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The Chemistry of Jellybeans

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Introduction

Chocolate, mint, blue raspberry, cherry, and lemon are some common flavors one might be used to tasting. These flavors of ice cream, candy, or drink have been perfected over hundreds of years to give them exquisite enhancement to highlight the sweetness or taste. While one might focus on the taste instead of the molecules at play, the chemistry behind these flavors is incredible and underappreciated. Out of all the media that the flavors lie inside, the jellybean stands out among its competitors. Jellybeans have been the foundation of flavor chemistry for many years, and this can be seen in the vast number of flavors available to us. The jellybean ranges from classics like cherry and lemon all the way to strange combinations like buttered popcorn or sausage. The ability to flavor has always been relatively hidden from the public. How did these people figure out how to flavor candy to taste exactly like fruit? How are they able to make them taste like grass, rotten eggs, or chocolate pudding? To answer these questions, one must jump back to the creation of the jellybean to understand how it has evolved into a chemical perfection.

Jellybeans were created as a hybrid candy. A combination of the famous Turkish Delight and an old treat of honey covered almonds. The honey almonds, called “Jordan almonds”, were enhanced over centuries and eventually evolved into a candy-coated substance, like the hard casing of the jellybean we know today. This candy is thought to travel back to ancient Egypt, where the rich could afford to eat honey covered nuts as a nice treat. The outer shell is now similar to that of a peanut M&M. The jelly consistency that exists inside many candies is said to be created by Bekir Effendi. In the 1700’s, this Turkish man found a way to produce a sweet, jelly-like substance form rosewater and covered it in sugar. This candy was called the Turkish

Delight and is still eaten today. Eventually, someone came along and thought to combine the jelly center of the Turkish Delight with the hard shell of the Jordan Almond to create the precursor to the jellybean.[1] It is not known where or when the first jelly beans were made, but history does know about the first commercial product known as the jelly bean.

History

The first appearance of the actual term “jellybean” was in 1861. During the Civil War, a man from Boston, William Schrafft, advertised a campaign to send the candy to soldiers. It is believed that they are beans due to Boston being a famous for multiple kinds of beans. These first candies were not flavored cherry or lemon but were rather just sugar candy. Schrafft owned a small candy store and the jellybean became a popular favorite among the city of Boson. Eventually, this candy became widespread because of it’s easy-to-store nature and ability to travel easily. Throughout the years, the jellybean became more of widespread phenomenon. Sometime throughout its production, people learned how to inject them with different natural fruit flavors while keeping the candy the same. In the early 1930’s in America, the jellybean quickly became a symbol of Easter.[2] Baskets would be filled with them to celebrate, and not soon later the candy would expand into much more. As companies like Jelly Belly started to make new flavors, the jellybean picked up much popularity. Most people know President Ronald Regan as being an avid jellybean lover. But after this candy became renowned, they had to expand the formula. From the first few flavors, which were all natural, the company had to figure out how to make new and more exciting discoveries.[3]

The process of discovering new flavors has not been really documented or explained over the years. The chemistry behind them is known, but how they implement the new ones is scarcely known by the public. The molecules that cause these flavors can be known but understanding how they are integrated into the candy is the difficult part in understanding food chemistry. The creation of the jellybean has put forward an interesting topic on how flavors are created or extracted from different plants and animals. The interesting ways that scientist have found how to flavor candy coconut, for example, has been an enigma to many. As time progresses and the science of the day becomes more and more advanced, new flavors are able to be synthesized or extracted to be used in our favorite foods.[4]

Into to Taste

How is it possible for jellybeans to have so many different flavors? For years I have questioned just how exactly how they flavor that small bean as vanilla or peach. Outside of jellybeans, other foods have also been of interest. There are so many questions that come up about the taste of certain foods. What makes food taste like what it is? These questions do not have simple answers, in fact, many of the biochemical interactions between the tongue and the food particles are some of the most complex phenomenon to explain. Jellybeans can taste like lemon or sweaty socks because of the molecules that are incorporated into the formula. When the jellybean is made, they are infused with molecules that contain the taste of what the manufacturer wants them to be. As long as the lab scientists can create, extract, or buy the molecules that contain the flavor, they can keep making a jellybean taste like whatever they want.

Abstract

The jellybean encompasses a large variety of flavors into one simple candy. The chemistry that connects the candy to the science world has an interesting past and an exciting past and present. The ability to extract flavors, or to artificially create them, is a fascinating cascade of reactions which allows food and candy to be colorful and distinct. What lies inside that little shell of hard glucose that allows something that seems so simple to have infinite possibility of taste? Molecules hold the key to understanding the complexity of flavor chemistry. Application of chemical instrumentation, such as gas chromatography can show just what combination of elements create the flavor of food and fragrance that are used in almost everything we eat today.

