

How do you make chocolate?

With no doubt, chocolate is a very common type of snacks today. Almost 80% of the participants of a survey done at Niagara College eat chocolate at home [3]. As chocolate is getting popular, it is not difficult to find a variety of brands of chocolate manufacturers in a supermarket. Nonetheless, the process of making chocolate is very similar, if not the same, for most of the chocolate manufacturers. This article will provide a disclosure of the steps involved while this sweet delicacy is being made.

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Graduating in 2014, Ringo Yip is currently a senior majoring in Chemical Engineering with an emphasis on Nanotechnology at USC. Hoping to pursue a career in the food industry, Ringo has been very interested in the connections between engineering and food processing. On this article, Ringo has chosen to write about the manufacturing process of chocolate, and is hoping to provide valuable pieces of information for readers who are interested in this field as well.

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Etymologists speculate that chocolate originated from the bitter brewed Aztec drink, “xocoatl.” [1]. Should this be the case, then chocolate was not a sweet treat in a solid form, but first, a beverage made by the Aztech with cocoa beans before the 1300s. By the 1600s, although chocolate was finally introduced to Europe, the recipe for making sweet chocolate still remained to be a secret, and only the rich had the luxury of enjoying it [2]. Nowadays, access to the taste of chocolate is no longer a luxury, but rather, one of the most popular foods. According to a survey conducted by a group of students at Niagara College in Canada in 2009, at least 70% of the survey-participants bought chocolate at least a couple of times a month [3].

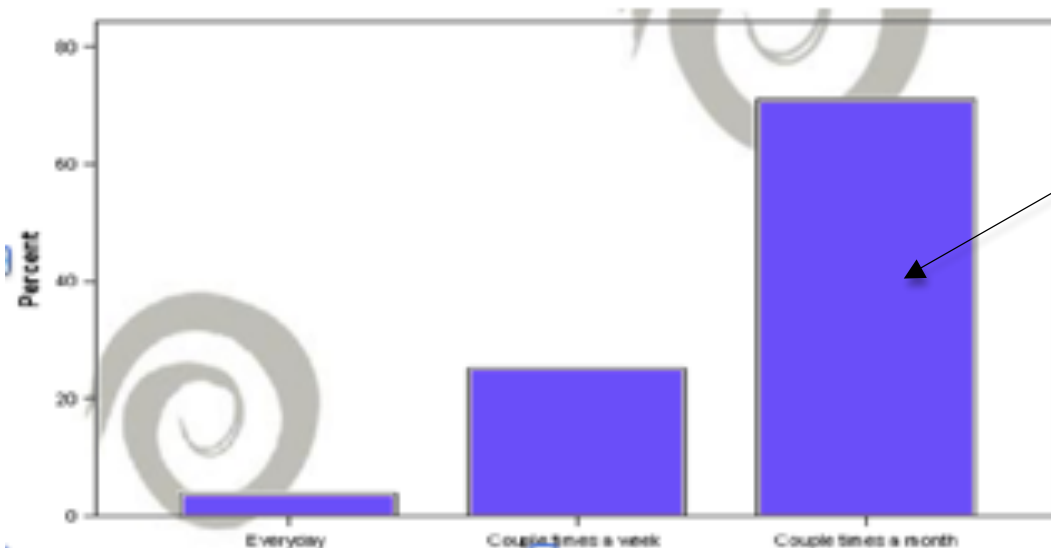


Figure 1: How often do people buy chocolate?

Process

While chocolate is certainly delicious, making it is not an easy thing to do. The whole process takes a series of steps, which have to be done in order. Starting from “Raw Materials”, the following schematic, Fig. 2, shows the multiple steps required to finish the whole process.

