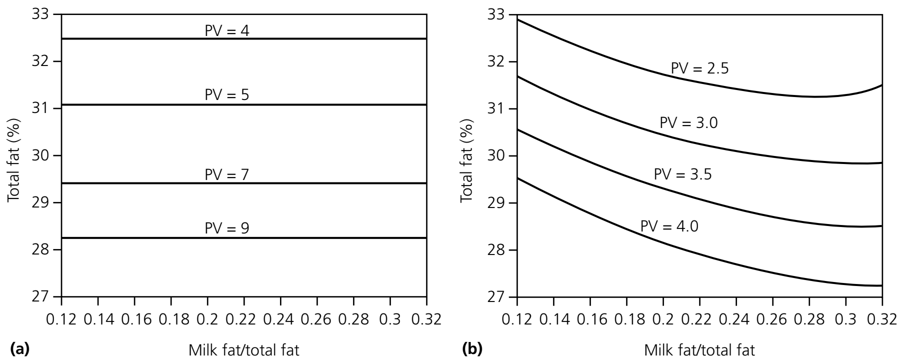

Figure 5.4 Effect of total fat and milk fat/total fat ratio on the plastic viscosity (Pa s). (a) Low free fat (b) High free fat.

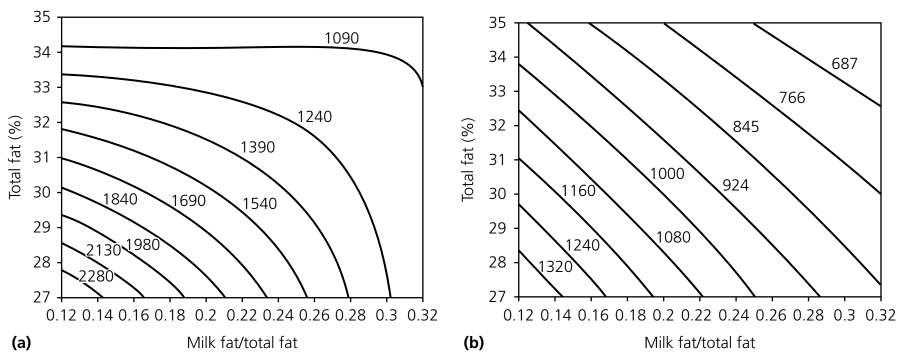

Figure 5.5 Effect of total fat and milk fat/total fat ratio on the chocolate hardness. (a) Low free fat (b) High free fat.

"free" fat, is termed a high free fat system, which results in alteration of the processing and sensory properties of the chocolate. The flavour differences between chocolate made using the two systems may be partly attributed to the different stages of the chocolate process at which the milk fat is added. AMF, when used with SMP in a high free fat system, is usually added at the viscosity adjustment stage, unlike the milk fat present in WMP, which is added at the start of the chocolate process. AMF in the high free fat system is sometimes not present at conching, when heating and some flavour generation occur.

Some manufacturers prefer the flexibility of being able to adjust the levels of SMP and milk fat independently in their milk chocolate formulations. However, this advantage can be outweighed by the need to carry supplies of two ingredients. In addition, specialised systems to handle both powders and liquid fats are required. Figure 5.4 shows the effect on the plastic viscosity (Chapter 11) in milk chocolate for a low free fat system (WMP) and a high free fat system (SMP and AMF). It is clear that there are significant rheological advantages in having a higher level of free milk fat, which also provides the benefit of potential savings in milk fat or cocoa butter. However, this advantage is offset by the softening effect of high levels of free milk fat. Figure 5.5 shows the hardness of chocolate products for a low free fat system and a high free fat system. There is a substantial softening in the chocolate product manufactured with high levels of free milk fat.

5.2.2.5 Fat bloom in chocolate

Fat bloom in chocolate is often characterised by the loss of gloss and dulling of the chocolate surface through to the presence of grey/white clusters that have the appearance of mould (Aguilera *et al.*, 2004; Hartel, 1999; Timms, 2003). Fat bloom also affects the texture of chocolate. Fat bloom can be classified into categories according to the conditions under which it is developed:

- Composition related,
- Processing related,
- Storage related.

Composition bloom occurs because of eutectic formation due to the use of incompatible fats, or levels of fat, in the recipe formulation. If the milk fat used exceeds the eutectic point, the two different fat structures will crystallise in an unstable network and the smaller triglycerides will be more mobile leading to fat migration and separation. Processing promoted bloom is mainly caused by under- or over-tempering of the chocolate (see Chapter 13). Under-tempering happens when the chocolate contains too much of the β′(IV) form and bloom appears in shortly after production when the quick transformation of the unstable β′(IV) to β(V) takes place. Over-tempering happens when too much seed has crystallised or the seeds are too large and bloom develops while the chocolate is solidifying. Over-tempering appears as a dull appearance on the chocolate, while the under-tempered is visible as white fatty spots on the surface (Lonchampt and Hartel, 2004). It can be difficult to predict the right tempering procedure for milk chocolate because of differences in the amount of free fat in the type of milk powder used and the melting point of the milk fat.

Storage-induced bloom occurs in well-formulated and tempered milk chocolate over time because the crystal form β(V) formed on tempering is not the most stable in cocoa butter, so over time the transformation to β(VI) will occur. It can take years for a well-tempered and stored chocolate to bloom, but if the temperatures fluctuate during storage the transformation goes faster and bloom appears sooner.

Its widely accepted that milk fat prevents bloom formation when added to dark chocolate and in compounds based on cocoa butter alternatives (Lonchampt and Hartel, 2004; Timms, 2003). Most of the work on bloom inhibition has been conducted on dark chocolate, in which bloom is more obvious on the dark background and milk fat levels are usually lower than in milk chocolate. The addition of 1–2% milk fat to a dark chocolate formulation is able to delay bloom formation. The higher melting fractions of milk fat (see Section 5.3.1.2) are more effective