Taste Receptors

The human tongue is basically just a plate of receptor proteins. The taste buds that we have are covered in tiny proteins that pick-up signals for taste, heat, or touch. Every single taste bud that a tongue has the receptors for different tastes that appear in nature. The receptor takes in one of those flavors and our brain records it as taste. If a jellybean is eaten, the receptors will signal the brain of what flavor might have been placed on them, maybe sour or sweet. The first sensation the receptors get when a jellybean is put on them is that of the hard candy shell, which is shown in Figure 1. This structure is call shellac, and along with the sugar already involved in making the candy, this substance gives the outside a shiny look as well as some extra sweetness. After the jellybean is opened, more molecules spill out and cause our taste buds to react even more.

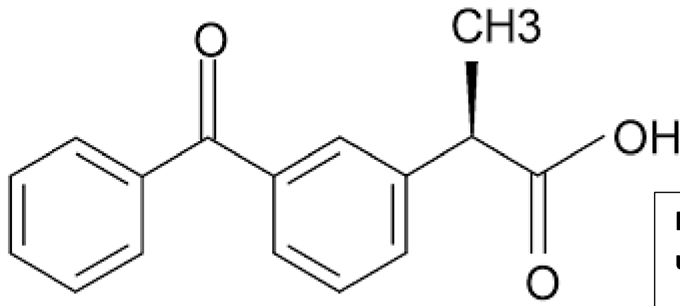

Figure 1: Structure of shellac, the ingredient used on the outside of jellybeans.

Our taste receptors have five main flavors that govern the flavors we taste. These five tastes are: sour, sweet, bitter, salty, and umami. These are the five receptor types our taste buds have. These receptors are the reason we are able to taste different flavors, but it is a little more nuanced than just tasting five things. Each molecule that we taste causes a different sensation throughout the receptor that causes a different response from the brain. Our tongues are not that complicated when we look at it from this point of view. They work through the process of channels. In all of our cells, there are proteins that allow large or small molecules in or out of the cell membrane.[5] These proteins are called ion channels, they work based on the concentration of ions that are on either side of the channel. Each channel works differently for each type of taste receptor present on a taste bud. The selectivity of the channels allows us to be able to differentiate the different tastes when a certain molecule lands on our tongue. Each of the five tastes have a unique receptor pathway that works to open these ion channels and provide the brain with a chemical signal to taste. The important thing to remember about the taste pathway is that taste is just the result of ions flowing into a cell and signaling the brain of that depolarization that occurs.[5]

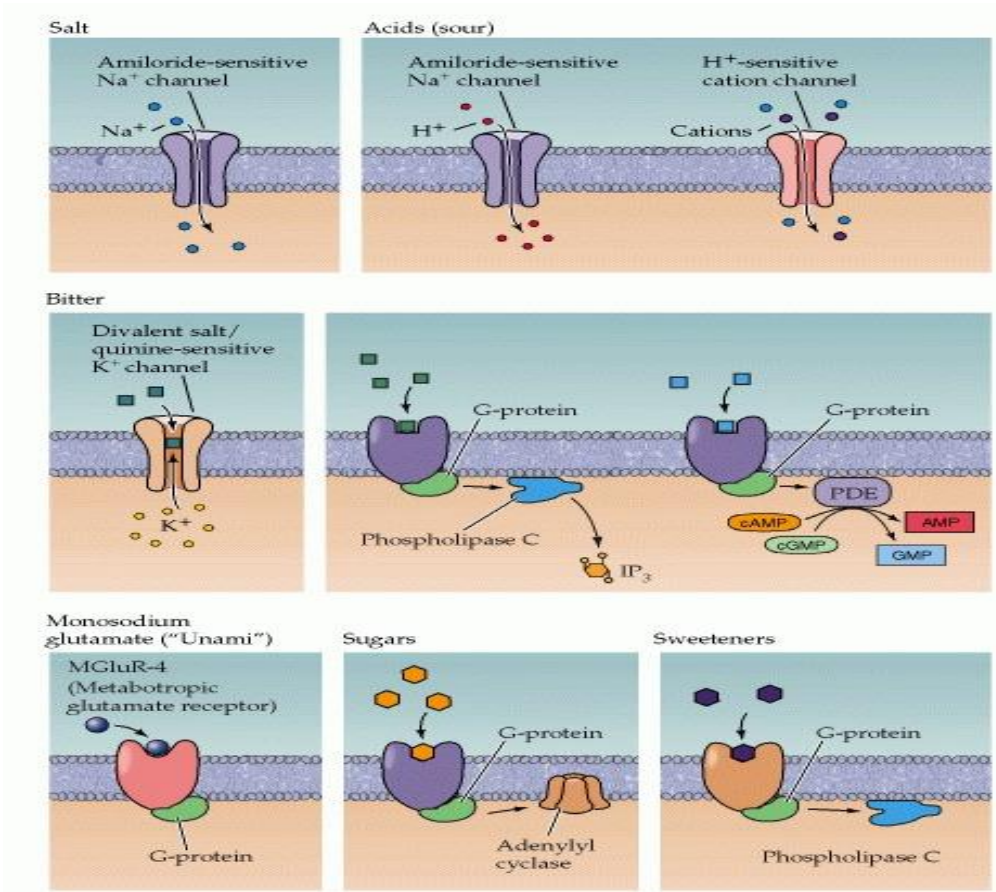

Figure 2:

Ion channels found in the plasma membrane. Each causes a different taste sensation to be communicated to the brain via depolarization.

