Chocolate Fat Bloom

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Fat bloom is a common occurrence when working with chocolate products. It is a physical defect that appears during storage of chocolate and is characterized as a whitish layer on the outer surface (Figure 1). Chocolate with fat bloom is not only visually unappealing, but also impacts the flavor and textural qualities, which are important determinants of consumer preference. The phenomenon is not fully understood, but research suggests there are many factors which may contribute to fat bloom formation such as poor tempering, mixture of incompatible fats, disrupted cooling methods, temperature fluctuations, storage conditions and abrasion or finger marking.

Fat bloom impacts all of us: manufacturers, suppliers and customers alike. It is important to understand when and why it is occurring to hone in on the problem and implement a corrective action. Overall, fat bloom is inevitable, but once you understand the fundamentals you can prevent it from occurring prior to the end of shelf life.

CHOCOLATE STRUCTURE

Chocolate has a complex flavor profile and compositional matrix consisting of sugar, cocoa particles and emulsifiers dispersed in a continuous phase of cocoa butter (Figure 2). Cocoa butter is a polymorphic fat composed of three main triglycerides (TAGS). These TAGS are the building blocks of a strong foundation. A TAG molecule is composed of a glycerol backbone with three fatty acid chains linked by ester bonds. This molecule is most commonly illustrated in a chair-like or tuning-fork formation. These TAGS can crystallize in six different polymorph formations (Forms I-VI), which have specific melting points. Polymorph Form V is the ideal form to achieve when working with chocolate. When cocoa butter is in this form, chocolate achieves many favorable attributes such as a smooth, even melting, clean snap and nice gloss. This can be accomplished by tempering.

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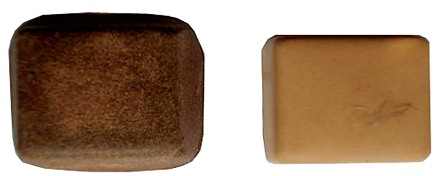

Figure 1

Molecular Chocolate Matrix

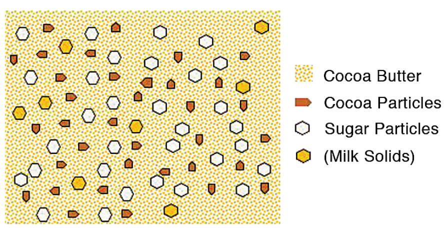

Figure 2

Dirty moulds can initiate fat bloom due to a residue chocolate layer being left on the mould that acts as seed or site of crystal nucleation for subsequent deposited chocolate.

Envision that all the TAG molecules are individual and mobile when cocoa butter is in its liquid state at 120°F. As the mass begins to cool, crystals begin to form and eventually a crystalline lattice is created (Figure 3). If the TAG molecules create a disorderly nonuniform stacking, fat bloom formation can occur in the finished chocolate product. This can be initiated by temperature fluctuations, improper application techniques, improper handling or processing failures when working with chocolate.

INVESTIGATING FAT BLOOM

It is important to ask the following questions when investigating cause of bloom:

- How does fat bloom affect our product?
- Where is it seen on the production line?
- When do we see it occurring?
- What is the cause?
- What challenges do we experience while working with chocolate prior to production, during production or postproduction?

Fat bloom can appear in many different ways, but the following case studies will give you general guidelines to help determine the root cause and answer the questions posed above.

TYPES AND CAUSES OF FAT BLOOM

Extreme temperature fluctuations (postapplication) The image in Figure 4 shows that environmental handling conditions were not ideal. In this case study, bloom has impacted the structural integrity of the chocolate product and completely deformed it. This is caused during transportation or distribution, e.g., the shipping truck sitting at temperatures 5° to 10° above the melting point of chocolate.

Dirty moulds (during application) Dirty moulds can initiate fat bloom due to a residue chocolate layer being left on the mould that acts as seed or site of crystal nucleation for subsequent deposited chocolate. This newly deposited chocolate will form surface bloom. Proper cleaning of moulds is essential.

Temper (during application) Figure 5 is a great representation of improper temper that caused fat bloom. Can you see the layers formed? This indicates that in each layer the chocolate was already crystalizing as it was deposited into the mould. It is important to note that the cross-sectional view of a chocolate product can give insight to your bloom investigation as well.

Cooling (postapplication) Figure 6 reveals a common case of fat bloom found right after the cooling tunnel or on retail

Cocoa Butter Solidifying Schematic

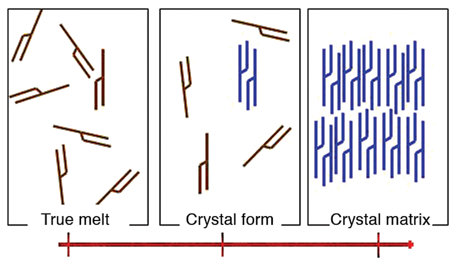

Figure 3

Extreme Temperature Fluctuations

Figure 4

Poor Tempering

Figure 5

shelves. This is due to improper cooling. Chocolate is more susceptible to this type of bloom if you have poor temper as well.