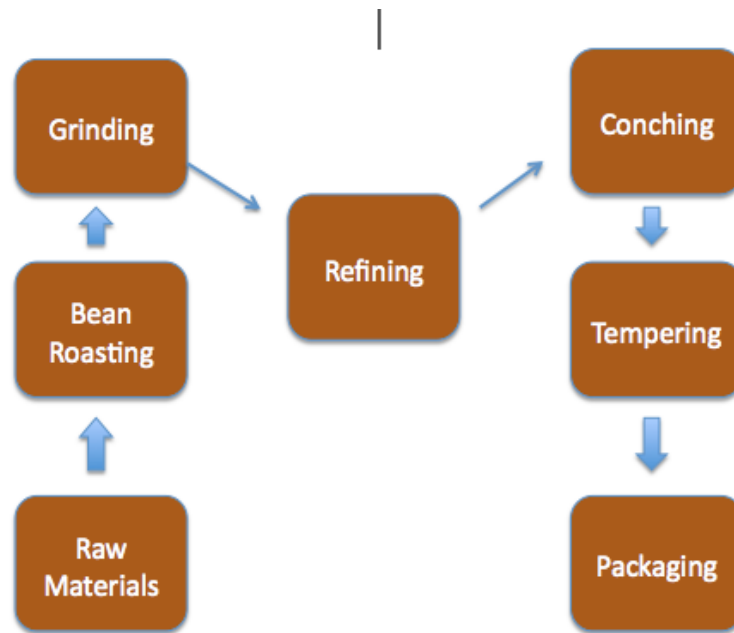


Fig. 2: The steps involved when making chocolate

Raw Materials

In the 1000s, people in Central America could use 100 cocoa beans to buy a slave, since cocoa beans used to be a currency [2]. However, they are no longer a type of currency today. Instead, they are the most essential ingredients to make chocolate.

Cocoa beans are usually grown within 20 degrees north or south of the equator [4]. Some of the heaviest producers of cocoa beans include Ghana, Indonesia, and Ivory Coast. One thing they all have in common is that they are all tropical countries [4]. Their tropical weather conditions are excellent for the growth of cocoa beans. Among these countries, Ivory Coast has the highest productive rate of cocoa beans.

To select good cocoa beans, farmers must evaluate them based on factors including level of infestation and degree of fermentation.

Infestation

Infestation is a state of being invaded by pests or parasites. Only the beans with fine qualities, which have to be non-infested, can be selected to make chocolate. Therefore, farmers must carefully determine whether the beans are infested before selecting them. Farmers need to discard them if the beans are infested [8].

Fermentation

Fermentation is a process that naturally occurs in cocoa beans. It is a step that turns sugar into acids and alcohols, which will start the chemical reactions that form the precursors of chocolate flavor [16]. It is essential to ensure that the cocoa beans are fermented before they are selected. Farmers select the beans depending on how well they are fermented, based on the colors. Unfermented beans tend to have a color of slate gray, while completely fermented beans are usually rich dark brown. While fermented beans contain the precursors, studies have shown that unfermented beans do not contain those precursors found in the fermented cocoa beans [16].

Roasting

The purpose of roasting cocoa beans is to bring out the pure chocolate flavor of the beans. Generally, the whole roasting process involves two big steps: bean roasting, and nib roasting.

In the first step, bean roasting, cocoa beans are being roasted in order to get the shells cracked and removed. The reason is to get the nibs, which exist inside the beans, out of the shells. It is necessary to obtain the nibs because they are the essence of pure chocolate.

Once the nibs are obtained from the beans, the second step, nib roasting, is conducted. The goal of nib roasting is to perform a deeper level of roasting in hopes of producing a more robust and intense flavor of chocolate [6]. As the shells are gone, the roasting time in the process becomes easier to control [6]. According to an experiment conducted at Karlsruhe Institute of Technology in Germany, there is a limitation of heat transfer for beans due to their larger particle size, but not in nibs [15]. Since heat transfers more smoothly in nibs than beans, it is easier to control the roasting time in nibs than beans while roasting because of the faster heat transfer rate. In other words, due to the faster heat transfer rate, it takes a shorter amount of time to reach the temperature required to roast the nibs than it does to roast the beans [15]. As a result, it becomes easier to control the roasting time.