The first receptor is salt. Salt has the most simple channel in terms of transmembrane proteins. The receptor for salt sits on the outside of all cells and works by opening when sodium ions are detected by the receptor. Sodium ions then flow through the channel and into the cell, which in turn causes a depolarization to occur. Depolarization is the difference in ion concentration on two sides of a membrane. This difference in charge potential causes nerve cells to be stimulated. This stimulation given off by the nerve cells tells the brain that salt has entered the receptor, causing a salty taste to be communicated to the brain.[5]

Sour taste receptors work very similarly to salt. The proton channels that dictate the sour receptors work very much in the same way as the sodium channels work for salt. Sour solutions are determined by the concentration of hydrogen ions, or protons. When something sour lands on the taste receptor, the proton channel opens and the hydrogen flows into the cell and gives off the same neuron interaction that the sodium does. However, since this is a different ion causing the difference in concentration, our brain receives a much different signal. They work very similarly but the end result is a different receptor being activated. The other taste receptors for the other three receptors have more complicated pathways. The salt and sour channels can be seen in Figure 2 and are simply a one-way route into the cell to cause neurons to be stimulated.

Bitter taste receptors function in a completely different way than the ion channels from the last two kinds of taste. Looking at Figure 2, the bitter channel has a large, circular protein attached to the plasma membrane instead of the normal ion channel protein that the salt and sour receptors have. This large protein is called a G-protein-coupled-receptor, or GPCR. The GPCR is a large transmembrane protein that is responsible for transporting large molecules into the cell. Since most bitter molecules are fairly large, the cell needs a different mechanism to allow these molecules inside the cell. The GPCR pathway begins when a target molecule fits into the groove on the outside of the cell. Various bitter molecules are allowed fit into this position, which starts a cascade of reactions. Two different pathways can be active from here. The first happens when the molecule binds into the receptor and phosphodiesterase is activated. This enzyme cuts phosphodiester bonds, which in turn closes cyclic nucleotide channels. When these channels close, the concentration in the cell becomes off balance and then the neurons send a signal of a bitter taste.[5] The second pathway happens when the molecule binds and causes phospholipase C to become active, and it starts to produce inositol 1,4,5-trisphosphate, or IP_3. IP_3 leads to an increase of calcium ions inside the cell.[5] When the calcium ions concentration inside the cell becomes too high, a depolarization occurs, and our brain receives a signal that something bitter has touched our tongue.[5] Both pathways can become active at the same time, which could be a reason why our tongues seem to taste bitter much stronger than other tastes.

Sweet tastes occur when a different GPCR is activated as a carbohydrate binds into it. Sweeteners can vary in taste due to the way their structure fits differently into the GPCR. Both of these pathways for sugars and sweeteners involve potassium channels. In the case for natural sugar, when the GPCR is activated, an enzyme adenylyl cyclase increases the cAMP concentration in the cell, which leads to the closing of the potassium channels. For the saccharide sweeteners, the IP_3 from the bitter pathway is released to cause calcium ions to rise, but it also releases diacylglycerol, or DAG. DAG activates protein kinase A, which closes the potassium channels. Much like the bitter pathway, both of these events can happen simultaneously, causing an elevated sweeting taste for a given molecule.

Umami is the final taste receptor we have, and this one covers meaty or savory flavors. This receptor works kind of like a combination of sweet and bitter receptors. When a glutamate lands in the GPCR, the pathway goes on the same way it would for bitter pathway, but a different channel is used. Instead of just the calcium channel being opened or closed, several different ion channels are either opened or closed. Because of this, there are several different receptors that play key roles in the process of this taste.[5]

Jellybeans can exhibit all of these different molecules that can stimulate these receptors. Every jellybean that is made has sweetness to it, as most candy do. However, since there are so many different flavors of jellybeans, there is a large variety to the tastes that end up being communicated to the brain. When it comes to the traditional jellybeans, the fruit flavors will give a general sweet taste along with the molecules responsible for that flavor. Limonene, for example, is the molecule responsible for the orange flavor. When the jellybean touches the tongue, the sweetness from the outside shell is accepted by the receptor, and then the inside is communicated. The limonene is able to be accepted by the sweet, sour, and bitter receptors. Each of these receptors are bound by the molecules of limonene, and our neurons record that specific transition of ions as the taste for orange. Since there are more than one flavor molecule used for orange, that must mean that the other molecules mimic the same ion flow that limonene does, so our brain is able to remember these kinds of ion flows. The specific binding of the molecules causes our brain to remember what kind of channels are opened or closed, so we can remember what flavor we are tasting.

