Chocolate and Theobromine

Chocolate has become a part of everyday life throughout the world. Many enjoy different chocolate selections such as cake, ice cream, chocolate bars, etc. as desserts. Furthermore, chocolate has solidified itself as a common gift during many holidays such as Valentine’s Day, Easter, Halloween and Christmas, making it a highly lucrative industry, valued at over $80 billion a year. Europeans, specifically individuals from Switzerland, consume the greatest amount of chocolate. Europeans are said to consume an average of twenty-four pounds of chocolate annually per capita. Americans on the other hand are said to consume an average of eleven pounds of chocolate annually per capita [11]. It takes about twelve cocoa seeds to make one ounce of dark chocolate, while it takes about four cocoa seeds to make one ounce of milk chocolate [6].

Theobromine Structure [7]

The primary alkaloid in cocoa beans is theobromine and is present in the cocoa bean and throughout the production of chocolate [7]. Many people eat chocolate but are unaware of the long process of changing the cocoa bean into the chocolate we eat. The majority of cocoa in the world is produced in Africa, more specifically the Ivory Coast, and South American [9]. Cocoa beans are found in pods which grow on *Theobroma cacao* trees. In order to begin the process of making chocolate, the cocoa beans as well as the pulp which surrounds the beans are removed from the pods. They then are then left in baskets or containers for anywhere from two to eights days in order to ferment together. The fermentation allows the flavors of the beans to blend and mellow together, while also reducing the bitterness of the product. The length of the fermentation process varies with the quality of the desired chocolate products. A longer fermentation process is usually correlated with higher quality chocolates, while a shorter fermentation process is usually correlated with lower quality chocolates [8].
After the desired fermentation process is complete, the beans are taken out of the containers and are left to dry by spreading the beans out into a single layer and left in the sunlight. This drying process is often times done on wooden floors or electric dryers and can take anywhere from one to two weeks. During this time, the beans change their color from a reddish brown to a darker brown. After the drying process is complete, the beans are then able to be sent around the world to various chocolate manufactures [1].

Once the cocoa beans are at different chocolate manufacturing plants, the beans are roasted for various lengths of time and temperatures in order to reveal more of the bean’s color and flavor. After roasting the beans, they are transferred to a machine called a winnower. The winnower removes the bean’s shells and the beans are then called nibs. These nibs contain cocoa butter, the fat, and are ground together to create a paste which begins to smell and resemble the typical chocolate we consume [8]. The paste has pressure applied to it in order to remove the cocoa butter [1]. Only about ten to twenty-five percent of the cocoa butter still remains in the leftover paste, which is then pulverized and becomes cocoa powder [1, 8].

Depending on the type and quality of chocolate which is going to be made, different ingredients are then added to the cocoa powder. Lower quality chocolate is produced by mixing the cocoa powder with vegetable fats, sugar and other flavorings. Higher quality chocolate on the other hand is produced by mixing cocoa powder with re-added cocoa butter, milk, sugar, vanilla, etc. The mixed chocolate solution (cocoa powder and added ingredients) is then smoothed out by rollers and sent to the conching machines. The conching machines massage and knead the chocolate mixtures from anywhere from hours to a couple of days. The conching process determines the texture and flavor of the final chocolate product due to the variation of length, temperature and speed of the conching process. After the conching process, the chocolate mixture is tempered (cooled at a precise temperature) in order to produce a smooth and shiny appearance. Finally, the chocolate is able to be molded and shaped, wrapped and shipped out for other to enjoy [8].

Depending on the type of cocoa beans, the amount of theobromine varies. The amounts in cocoa beans can be anywhere from 300-1200 mg/ounce [7]. This molecule also varies by the type of chocolate made. White chocolate contains the least amounts of theobromine of any type of chocolate because of the ingredients used to produce it; cocoa butter as opposed to cocoa powder is used [2]. Milk chocolates and chocolate syrups contain the second least amount of theobromine. Cocoa powder, dark chocolates and unsweetened baking chocolate contain the
most amounts. To give a comparison, a regular Hershey’s milk chocolate bar contains about 64 mg of theobromine, while a Hershey’s dark chocolate bar contains about 215 mg [3].

