten larger and larger to meet the growing demand.

Nowadays, at an average-sized cereal processing plant, about 500 tons (that is a million pounds!) of raw grains and flour are brought in each day in railroad cars and trucks, and converted into thousands of packages of breakfast cereal.

Over the years, an endless variety of cereal products have been developed, from healthy products (that often taste curiously like cardboard) to the sugary sweet cereals favored by most kids. Just add milk for an instant meal. Preparation time is negligible. And, if you are too rushed to slice fruit into your bowl, there are packaged cereals with dried fruit already added.

If you think even pouring milk in a bowl is too much of an effort, you can buy the entire bowl of cereal, including the fruit and milk, in a convenient bar. Some of us might think these new cereal bars are over-processed, but others buy them as a convenient and nutritious breakfast they can eat on the way to work.

Regardless of your perception of the food industry, processing of foods serves an important purpose in our society – providing a variety of foods with the convenience we want and the nutrition we need.

3

Vintage Wines and Chocolates*

What do wine and chocolates have in common? Sure, a nice red wine goes well with a smooth, dark chocolate, but let's dig deeper into the raw materials. The grape and the cocoa bean, from which wine and chocolate are derived, are both plant products whose characteristics vary with each harvest. The quality of both grapes and cocoa beans, and therefore wine and chocolate, depends on environmental factors like rainfall, sunshine, and temperature, which affect the chemical composition within the raw materials.

You know from experience that not every grape is equally sweet and delectable – sometimes there are sour grapes or even grapes that look delicious, but have little flavor. The same variability is also found in cocoa beans. In fact, almost all fruits and vegetables experience some degree of variability from harvest to harvest.

Vineyards use the variability in grapes, from year to year and region to region, by making vintage wines with unique character. Wine from a good vintage year can be a lot different from the same wine made in a different year. Despite that same variability in cocoa beans, however, chocolate manufacturers generally want their chocolate to taste the same no matter what.

In fact, most food processors work with variable raw materials, yet must produce a consistent product. This variability is what makes the food processing industry unique from many other processing industries. Food manufacturers somehow must accommodate differences in their raw materials to make a product that tastes, looks, and feels the same day after day.

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* Not published as a column in *The Capital Times*

How do the large chocolate makers account for variability in the cocoa bean to produce the same product year in and year out?

Chocolate makers have chocolate tasters, who go to the source to taste the raw materials. Sounds like a great job, doesn't it. Unfortunately, chocolate tasters taste the cocoa beans and not the finished chocolate. Chocolate liquor is ground-up cocoa beans, but despite being called liquor, there's no alcohol in it to offset the bitterness. Chocolate liquor makes your mouth pucker so badly that it makes those sour candies seem sweet. Try some yourself – its often called Baker's chocolate.

These brave chocolate tasters evaluate beans from various sources and select those beans that they know from experience will give the taste they are looking for. Chocolate makers then blend beans to wipe away differences in individual batches, and produce a consistent product. To some extent, chocolate makers can also manipulate process conditions, like roasting temperatures, to make sure their chocolate tastes the same regardless of the differences in cocoa beans.

In fact, if food manufacturers knew enough about the chemistry of their products, they could adjust conditions to offset differences in raw materials and make a consistent product. For example, grape juice manufacturers, working with the same grape variability as the vintner, are capable of producing juice with a consistent taste.

Grape juice producers use an approach called standardization, where the chemical composition of the raw material is adjusted to ensure uniformity of the important factors that affect their product. They measure acidity, sugar content, and a variety of other parameters, and then blend juices from different sources with different levels of these parameters to make a product that tastes the same all year round, despite huge differences in grape quality.

Perhaps, the day is coming when we can eat a vintage chocolate with a vintage wine. In fact, varietal or single-origin chocolates, which celebrate the intricate differences of taste of a specific bean from a specific growing region, are a growing trend.

4

Preserving Strawberries, and Other Foods

There's nothing better than the taste of a freshly picked, ripe, and juicy strawberry. They're delicious and nutritious – just don't cover them with too much sugar. Unfortunately, in most of the world, you can only get fresh strawberries for a month or two every year.

For hundreds of years, our ancestors only ate strawberries in early summer – the rest of the year they only had memories. Thanks to the wonders of modern food preservation (and the trucking industry); we can now enjoy strawberry products at any time of the year. Preservation practices are the bread and butter, with strawberry jam, of the modern food industry.

Perhaps the earliest preservation technique was salting and drying of meat into jerky and pemmican, extending the "shelf life" so there was food during lean times. When the desert nomads first made milk into cheese, they were practicing another example of preserving a perishable raw material.

However, the start of the modern food preservation industry is considered to be during Napoleon's reign, in the early 1800 s. Napoleon offered a prize to whoever could develop a method of preserving foods to feed his soldiers in their march of conquest across Europe. In response, Nicolas Appert, an inventor, developed a method of preserving foods by heating them in a sealed jar to destroy microorganisms and prevent subsequent contamination.

Appert's invention was the start of the food canning industry. Canned foods, including those eaten by Napoleon's army, don't taste a lot like the original product – canning is just another way to say cooking the heck out of a food. It's hard to believe that Napoleon truly enjoyed fine French cuisine from canned foods.

Although canning is still an important preservation tool for the food industry, its use has been reduced in recent years by the development of vastly superior preservation techniques.

Nowadays, the food processing industry has a myriad of methods to preserve foods like fresh fruits and vegetables. They can be canned, frozen, and dried; even making jam is a form of preservation. What is the ideal way to preserve strawberries? Freezing is probably the best way to preserve nutrition, flavor, and texture; but still, a frozen strawberry when thawed generally does not have the same firmness of a fresh berry. We generally sacrifice some aspects of quality in all preservation techniques.

And, how the strawberry is frozen can have a huge impact on its quality when thawed.

Warm strawberries placed in the freezer at home may take several hours to freeze, depending on the size of the container. As ice crystals form and grow, they damage the cellular structure of the berry. With slow freezing, as in the home freezer, the ice crystals first form outside the cells, leading to an osmotic water imbalance between the intracellular water and extracellular water. Water flows out through the cell wall to offset this imbalance, causing dehydration and shrinkage of the cells. Ultimately, this leads to breakdown of the cell walls and loss of structure upon thawing. The result is a mushy strawberry when thawed.

In the food processing plant, strawberries can be frozen in blast freezers, solidifying the berries within minutes and reducing the possibility of osmotic water loss from the cells. Even better, the strawberries can be immersed in liquid nitrogen to freeze within seconds. The changes to the cell structure are drastically minimized compared to slow freezing, leaving strawberries with nearly fresh-like texture upon thawing.

The food industry is always looking for new and better methods to preserve foods. One "new" way to preserve strawberries and other foods, if a process that has been studied for over 40 years can be called new, is to irradiate them with high-energy gamma rays or X-rays. Irradiation uses ionizing energy to destroy microorganisms and stop respiratory reactions in a food, leaving them safe to eat, yet