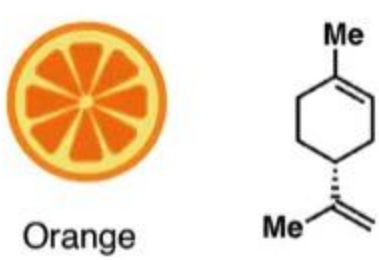

Figure 3: Limonene molecular structure, one of the main flavor molecules used for orange and lemon flavor.

Natural Flavors

Flavor chemistry is an interesting subject. One might think acquiring natural resources to flavor foods might be a relatively new discovery, but this science goes back as far as ancient Egypt. Many different plants were used to infuse objects with scents or tastes. Many of the scents were put into perfumes for burial purposes, or to burn candles. Most of these scents came from tree bark, which was easily available to these people, or by squeezing fruits, like oranges, that they could easily grow. Many plants were probably also used for their strong scent in the same way. This simple use of taking something that smells good from a plant has evolved into a current market worth around $16 billion.[6] I do not think that the Egyptians were making that much with their bark extraction, but there have been a few years between then and now. Along with being much more advanced in the ability to isolate a particular flavor, there are rules that have to be followed for a molecule to still be considered "natural". Since there are so many chemical processes that the essence of the flavor has to go through, it could eventually go through enough refining to be considered an artificial flavor. Although artificial flavors still originally come from natural places, they are altered to form something completely different than what was started with. An interesting example of how natural flavors can be altered and still remain a natural flavor is that of the raspberry flavor. As gross as it may seem, there is a beaver anal gland that is used to produce this raspberry flavor.[7] Even though it does not come from a raspberry, or even a fruit, it is still considered a natural flavor because it still comes from a natural thing.[7]

The process of extracting natural flavors must follow the Code of Federal Regulations in order to remain a true natural flavor. This Code states, "the essential oil, oleoresin, essence, or extractive, protein hydrolysate, distillate, of any product of roasting, heating, or enzymolysis, which contains the flavoring constituents derived from a spice, fruit juice, vegetable, or vegetable juice, edible yeast, herb, bud, bark, root, leaf, or similar plant material, meat seafood, poultry, eggs, dairy products or fermentation products thereof whose significant function in food is flavoring rather than nutrition".[6] A natural flavor must also follow the definition of an “organic” food. This requires the origin of the flavor to come from something genetically unaltered by any source of biochemical modification. These regulations are put into place so that everyone knows where the flavors are coming from. This does not, however stop some of the flavors from coming from weird places, like in the beaver example. There is a payoff, however, to wanting to use the natural materials instead of creating artificial flavors. Natural flavors are generally thought of as healthier than their artificial counterparts.

Natural flavors, unfortunately, are much more costly than their artificial counterpart. The ability to supply the original base of the flavor can fluctuate depending on several factors like time of year or weather. Vanilla is one example on how natural flavors sometimes take extreme dedication in order to produce some amount of a certain flavor. The vanilla beans were discovered in Mexico, but had to be moved to Madagascar, where the conditions for growth were better for the plant.[7] Because of their relatively easy farming conditions, and extremely high cost per pound, vanilla beans, and other easily grown produce such as oranges, lemons, and strawberries, can easily have their essence extracted and sold for flavoring. These plants must be taken care of, however, which causes them to have a high cost overall than creating an artificial flavor. Vanilla is one of the most common flavors in almost every type of consumable food or drink. The fragrance and taste of the vanilla comes from the molecule vanillin, which makes up around 2% of every vanilla bean. Vanillin fits in with the certain type of molecule that labeled to have a strong aroma because of its high vapor pressure and low molecular weight.

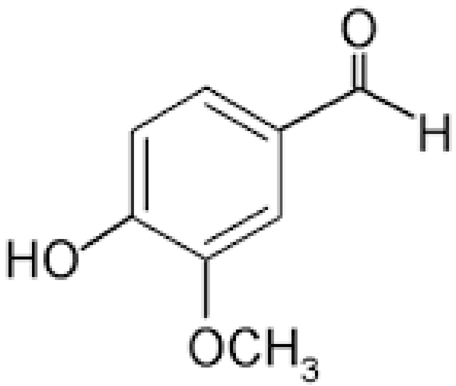

Figure 4: The structure of vanillin. This molecule is what gives vanilla it's flavor and aroma that billions of people in the world can easily recognize.

The plants used in natural flavoring are almost always entirely used up to produce different kinds of flavors. The inside of an orange can produce the sweet fruity taste, while the outside can give the bitter flavor, which is not normally used in flavor chemistry, but can be used in many different oils or products. I will note that the using certain animals for natural scents has become illegal. Deer used to be hunted specifically to extract a certain musk scent given off by the ketone, muscone. Due to the development of synthetic fragrances, the practice of extracting these glands is no longer done to preserve wildlife in favor of harvesting a scent.