<table>
<thead>
<tr>
<th>Product</th>
<th>Serving (g)</th>
<th>Theobromine (mg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>HERSHEY’S Milk Chocolate</td>
<td>1.55 oz (43 g)</td>
<td>64</td>
</tr>
<tr>
<td>HERSHEY’S BLISS Dark Chocolate</td>
<td>6 pieces (43 g)</td>
<td>215</td>
</tr>
<tr>
<td>REESE’S Peanut Butter Cups</td>
<td>2 cups (42 g)</td>
<td>26</td>
</tr>
<tr>
<td>YORK Peppermint Pattie</td>
<td>1 piece (39 g)</td>
<td>53</td>
</tr>
</tbody>
</table>

Amount of Theobromine Found in Different Chocolate Products [3]

The amount of theobromine consumed is important because it has many different effects on the human body. Theobromine is very similar to caffeine but the effects which theobromine elicit are on a much smaller scale, about ten times weaker [9]. Theobromine is a mild stimulant like caffeine, but does not affect our central nervous system as much as caffeine does [2]. It is a mild diuretic, which increases urine production, as well as a molecule which dilates blood vessels so more blood is able to get through veins and arteries quicker. Lastly, this molecule aids in relaxing the smooth muscle and bronchi of the human lungs [7]. These characteristics are common among other methylxanthines, which are a class of alkaloids. Other methylxanthines include caffeine in coffee, theophylline in tea, nicotine, cocaine, and quinine [4].

While theobromine is common in chocolate, this molecule is common in other foods and drugs. Theobromine is also found in tea, cola nuts and is also used to flavor some soft drinks. While theobromine is sold as a supplement, it can and is used in many different drugs. It is sometimes used in medications which treat asthma because it helps to relax the smooth muscles of the lungs. It is sometimes suggested to eat some chocolate when one has a cough because this molecule is known as a mild cough suppressant [4]. Theobromine is used in some medications used to treat high blood pressure because of its ability to dilate blood vessels. Also, it is sometimes used in medications which help patients suffering from cardiac failure. When a patient suffering from cardiac failure has an accumulation of body fluids, theobromine helps rid the fluid due to its’ diuretic properties [7].

Although this molecule provides many benefits for the human body, too much theobromine, like too much of anything else, can cause theobromine poisoning. Theobromine poisoning is more common in animals but only affects a small amount of humans. Early stages of poisoning in humans may cause symptoms such as sweating, trembling, headaches and nausea. In more extreme cases, individuals may need to be hospitalized; it is more common that the elderly with poisoning need to be hospitalized. Theobromine is said to be many times fatal if an individual has more than 1000mg/kg of theobromine in their body; that amount is similar to consuming over five kilograms of milk chocolate [2, 4].
While theobromine is many times fatal for humans who have more than 1000mg/kg in their body, for animals it is much more dangerous. This molecule is especially dangerous for dogs and the amount needed to become fatal in dogs is significantly less than that for humans. Amounts as low as 20mg/kg can cause agitation, hyperactivity, vomiting and diarrhea. Theobromine amounts greater or equal to about 40mg/kg can cause high blood pressure, increased heart rate and possible heart arrhythmias. Doses greater or equal to about 60mg/kg can cause twitching, tremors and seizures. It is believed that at amounts of 100mg/lb or greater, fatalities of dogs can often times occur. To give an example, a fifty pound dog which eats 8 ounces of milk chocolate can show signs of poisoning [5].

Animals are affected more profoundly to theobromine due to difference of half lives. The amount of theobromine in humans is half the amount after six to ten hours. Animals on the other hand, take two times the amount of time humans do in order to have half the amount of theobromine in their body [7]. Due to this difference, it can take animals several hours to develop signs of theobromine poisoning and several days for the symptoms of the poisoning to go away [5]. It is also important to remember that different types of chocolate contain more theobromine than others. Even if an animal has less amounts of dark chocolate, it is still more likely to do more damage than larger amounts of milk chocolate.

If an animal does have theobromine poisoning, there are different treatment options for them. One common treatment for animals is to be given medication to induce vomiting. Another treatment is to be given charcoal in order to block theobromine absorption. Animals may also be given a fluid therapy to dilute the theobromine and help to excrete it faster [5]. Theobromine poisoning in humans is not very common and the treatment options vary for humans. Depending on the type and severity of symptoms which theobromine cause will dictate the treatment options for each individual [10].

Chocolate is and will continue to be a part of the lives of people around the world. The molecule, theobromine, is found in cocoa beans and is present throughout the production of chocolate. Dark chocolate contains the most amounts of theobromine and benefits the human body by dilating blood cells and being a cough suppressant. Too much theobromine can cause poisoning but in humans poisoning is not very common. Pet owners on the other hand, must be careful that animals do not digest it because this molecule is very dangerous, especially to dogs. Although this molecule in chocolate is dangerous to some, chocolate continues to give joy to many people and continues to satisfy our sweet tooth.
Works Cited


