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FOOD PROCESSING

Cocoa Processing: Tempering

What is tempering?

Tempering is an important process of making chocolate. It yields a glossy product with a melting temperature close to the temperature of the mouth and stable to temperature fluctuations. Cocoa butter is the fat component of chocolate that forms crystals with different structures (polymorphs) known as: I, II, III, IV, V and VI. The difference between these forms is the melting point – the temperature when the chocolate becomes liquid or loses its solid state (Table 1). The fat crystals in forms V and VI are more stable and have a higher melting point (Afoakwa, 2016).

In a proper tempering process, the chocolate mass must go through different temperatures to reach the stable crystals form V. Thus, when the chocolate mass reaches the solid state, the surface of the chocolate will have desirable characteristics such as: glossy and shiny surface, even color, compact structure, and proper snap. The chocolate also does not melt in the hands and is more stable to small changes in storage temperature following tempering.

Table 1. Polymorphs of cocoa butter (Beckett, 2008).

Polymorphs			Melting point (°C)	Characteristics
*	**	***		
I	γ	●	16-18	Melt easily, soft, crumbly.
II	α	■	22-24	
III	β'	▲	24-26	Better texture, compactness, and snap.
IV		⬢	26-28	
V	β	★	32-34	Shiny and glossy surface, compacted, proper snap.
VI		⬟	34-36	

** Roman letters ** Greek letters *** Shapes according to drawings on figure 1 for a graphic representation.*

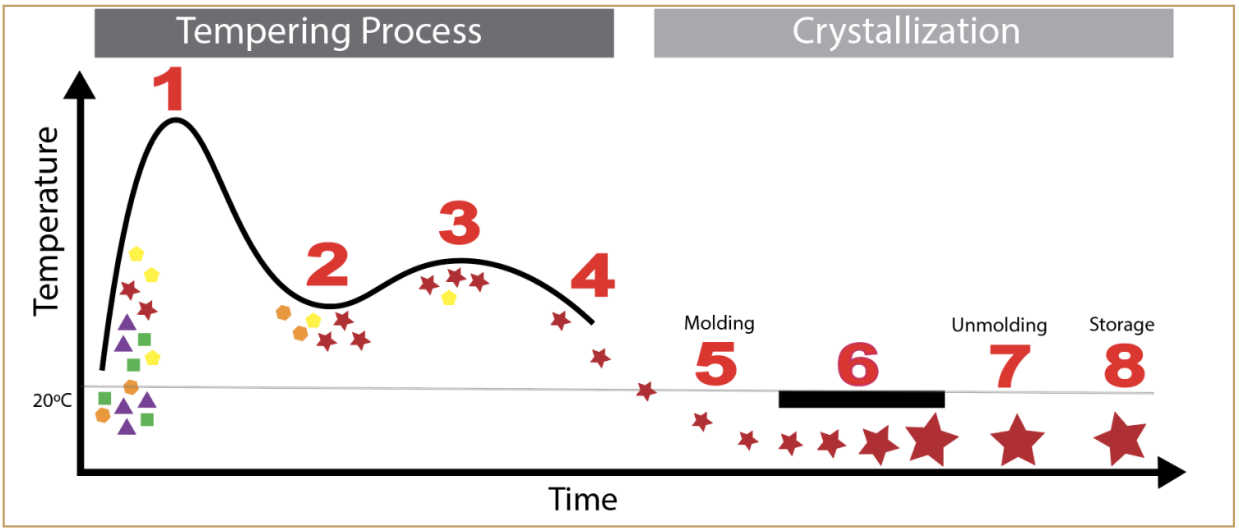

Figure 1. Tempering process and crystallization of dark chocolate.

Main steps for tempering

These are the 8 steps for an adequate chocolate tempering process (Figure 1):

1) Heating the chocolate mass to 40- 45° C, to melt all crystals.
2) Rapid cooling to 28-29° C, to create many fat crystals.
3) Reheating the chocolate mass to 31-32° C, to melt unstable crystal polymorphs and keep only type V structure.
4) Cooling to 29-30° C to allow the cocoa butter to crystallize to about 5% solids.
5) Immediate molding for solidification (the molds temperature should be similar to the temperature of the chocolate mass), with vibration to remove internal voids and bubbles.
6) Chocolate crystallization will last up to 24 hours, with a controlled temperature between 18-20° C.
7) Chocolate demolding with a slight tap, and packaging.
8) Storage on shelves at 18-20° C and 50-60% of relative humidity.

The temperatures described are reference values for a dark chocolate without the addition of milkfat or other fats components. Temperature settings can be established according to the place, environmental conditions, and formulation.

How tempering is done

▪ **Manual:** The chocolate mass is heated in a water bath or oven until liquid. Part of the mixture (2/3) is cooled using a cold surface, such as stainless steel or marble table, where a thin layer is spread. A back-and-forth movement is applied to distribute the temperature evenly with a scraper, until reaching the designated temperature.

Then, the chocolate mass is added back to the remained chocolate and stirred constantly until reaching 31-32° C, then cool slightly to 29-30° C for molding.

▪ **Tempering equipment:** Consists of a container that provides heating and cooling to the chocolate mass in stages that can be programmed, with continuous agitation. An effective way of working is by adding a few "seeds with V crystals" to the un-tempered chocolate mass from previously well-tempered chocolate. The tempered chocolate is molded and crystallized after the tempering process is done.

How to achieve tempering in small operations

In an industrial setup, heat exchangers are designed to provide temperature control with the use of chilled, cold, and hot water or air. In small operations or artisanal setups, similar services are required to control heating and cooling processes. The use of cold water and ice are required, but it is important to keep the chocolate isolated from contact with water. In addition, a closed area for chocolate tempering and storage is required to maintain an ambient temperature of 18-20° C and relative humidity of 50-60%; that is usually achieved with air conditioning and a dehumidifier.

What are the white spots on chocolate?

The white spots on chocolate is known as fat or sugar bloom. It is a physical defect that appears in the chocolate surface due to poor processing practices. It is not a microbial contamination. The bloom of the fat is produced by poor tempering or temperature fluctuations in storage. When storage temperature rises, the V-type crystals melt and recrystallize again in form VI, at the new storage temperature, and they appear as white spots on the chocolate surface (ADM Cocoa, 2008).

Figure 3. Chocolate with fat bloom (left) and a regular chocolate (right)

Sugar bloom occurs when water condenses on the chocolate surface from the air. The sugar on the chocolate surface dissolves with the water and then crystallizes as the water evaporates, thus forming a white layer. When working with chocolate, the area must be kept dry, and materials free of water.

Takeaway key points

- Fat crystals V formed during tempering process improve chocolate quality.
- Tempering requires a controlled temperature and relative humidity.
- Polycarbonate molds are preferred to improve chocolate quality.
- Chocolate temperature can be monitored with an infrared thermometer.

Glossary

Chocolate mass: a mixture of ingredients during the preparation of chocolate

Dark chocolate: cocoa liquor, sugar or sweetener, cocoa butter, emulsifier, and flavors

Milk chocolate: cocoa liquor, sugar or sweetener, cocoa butter, powdered milk or milk derivatives, emulsifier, and flavors

References

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