used to inhibit bloom without the softening effects that occur when intact milk fat is added to chocolate.

Kaylegian and Lindsay (1995) have described the technologies for milk fat fractionation, both of commercial and experimental interest. Milk fractions produced using dry fractionation are available in other countries, but are not currently produced in the United States. The process of dry fractionation, or crystallisation from a melt, starts by heating milk fat to ensure that all the fat crystals are melted. The liquid fat is then cooled to the desired fractionation temperature and crystallised with agitation. The crystal phase, or stearin, is separated from the milk fat slurry using pressure filtration, vacuum filtration or centrifugation. The remaining liquid, or olein, can be further crystallised at a lower temperature to produce further fractions. One of the major advantages of dry fractionation is that there are no additives. One disadvantage of dry fractionation is that some liquid fat remains trapped in the stearin. Dry fractionation is a slow batch process. Membrane filters adopted for milk fat fractionation in the 1980s allow more defined separation of the stearin and olein phases. Membrane filtration of the crystallised slurry also has the advantage that the process can be totally enclosed, therefore minimising exposure of the milk fat and fractions to the atmosphere and potential oxidation.

The chemical, physical and functional properties of milk fat fractions are highly dependent on the physical state of the fraction at separation [i.e., the solid (stearin) or liquid (olein) fraction], the temperatures used for fractionation and the number of steps in the fractionation process. From a functional perspective, milk fat fractions are characterised based on their melting point. Based on an extensive study of commercial and research fraction data, Kaylegian and Lindsay (1995) defined five categories of milk fractions:

- Very high melting fractions (VHMF): melting point above 45 °C (113 °F),
- High melting fractions (HMF): melting point between 35 and 45 °C (95 and 113 °F),
- Middle melting fractions (MMF): melting point between 25 and 35 °C (77 and 95 °F),
- Low melting fractions (LMF): melting point between 10 and 25 °C (50 and 77 °F),
- Very low melting fractions (VLMF): melting point below 10 °C (50 °F).

Many researchers and commercial suppliers use a more simplified definition that has three broader categories of melting ranges:

- High melting fractions (HMF): melting point above 30 °C (86 °F),
- Middle melting fractions (MMF): melting point between 10 and 30 °C (50 and 86 °F).
- Low melting fractions (LMF): melting point below 10 °C (50 °F).

Jordan (1986) showed that the use of an HMF of milk fat enabled a further 3% of milk fat to be incorporated into milk chocolate with no difference to the solid fat content. The solid fat content of mixtures of cocoa butter and milk fat fractions are shown in Figure 5.6. However, the HMF of milk fat does not substantially

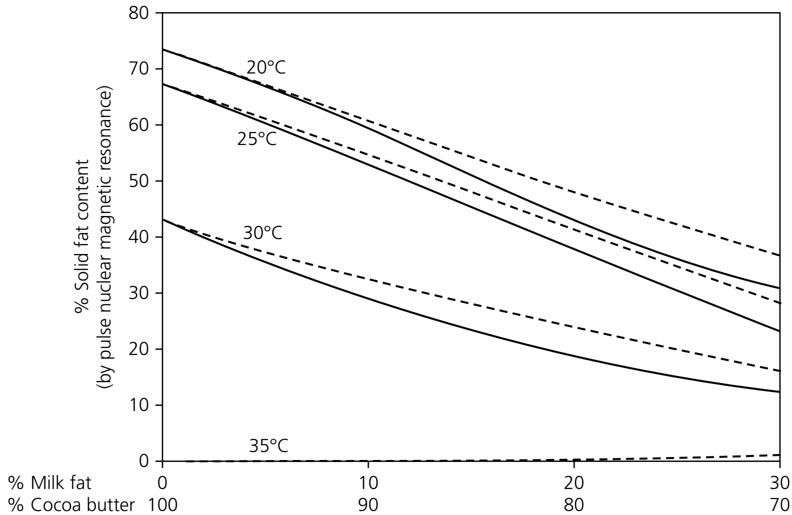

Figure 5.6 Solid fat content values for mixtures of cocoa butter and milk fat or fractionated milk fat.

increase the hardness of chocolate over the addition of an equivalent amount of standard milk fat (Timms, 1980). MMF has been found to soften chocolate to a greater extent than standard milk fat because of the eutectic effect of the middle melting triglycerides. However, MMF may reduce the brittleness of chocolate coatings for frozen confections.

An important benefit of milk fat fractions in chocolate is their ability to prevent the formation of bloom in chocolate, which is discussed in Section 5.2.2.5.

5.3.2 Milk powders

Milk powders contribute flavour and milk solids to chocolate and affect viscosity and texture. Codex (1999b) provides standards for the raw materials and composition of whole milk powder (WMP; 26% minimum milk fat, 5% maximum water content) and non-fat or skim milk powder (SMP; 34% minimum milk protein). Table 5.3 shows the typical composition of milk powders used in chocolate. Milk retentate, milk permeate and lactose are permitted ingredients for protein adjustment and most WMP products have standardised fat and protein levels to overcome day to day and seasonal variations in the raw milk (Caric, 1994). The low moisture content of milk powders provides an environment which keeps micro-organisms from growing and thus contributing to the long shelf life of milk powder ingredients (Table 5.5).

The typical specifications for milk powders for use in chocolate are shown in Table 5.6. The chemical, physical and microbiological properties of the product are all important. The key chemical parameters are titratable acidity and whey protein nitrogen index (WPNI). The WPNI is a measure of the level of preheat