Chocolate Fabrication

1. Introduction

Chocolate and its varied forms (candy bars, cocoa, cakes, cookies, coating for other candies and fruits) are probably most people's favorite confection. Chocolate is a raw or processed food produced from the seed of the tropical *Theobroma cacao* tree. Cacao has been cultivated for at least three millennia in Mexico, Central and South America, with its earliest documented use around 1100 BC. The majority of the Mesoamerican people made chocolate beverages, including the Aztecs, who made it into a beverage known as *xocolātl*, a Nahuatl word meaning "bitter water." The seeds of the cacao tree have an intense bitter taste and must be fermented to develop the flavor.

2. Raw Materials

The primary components of chocolate are cocoa beans, sugar or other sweeteners, flavoring agents, and sometimes potassium carbonate (the agent used to make so-called dutch cocoa).

3. The Manufacturing Process [1]

Once a company has received a shipment of cocoa beans at its processing plant, the beans are roasted, first on screens and then in revolving cylinders through which heated air is blown. Over a period of 30 minutes to 2 hours, the moisture in the beans is reduced from about seven percent to about one percent. The roasting process triggers a browning reaction, in which more than 300 different chemicals present in the cocoa beans interact. The beans now begin to develop the rich flavor we associate with chocolate. Roasting also causes the shells to open and break away from the nibs (the meat of the bean). This separation process can be completed by blowing air across the beans as they go through a giant winnowing machine called a cracker and fanner, which loosens the hulls from the beans without crushing them. The hulls, now separated from the nibs, are usually sold as either mulch or fertilizer. They are also sometimes used as a commercial boiler fuel.

Next, the roasted nibs undergo *broyage*, a process of crushing that takes place in a grinder made of revolving granite blocks. The design of the grinder may vary, but most resemble old-fashioned flour mills. The final product of this grinding process, made up of small particles of the nib suspended in oil, is a thick syrup known as chocolate liquor.

The next step is refining, during which the liquor is further ground between sets of revolving metal drums. The widely-used machine is roll mill (2 or 3 rolls). It has been recorded that the three roll mill was used to mill chocolate as early as 1915. Each successive rolling is faster than the preceding one because the liquor is becoming smoother and flows easier. The ultimate goal is to reduce the size of the particles in the liquor to about .001 inch (.00254 centimeters).

If the chocolate being produced is to be cocoa powder, from which hot chocolate and baking mixes are made, the chocolate liquor may be *dutched*, a process so-named because it was invented by the Dutch chocolate maker Conrad van Houten. In the dutching process, the liquor is treated with an alkaline solution, usually potassium carbonate, that raises its pH from 5.5 to 7 or 8. This increase darkens the color of the cocoa, renders its flavor more mild, and reduces the tendency of the nib particles to form clumps in the liquor. The powder that eventually ensues is called dutch cocoa.

The next step in making cocoa powder is *defatting* the chocolate liquor, or removing large amounts of butter from it. This is done by further compressing the liquor between rollers, until about half of the fat from its cocoa beans has been released. The resulting solid material, commonly called *press cake,* is then broken, chopped, or crushed before being sifted to produce cocoa powder. When additives such as sugar or other sweeteners have been blended, this cocoa powder becomes a modern version of chocolate.

If the chocolate being produced is to become candy, the press cake is remixed with some of the removed cocoa butter. The restored cocoa butter is necessary for texture and consistency, and different types of chocolate require different amounts of cocoa butter.

The mixture now undergoes a process known as *conching*, during which it is continuously turned and ground in a huge open vat. The process's name derives from older vats, which resembled large conch shells. The conching process can last between three hours to three days (more time is not necessarily better, however). This is the most important step in making chocolate. The speed and temperature of the mixing are critical in determining the quality of the final product.

Another crucial aspect of conching is the time and rate at which other ingredients are added. The ingredients added during conching determine what type of chocolate is produced: sweet chocolate consists of chocolate liquor, cocoa butter, sugar, and vanilla; milk chocolate contains sweet chocolate with powdered whole milk or whole liquid milk.

At the end of the conching process, the chocolate is poured into molds, cooled, cut, and wrapped.

The basic manufacturing process is demonstrated in Figure 1.