Natural flavors have had an interesting past and continue to develop to this day. While the regulations on them are relatively strict, there are new ways of producing these compounds without having to rely on a plant for their natural production. Biotechnology is gaining the understanding quickly on how to make use of microorganisms and enzymes to cause natural flavors to be produced faster. Frey and Rouseff say in their journal, “incubating natural cysteine and pulegone with the bacteria Eubacterium limosum can generate the potent odorant p-mentha-8-thio-3-one” showing that someday natural flavors may be able to be made in large quantities for an extremely low price.[6] Natural flavors will continue to be a big market as the world continues to flavor drinks and candy as well as give aroma to candles and perfumes.

Artificial Flavors

Artificial flavors get a bad name in today’s world. Almost every consumable product we see in the store has “no artificial flavors” written all over in red. Natural flavors do seem, from the word “natural”, to be better for the body. People have shot down the idea that artificial flavors can be healthy. Although the creation of artificial flavors is an incredible chemical discovery, it has become popular to discredit the science behind flavor chemistry. Most people call artificial flavors unhealthy or a lesser to natural flavors, but there is little evidence to back this up. Although there are so many misconceptions when it comes to artificial flavors, the fact is that artificial flavors can create the same flavor tastes that can be found in nature, but made in higher quantity, quality, and for much less cost. The original source of a chemical does not make any difference to what the final product is. The vanillin you can find in the bean is the same vanillin you can synthesize in a lab, there is little to no difference in their nutrition. While there is enough research to continue on about artificial flavors and their ability to be safe and no different from natural flavors, the battle will continue as to which is better.

Natural flavors are mixtures of multiple molecules that come from plants. Artificial flavors, on the other hand, are made from chemicals totally different from the end product. They also usually only contain one molecule, the one which is the flavor being targeted. Artificial flavors are created by combining several different chemicals until the desired taste is achieved. The flavor for almonds usually comes from the molecule benzaldehyde. While this molecule can be found in nature, it can be easily synthesized in the lab, with little different to that found in plants. While the process of synthesizing new flavors can be a long and difficult task, the end goal is to be able to flavor products with low cost and effort. Many flavors can be made in large quantities as the production of the molecules can be done quickly. There are some key differences, however, between a natural and an artificial flavor.

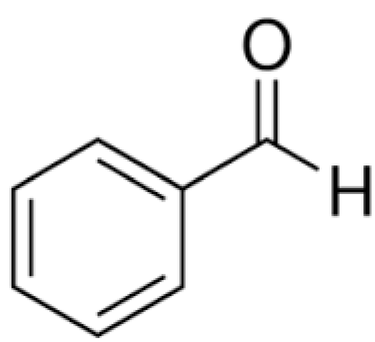

Figure 5:

The structure of benzaldehyde

Vanilla, as an example, is a common natural flavor, as we have explored already. When the molecule vanillin is artificial created, the vanillin is the only molecule that is produced. While natural vanilla has many other molecules with it, synthetic vanillin stands alone, 100% pure, as shown in Table 1. Remember that this vanillin, either natural or artificial, is made of the same components, where it comes from does not matter. While vanilla is a simple case of a single molecule that causes the taste, there are many fruits that are a combination of molecules that make up the flavors we associate with them. Grapes, strawberries, and many other fruits are all mixtures of chemicals that give the flavors we recognize.

	Flavor Chemical(s)	Amount	Comments
Vanilla Extract (1)	Vanillin (2)	82%	
	4-Hydroxybenzaldehyde	7%	Bitter almond flavor
	4-Hydroxybenzoic acid	3%	Faint nutty flavor
	Vanillic acid	7%	Creamy flavor
Synthetic Vanilla	Vanillin	100%	

Table 1 shows the difference in natural vanilla extract against a synthetic vanilla flavor created artificially.

Highlighted Differences Between Natural and Artificial

The American Council on Science and Health set out in their publication to help the world realize two main facts about natural and artificial flavors, “(1) That artificial flavors are inherently less healthy than their natural counterparts, and (2) that a flavor chemical obtained from a natural source is either different or superior to the same flavor chemical produced in a laboratory.” In fact, usually the opposite is true regarding what people often think about artificial flavors.[6] Artificial flavors are usually around 100% a pure product while a natural born chemical will always have impurities involved in its makeup. These can include toxic or unhelpful molecules together with the flavor molecule. As shown in Table 1, the natural source for vanillin has a lot of other molecules that come with the vanillin. While these other molecules add to the natural flavor of the vanillin, there could be some molecules out there that are paired with toxic or carcinogenic molecules. That would make the artificial version of vanillin be much healthier than the natural alternative.

