7.6 Vegetable fats with specific properties

Apart from the three types of cocoa butter alternative described in the previous sections of this chapter there are also two groups of vegetable fats used in chocolate and compound coatings with specific properties. One group of these fats inhibits the polymorphic transformation from Form β_V to Form β_{VI} and, in doing so, inhibits the formation of fat bloom caused by either higher temperature storage or oil migration from a centre into the chocolate. The other group of fats are intended for use in compound coatings with reduced calorie content.

7.6.1 Anti-bloom fats

Section 7.2.2 describes the polymorphism of cocoa butter and the fact that it can exist in a number of different polymorphic forms (see Table 7.4). When chocolate is properly tempered the cocoa butter will crystallise in form β_v. However, depending on the product's construction and the conditions under which it is stored, this cocoa butter can transform from form β_V to form β_{VI}. This polymorphic transformation is usually accompanied by the formation of fat bloom. The change from form β_V to form β_{VI} occurs more quickly at higher temperatures and is also accelerated by migration of soft oils (e.g. nut oils) from a filling into the chocolate.

It has been suggested that replacing 15% of the cocoa butter in chocolate with illipe can delay the onset of bloom in dark chocolate truffles because of its higher StOSt/POSt ratio (Ali *et al.*, 1998). In a chocolate containing 33% total fat 15% replacement of the cocoa butter in the fat phase with illipe equates to the presence of 5% illipe in the whole chocolate. This is a permissible level in EU chocolate and in most of the chocolates in other parts of the world, where vegetable fats such as illipe are permitted. This principle of increasing the StOSt/POSt ratio to slow down the onset of bloom is also used by incorporating cocoa butter improvers (CBIs) based on high levels of shea stearin or sal stearin. These work on the principle of increasing the level of StOSt in the fat phase of chocolate to increase its melting point. Thus, polymorphic transitions that are faster in the presence of higher proportions of liquid oil (either because part of the chocolate fat has melted or because softer oils from a centre have migrated into the chocolate) take place at higher storage temperatures, giving an extra degree of protection.

Taking this principle a stage further, the Fuji Oil Company in Japan developed a product called BOB or Bohenin (1,3-dibehenoyl-2-oleoylglycerol). Behenic acid is a saturated fatty acid containing 22 carbon atoms and so BOB is an extension of the kinds of symmetrical monounsaturated triglycerides found in cocoa butter and CBEs in which palmitic and stearic acids are replaced by behenic acid. This has the effect of increasing the melting point to about 52 °C (US Pharmacopeia Convention, 2009). It is added to chocolate at the 5% level in the same way as CBEs and CBIs are. If the temperature of the chocolate is raised above its normal melting point but below the melting point of BOB it is claimed that the chocolate does not melt fully and that when cooled down the BOB is able to re-seed the chocolate in a stable polymorphic form (Koyano *et al.*, 1990).

Taking a different principle, various other vegetable fats were developed to inhibit bloom formation in chocolate. Instead of being based on increasing the melting point of SOS triglycerides in chocolate, these were based on $H_2M + HM_2$ triglycerides, where H denotes a saturated fatty acid with a chain length of 16 carbon atoms or longer and M denotes a saturated fatty acid with a chain length of 8–14 carbon atoms (Cain *et al.*, 1995). Initially they were intended for use as a vegetable fat at an inclusion level of 5% in chocolate. However, in the EU, the 2003 chocolate regulations prevented such use because they contained vegetable oils which were not one of the permitted six oils.

The concept has, however, been further developed to take positive advantage of migration of fats from a filling into the chocolate coating. Such migration often results in bloom formation on the chocolate, but if one of these anti-bloom fats is incorporated as part of the filling, it will also migrate on storage with the softer filling fats (Smith *et al.*, 2008). As it migrates into the chocolate it gives the protection necessary to prevent bloom formation. Using the fat in this way also means that it is not restricted by local chocolate legislation, because it is not added directly into the chocolate.

7.6.2 Lower-calorie fats

With the increasing development of lower calorie triglycerides systems, some chocolate manufacturers have used them to manufacture low-calorie confectionery. The two main products in this category are Caprenin™ and Salatrim (now marketed under the name Benefat™). Caprenin™ is a triglyceride produced by Proctor and Gamble, which contains caprylic (C8), capric (C10) and behenic (C22) fatty acids (Peters *et al.*, 1991). It is claimed to have 5 cal/g compared with 9 cal/g for normal fats. The chain length of behenic acid is such that it is poorly absorbed by the body and thus has a lower calorific value than fatty acids such as palmitic and oleic acids. The shorter chain acids, caprylic and capric acids, are metabolised via a different metabolic pathway in the body, which means that they are closer to carbohydrates in this respect.

Salatrim or Benefat™ (Smith *et al.*, 1994), marketed by Danisco, contains short and long fatty acid triglycerides and is also claimed to have a calorific content of about 5 cal/g. The short-chain fatty acids are basically metabolised as though they were carbohydrates and therefore with a much lower calorific value than normal triglyceride systems. As with Caprenin™, the long-chain fatty acids from Benefat™ are less well-absorbed. Benefat™ has been used in some bakery coating systems, chocolate chips and so on.

Conclusion

The scope for producing vegetable fats for use in chocolate and coatings with different melting profiles, crystallisation characteristics, processing benefits and so on, is essentially limitless. Vegetable fats can now be tailored for use both as CBEs (at the