You must look at the cooling capacity and check the temper prior to moulding.

Temper/depositing (during application) This is a unique case of fat bloom (Figure 7) which needs to be investigated further. At first glance, it appears to look like a milk/dark drops mixture; however, taking a closer look, you can see the streaking in the individual drops. You can perform a quick visual and sensory analysis to test for fat bloom. Looking at the cross-section (Figure 8), one can see that the dark drop on the bottom is very uniform whereas the light drop on the top is very speckled and crumbly looking. The taste is also very dry, void of flavor and crumbly in the mouth. When you melt down the drops, the color slide indicates the same color chocolate. These tests helped draw the conclusion that this was not a mixture of milk and dark drops, but it was fat bloom.

Formulation (prior to application) If you see extensive bloom (Figure 9) and you have ruled out all environmental factors and production as a factor that may cause bloom, you need to look at the formula. There may be an inherit formulation issue that caused the chocolate to bloom at a quicker rate when exposed to high heat temperatures. This type of bloom forms within 2 to 4 weeks after depositing and is caused by a mixture of incompatible fats.

Interaction with inclusions (postapplication) Figure 10 reveals fat bloom formation due to cocoa butter interacting with incompatible oils, such as peanut oil. These liquid oils will migrate into the chocolate shell by dissolving cocoa butter liquid fractions, then migrate to the surface and form bloom. It helps to create a thicker chocolate shell around the center to prevent invasive migration and bloom on the surface from occurring too rapidly.

Fat bloom can develop at many differ-

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Insufficient Cooling

Figure 6

Poor Tempering/Depositing Problems

Figure 7

Formulation Issue

Figure 9

Interaction with Inclusions

Figure 10

Visual/Sensory Analysis of Bloom

Flavor/texture test

Wet slide test

Figure 8

Combining cocoa butter and a lauric fat such as palm oil or coconut oil will promote blooming and result in a soft texture due to their eutectic effect.

ent stages. The timeline in Figure 11 is an excellent gauge to help identify the root cause of bloom based on when it appears throughout production. Once identified, a corrective action can be taken, but there are also various preventive methods you can utilize to inhibit fat bloom formation.

PREVENTATIVE METHODS

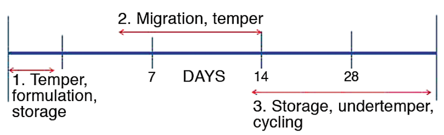
Tempering

It is essential to understand that the subtleties in this time/temperature process can impact your product further down the line. If chocolate is not properly tempered, the incorrect crystalline structure is formed, which in turn can lead to bloom. A great test to check temper is using the Tricor tempermeter instrument. It is a quick method for operators to use on the line. The easy readouts are translated into a number indicating *good*, *great* or *need to retemper*.

Knowledgeable Formulation

During formulation it is important to think about the end application and how the chocolate will function. You must consider the other fats in the final formulation and weigh the risk of incompatibility. Combining cocoa butter and a lauric fat such as palm oil or coconut oil will promote blooming and result in a soft texture due to their eutectic effect. A good rule of thumb: a maximum of 5 percent cocoa butter or lauric oil on a total fat basis can be added to a lauric oil-based or a cocoa butter-based product respectively. Other products used in final formulations with chocolate are nut oils (enrobed nuts), coconut oil (meltaways) and soybean oil (liquid chips). Creating a barrier between the two incompatible fats is another key idea to consider. A great example of strategic layering is seen in candy bar products, where sugar caramels create a barrier between the nuts and the enrobed chocolate layer. Also, a common ingredient added to inhibit bloom (within the standard of identity for chocolate) is milk fat. The medium chain fatty acids in milk fat can interact with cocoa butter structure to prevent migration and bloom.

Timeline Gauge for Bloomed Product



Bloom can occur at different times and for different reasons prior to, during or postapplication.

1. Immediate: within 12-28 hours
2. Intermediate: 1-2 weeks
3. Long term: 3-8 weeks

Figure 11

Proper Storage

This is something we can try to control while transporting chocolate. Proper storage, whether it be postproduction, warehouse, distribution, customer end or retail shelving, is essential to prevent bloom from occurring before the shelf life expires. At this point, chocolate is most susceptible to temperature fluctuations. The best conditions for chocolate storage are a controlled environment at room temperature and 40 to 60 percent relative humidity.

CONCLUSION

Currently, there is ongoing research in industry and academia which aims to understand fat bloom phenomenon in chocolate. Some studies suggest that ingredients such as emulsifiers, seeding agents or even fruit juices can help inhibit bloom. Fat bloom will naturally occur after a long period of time (~2 years), but if we aim to truly understand and investigate how it may occur, we can minimize or prevent it, thus producing the best possible chocolate product. □

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