Both natural and artificial flavors are used in jellybeans. Since artificial flavors are easier to make in large quantity, and usually cost less to produce, most candy manufactures use artificial flavors more than natural. An essential use in jellybeans for artificial flavors is the ability to make flavors that do not usually occur naturally in food-safe environments. The strange flavors like dog food and sweaty socks can only be made artificially because those flavors do not really occur naturally to extract.[6] The molecules engineered to make these flavors able to be consumable is an amazing work of chemistry. The flavor chemists that work to create new flavors have an amazing understanding of molecules and how small changes can make something taste completely different. Jellybean flavors like bacon and buttered popcorn are created artificially and are still being perfected to taste just like the natural counterpart. Changing molecules to be safe to eat and taste good is a difficult feat that the food chemists tackle every day.

Analytical Analysis

The structures of molecules are not discovered simply. The process of drawing out the structure of a molecule takes some working backwards from signals shown in chemical instrumentation. Many studies in determining structures use gas or liquid chromatography to understand the chemical makeup of a molecule. Chemical instrumentation is one of the most essential parts to understanding what molecule is inside a jellybean to give it its flavor. Unfortunately, the candy companies do not post their molecules on the internet to be viewed, but many valiant scientists have gone through the trouble of finding the molecules through chemical instrumentation.[8] Mass Spectrometry and HPLC are two of the best chemical instruments to use to identify molecules. HPLC is helpful in identifying components in a jellybean because it separates mixtures and can analyze each part of individually. HPLC can scan a vast array of different materials and molecules. When it comes to scanning candy, or jellybeans, there are a lot of different parts that have to be looked at in HPLC to make sure the whole piece of candy is acceptable to be consumed. The outside shell of the jellybean, the inside flavor molecules, and the colorants of every part of the candy must be scanned to make sure they are safe to be consumed. Since the HPLC can look at the individual parts, and can hold more sample than most other instruments (1-2 mL), these samples can be run quite quickly. Any strange anomalies on the scan will be analyzed further to understand any issues that might be at play.[8] Other than HPCL, Gas Chromatography and Mass Spectrometry are used to analyze all these compounds as well. These other two methods are used just as often as HPCL but are used to understand different elements of the candy.

Chemical Analysis on Natural Flavors

When it comes to analyzing natural compounds in the chemical instruments, HPLC can give back some of the best data compared to other methods of analysis. HPLC can easily determine the compounds found in any sort of natural product. Vanillin for example can be easily isolated and seen in Figure 6 as the most abundant molecule in vanilla extract. The chromatogram shows that out of all the molecules present in this extract vanillin is the most abundant. There are other molecules present in the scan, which shows that this is probably a natural sample from a vanilla bean. If this was a synthetically made sample, we probably would not see the vanillic acid appear, or any of the other peaks that are quantified on this graph. The HPLC is useful in showing the abundance of these molecules as well as how similar they are to each other. Any kind of natural compound can be scanned through the HPLC and similar answers can be found. Since molecules have a specific footprint, every single item run through an HPLC will have a different output on the graph. Because of this, analysists can see what normal vanillin should look like, and if there are any issues with the compound, the graph will stand out.[8]

Mass Spectrometry is another extremely helpful method of understanding what compounds have been extracted. Mass Spectrometry simply applies a voltage on a sample and hits off hydrogens on the compound. This compound without a hydrogen can be detected electrically. Because of this, the scan we see has a lower mass than the original sample since a hydrogen was removed, causing it to become lighter. This new sample will be at least one mass unit lighter than the original compound that was being observed. Figure 6 shows a Mass Spectrometry scan of vanillin, which is one mass unit lighter than what vanillin should be, since the hydrogen was removed in the instrument. Mass Spectrometry can identify molecules by this removal. If the sample has a known weight, then if the compound that is desired is quantified as one mass unit under the known weight, the sample has been extracted correctly. The vanillin for example has a mass of 152.15 g/mol. We see in the scan that there is a large peak at 151, that means the hydrogen has been hit from the molecule, and vanillin has been extracted or synthesized. If that mass unit is 140 g/mol or 160 g/mol instead, there might be an issue with the synthesis, and vanillin is probably not a main product in the sample run.[9]