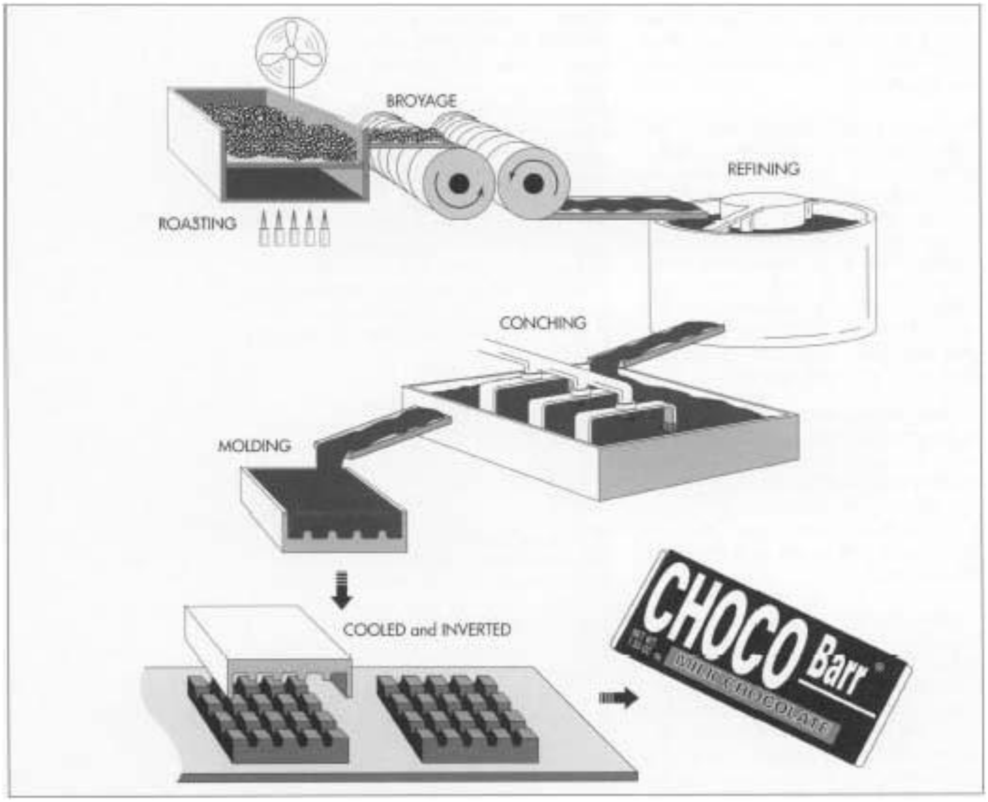

Figure 1. *Schematic process of chocolate*

4. Particle Size and Chocolate

During the manufacture of chocolate bars, viscosity is the key point. If it is too high, the chocolate does not flow well during its processing. There are two common approaches used in chocolate industry to reduce the viscosity of chocolate: the first one is to have a large stirred tank shearing a small amount of chocolate; the second one is to highly shear a few kilos at a time in a continuous processor. Another used approach is to add emulsifier to add more fat.

Someone recommends [2] a bi-modal particle size distribution by specifically selecting the mean particle size for each ingredient to obtain the desired particle size distribution. The mean particle size of each ingredient (fine to coarse) is selected based upon the desired global particle size distribution. The function of processing this way is to pack small particles in the interstices of large particles.

Particle size influences fluidity of fatty suspensions, confectioneries, and particularly that of chocolate. If the particles are too small, fluidity is decreased and manufacturing the chocolate is much more difficult, as the chocolate mass becomes too thick.

In chocolate, large particles are important for mouthfeel with respect to grittiness, and small particles are important with respect to chocolate flow properties. Indeed, a large amount of fat is needed to cover the particles and to allow them to move in the chocolate mass; if the amount of fine particles is high, then there is an important need for fat to cover said particles and to have a chocolate with an acceptable fluidity from a manufacturing point of view. Thus, when the amount of fine particles is too high, fat is mostly used to cover said particles and is no longer free to allow particles to move, rending the chocolate mass too thick to be handled properly.

5. Roll Mill and Refining Processing

Refining is the final grinding of all particles in the liquid chocolate together to produce an even, extremely smooth texture in which no grit can be detected on one's tongue or pallet. This means the largest particles should be in the range of 15-30 micron. If the cocoa liquor has been properly ground, the purpose of refining is to reduce the size of added sugar crystals and, in the case of milk chocolate, the particles of milk powder.

Figure 2. *Five roll mill*

Usually during the refining process, cocoa liquor, crystalline sugar and milk components are added in a mixer with part of the cocoa butter. It is important that the feed materials to the rolls are well-mixed. In some systems, a two-roll refiner known as a prerefiner (a two-roll or three-roll mill) employed to prepare the feed for the main stack. Fiver roll refiner can be used as finer after 2 roll refiner (Figure 2). The gap between the rolls decreases from bottom to top while the speed of rotation increases. The cocoa liquor is introduced between the bottom two rolls. The film of chocolate leaving each gap is transferred to the faster roll and so moves upwards. The product is scraped off the top roll. Uncompressed rolls are barrel-shaped. Hydraulic pressure is applied to the roll stack to compress the camber on the rolls and obtain an even coating across the length of each roll. The reduction ratio attainable is 5-10, which should result in the particles in the product being in the correct size range. The temperature of the rolls is controlled by circulation of water through them [3]. The advantage of roller mills is that it is possible to achieve a more consistent particle size in the ground chocolate. In some cases, a homogenous chocolate can be put through a mill to reduce particle size without a liquid base or carrier. This helps create a better mouth feel [4].

Generally, at this stage, the maximum particle size is between 100 and 150 microns. The last grinding step takes place on a five-roll refiner, at the end of which 90% of the particles, in volume, have a diameter below 35 microns, generally (D90 < 35 microns).

6. Example [5]

Ingredient	Usage Level (%)
D-Milk Chocolate, Bloomer	52.63
Kreemy White Coating, Blommer	23.55
Anhydrous Milkfat	14.19
Trucal	6.31
Milk, Whole, Dry Powder	3.06
Flavor	0.23
Soy Lecithin	0.03
Total	100.00%

Preparation:
1. Melt anhydrous milkfat with lecithin and add to dry milk powder.
2. Put through the three-roll mill.
3. Melt white confectionery coating and add dairy calcium slowly.
4. Add the milk mixture, mixing until incorporated.
5. Add flavor and slab.
6. Cut slabbed center in squares and enrobe in milk chocolate.

Conclusion
The aim of refining step in chocolate manufacturing is to control the particle size of chocolate. Particle size of raw materials plays an important role in chocolate taste. Roll mill is the accepted instrument employed in refining step in chocolate manufacturing. The quality of roll mill is an important factor for chocolate processing. Our company enables us to offer the value-added advantages of in-house manufacturing. Our goal is to provide the highest levels of quality, reliability and still maintaining and competitive price.

References:

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