Taking the nibs out is important in controlling the roasting time. For example, one of the chocolate manufacturers, *Ghirardelli Chocolate*, takes the nibs out from the beans for the roasting process, too, so that it can control the roasting time of the nibs more

easily in order to bring out the intense chocolate flavor that its products are well known for [7].



Fig. 3: Nibs of cocoa beans [8]



Fig. 4: Nib Roasting [7]

Grinding

Grinding is a process of turning nibs into smaller pieces. When nibs become smaller, they liquefy in a form that is called “chocolate liquor” in the industry [5].

Additionally, grinding helps bring out the cocoa butter that naturally exists inside the nibs. It is an important part of chocolate because it contains a cocoa flavor and aroma. Each bean is made up of approximately 54% of cocoa butter. As the nibs are in the process of being grinded, heat is generated due to the friction involved, which aids in bringing out and liquefying the cocoa butter that is essentially the fat of nibs. The image below, Fig. 5, shows a skim of the inside of a cocoa bean.

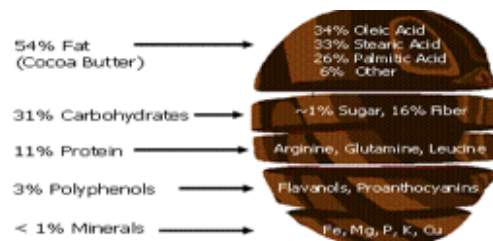


Fig. 5: What's inside a bean? [10]

Meanwhile, sugar is simultaneously added at this point. Since the particles of sugar and cocoa are in similar size, if not the same, they become evenly distributed, and are coated with the cocoa butter being made in the process [9]. After this step is performed, the taste and scent that most people are familiar of have begun to take form.



Fig. 6 : A chocolate mill [9]

Figure 6 displays an image of a chocolate mill. A chocolate mill is required to perform the grinding process. This equipment generates friction and heat that help facilitate the whole process [5].

Mixing

Mixing is a crucial step because it blends all the ingredients in a mixer. The ingredients may include lecithin, milk, vanilla, or additional cocoa butter if needed. Normally, additional cocoa butter is not needed because there is already enough cocoa butter being made during the grinding process. It is only needed if the manufacturers think the amount of cocoa butter is not enough to coat the cocoa and sugar, but this situation is rare. Also, depending on the type of chocolate being made, the amount of added ingredients, such as milk, varies. For instance, milk chocolate contains 12% milk, and white chocolate contains 14% milk [14].



Figure 7: A mixer [15]

Refining

Refining turns the texture of chocolate into a smooth consistency. At this point, the chocolate, which has the required ingredients mixed, still has a rough texture because it is in a form of chocolate paste. The roughness is not ideal since it may hinder the conching process that will be explained later. Therefore, refining is necessary to turn the roughness into smoothness. The chocolate paste is imported into a chocolate refiner, a machine composed of a series of rollers that are pressed tightly against on each other [5]. All the rollers spin in the same direction, and each consecutive roller spins faster than the previous one, beginning with the first roller. Specifically, the refiner causes a tremendous amount of shear force and friction, which turn the chocolate paste into a smooth texture after it has passed through the rollers. As the chocolate paste is passing through the rollers, the rollers crush and press the chocolate paste into flakes that are significantly reduced in size, compared to that of paste. Now, after turning into flakes, it has a smooth texture that many of us are familiar of.

Conching

Conching, a step driven by a stirring under high speed, involves developing the chocolate flavor in conches [5]. Since now the chocolate is in a smooth state after refining, it is ready to be stirred. *Note:* It is important to ensure that the texture is smooth before conching because a rough texture is difficult to stir due to the large particles that exist inside the unrefined ingredients, such as the unrefined sugar particles.

The purpose of this process is to remove any physical flaws before the final product is made through constant stirring of high agitation. Such flaws might include high viscosity, moisture, or any lingering acidic flavors [7].