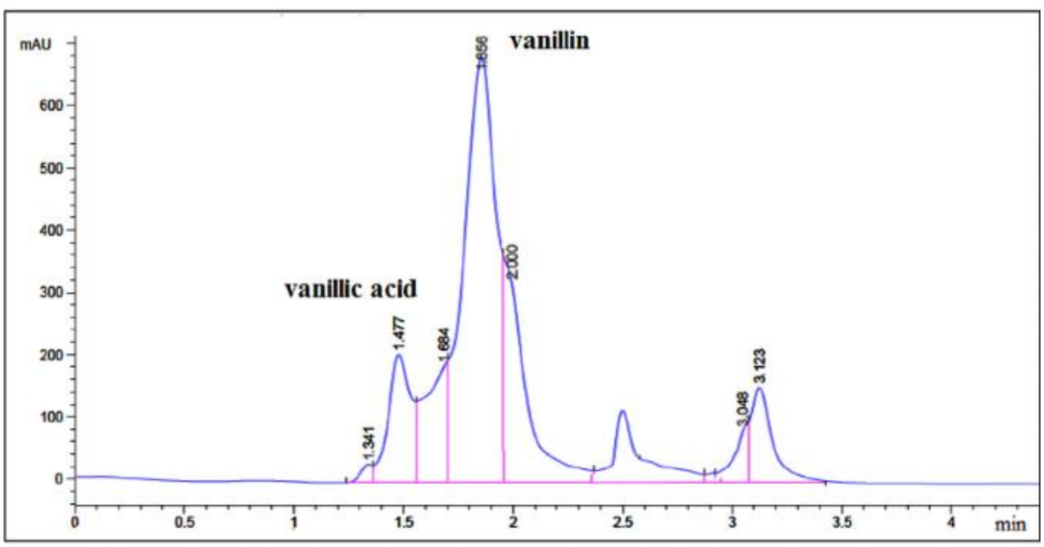

Figure 6:

The graph of an HPLC run of vanilla extract. There are several molecules present in the compound, but Vanillin stands as the most abundant molecule. Vanillic acid can be quantified, but most of the other molecules are not abundant enough to identify.

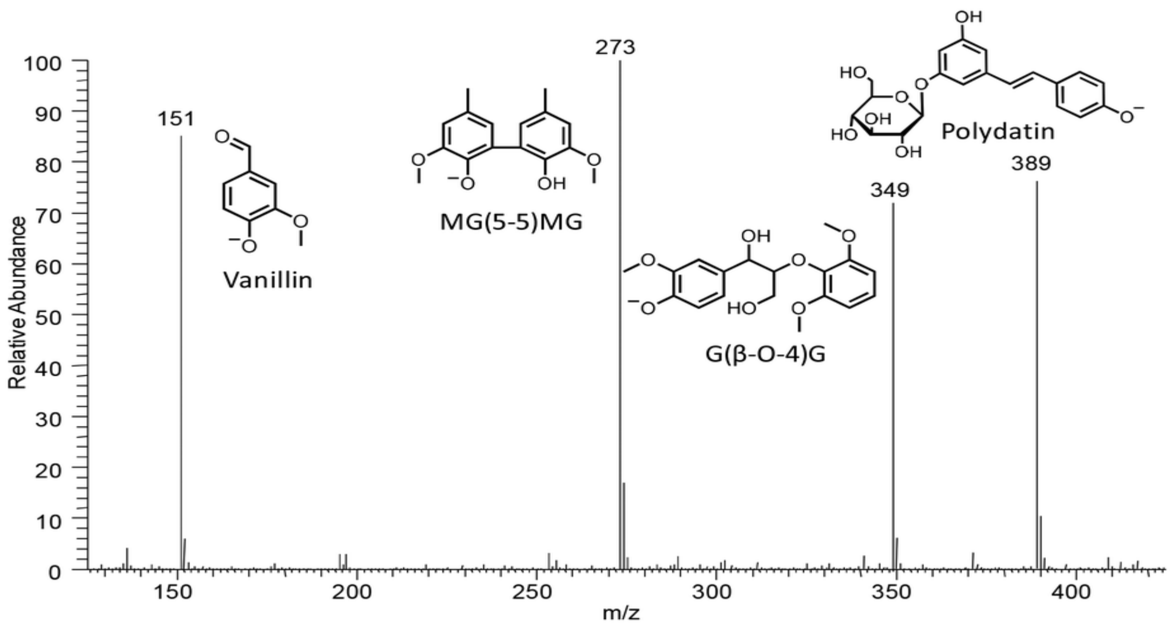

Figure 7:

Mass Spectrometry scan of multiple compounds. Vanillin stands out at the front of the graph. The molar mass of vanillin is 152.15 so the mass spectrometry scan of 151 we see is exactly what we want. This shows that we have extracted vanillin in a large quantity.

Gas Chromatography is another very helpful chemical instrument that is useful in understanding the molecular structure of jellybeans. Gas Chromatography is a method that heats up a sample to vaporization and the gas particles enter into the machine. The particles are pushed by an inert gas into a detector which can analyze the molecules. Gas Chromatography is one of the best ways to determine the structure of molecules to work toward a new flavor breakthrough. This machine allows the components of the molecules to be understood and seen as what is known as a flavor profile. Since odor is one of the main components of taste, Gas Chromatography utilizes the vapor of the sample to learn what is inside of a food, drink, or candy item.[10] Limonene, as shown in Figure 8, has a fairly strong odor. Most people would be able to identify the smell of this molecule, which makes it a very usable sample in a Gas Chromatograph. The sample as seen in Figure 8 shows a high quantity of limonene. There are a few other components on the graph, but limonene stands out as the key molecule being run.[11]

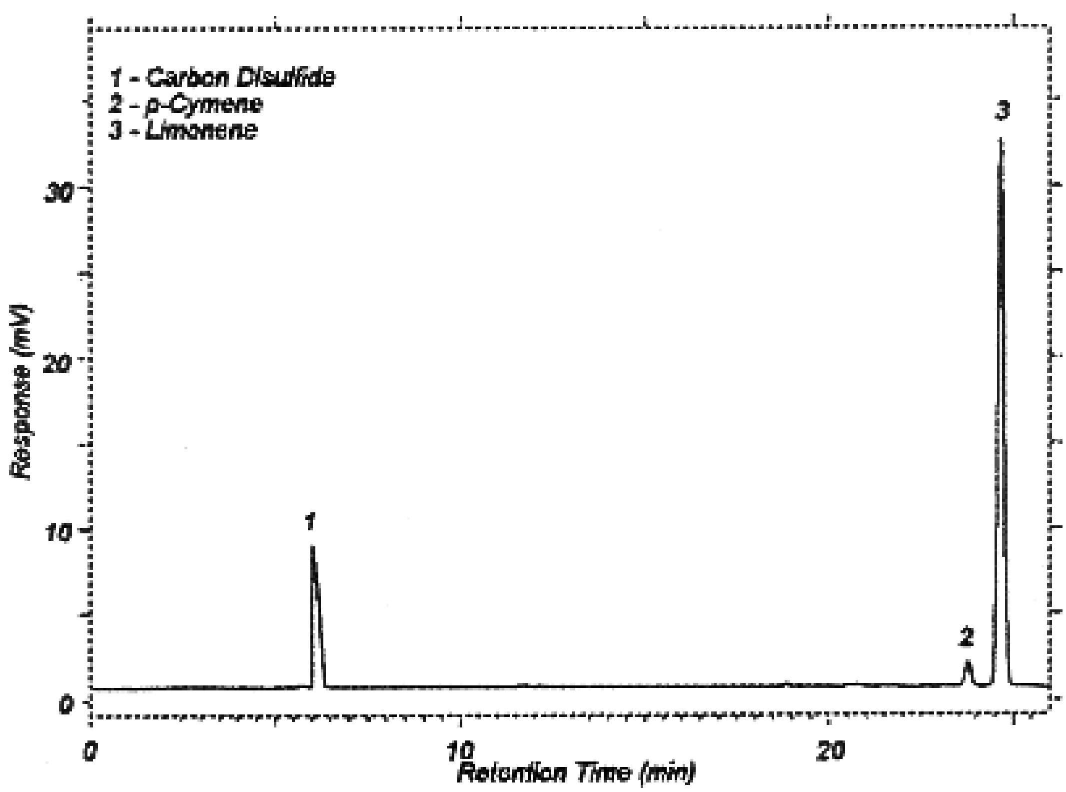

Figure 8:

Gas Chromatograph of Limonene, the main flavor molecule in lemons.

Summary

From the intricate nature of the biochemical interactions that govern taste receptors and neuron pathways to the mechanical understanding of chemical instrumentations, jellybeans are crafted masterfully by chemists every day. While they might seem like everyday objects with no real difficulty to make, jellybeans take a lot of thought and science to make every single one of the candies. Most scientific discoveries are thought of as big explosions or some bright lights, but new jellybeans are made constantly even though they may not seem very important. Flavor chemists utilize all of their abilities when it comes to making jellybeans. They are not just one kind of chemistry; they must use some knowledge from several disciplines to reach a final product. Biochemistry is used to understand the taste pathway so that no flavors are created that will be harmful to the body or to the environment. Analytical chemistry is used to determine structures, functional groups, and whether the compound has harmful groups attached to it. Creating new foods, drinks, and candy seems so trivial, but it actually takes a lot of hard work and understanding. Most people do not think about the difficulty there might be to create a certain food. Throughout my research, I have found that there is a lot more behind the scenes of food chemistry than I knew at first. The combination of these areas is what make food chemistry so special. New and improved methods of food making are still being made to this day, and it is a field that will continue to grow and improve for years to come.

Conclusion

Jellybean are a complex candy that must go through many stages of development before they are perfected for the public to consume. The science behind them has been building for centuries, with new development every day. Learning more about the taste receptor pathways helped me to see that consuming food is much more than just eating. There are so many small complexities that make up the different pathways that the molecules in the food have to take in order for us to taste and process the food. While they seem like simple actions that are done all the time, the intricate methods of the ion channels, GPCR, and taste receptors are complicated pathways that are not as simple as they seem. The human tongue has many interesting interactions with the food we eat. However, the tongue is not the only part of our body that is stimulated by flavors; smell is also a large factor that works together with taste, which makes the system even more complicated. Similarly, the complexity of flavor is also much more complex than what most would assume at first glance. The use of chemical instrumentation and creating new molecules to flavor food in a safe and efficient way is a difficult process that many do not think of when they go to buy a certain food. Jellybeans are an interesting chemical wonder that seem simple on the outside, but inside is an amazing creation that utilizes chemistry to make a delicious candy.

Works Cite

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