Conches are used during this step. Essentially, conches are large mixers that are able to stir the chocolate mass under high speed [7]. This process requires a large amount of mechanical energy to be expended, thus causing a rise in temperature. High temperature facilitates the process of removing physical flaws because it accelerates the rate of chemical reactions, such as the dissolving process of particles of the ingredients, required to remove them. Conching is important because it, in a sense, is doing a “wrap-it-up” job before the chocolate is considered a finished product. It ensures that the chocolate mass does not contain any harmful flaws or imperfections, such as moisture [7]. The following picture displays an image of the conching process. The chocolate mass is being stirred agitatedly in accord to the direction of either arrow shown below.

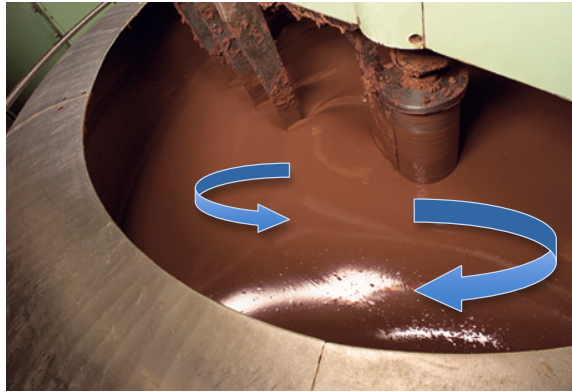


Fig. 10: A concher stirring a chocolate mass [11]

Tempering

The tempering process of chocolate is a key step in ensuring the chocolate has a well-defined structure. Although the physical flaws are removed after conching, the internal crystal structure, which consists of fatty acid crystals coming from cocoa butter, is still disorganized because they are not well connected to each other [18]. Unless if the chocolate has an organized crystal structure, this delicacy may have already started melting on your hands before it is put inside your mouth.

To bring the disparate crystals to an organized form, the process of tempering is necessary. In the process, the chocolate is first cooled, causing the other inert fatty acid to form new crystals. The temperature is then raised to tightly connect the new and old crystals together and keep them from solidifying [18]. Consequently, the structure becomes much more organized.

Once the chocolate has an organized crystal structure, it won't melt as easily because a higher temperature is needed to pull the connected crystals apart. As a result,

the chocolate has a well-defined form that is much more stable than it is before the tempering process.



Fig. 11: A chocolate product after tempering [13]

Fig. 11 is an example of a chocolate product after the tempering process. It has a structured and specific shape.

Packaging

Once the chocolate has formed its shape, it is ready to be packaged. Usually, aluminium foil is used to store chocolate products. Because of the vulnerability of chocolate, the qualities can easily deteriorate when it is exposed in the air or under the sunlight. Therefore, aluminium is popularly utilized to package the chocolate products in the industry.

Aluminium foil provides a barrier for humidity or sunlight, and thus it helps prevent such harmful factors as oxidation or any penetration of unwanted odor [13]. Additionally, since packages made of aluminium foil possess re-wrapping properties, spoilage of chocolate products can easily be avoided. For instance, if wrapped in foil properly, dark chocolate can last up to two years or more [13]. Similarly, milk and white chocolate can last up to one or more year. However, in comparison to dark chocolate,

they have a more limiting storage time because they contain more fat, milk and sugar, which melt at a low temperature [14].

Once the product is packaged properly, a final product of chocolate is ready to be enjoyed by chocolate-cravers! Although it only takes around a minute to have a piece of chocolate bar get melted in your mouth, the whole process from picking cocoa beans to packaging can take around a few weeks. With all the steps mentioned above, making chocolate really is not an easy to do.

Multimedia

The sources below are suggested to provide additional information regarding the chocolate making process.

[1]

<http://www.youtube.com/watch?v=BLUEptVYHN4>

This link is a video that provides the site tour of Hershey Chocolate World Factory.

[2]

<http://www.youtube.com/watch?v=0TcFYfoB1BY>

This video provides an overview of the whole chocolate making process of Hershey Chocolate.

[3]

<http://www.delish.com/entertaining-ideas/holidays/christmas/chocolate-desserts#slide-1>

This link provides recipes for making Christmas chocolate!

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