- This stability allowed the original manufacturers to make use of milk when it was readily available in the 'flush' and safely store crumb for chocolate making in less plentiful milk supply periods. It is possible to store crumb in cool conditions for up to 12 months without perceptible flavour deterioration.
- Chocolate made via a milk crumb process can be more resistant to melting in hot climates, because some of the softer milk fats are bound within the crumb structure rather than in the continuous fat phase.
- A typical crumb recipe contains some 85% of the ingredients for chocolate making. This means that the subsequent chocolate manufacture is simplified to processing crumb, fats and emulsifiers.
- Since most of the flavour of the chocolate has been developed during crumb making it is not necessary to conche the chocolate for long periods of time to initiate Maillard browning and caramelisation reactions (See Chapters 8 and 10). This means that advantage can be taken of some of the rapid chocolate liquefaction techniques described in Chapter 15.

## 6.3 Typical crumb recipes

Table 6.1 gives the composition of some typical crumb recipes. These assume that full cream milk is used and the cocoa liquor or mass contains 55% cocoa butter. It is perfectly possible to use other ingredients, such as skimmed or partially skimmed milk, cocoa powder and sugars other than sucrose. The regulations in particular countries may also permit the use of separate milk components, such as whey, casein or lactose.

## 6.4 Flavour development in chocolate crumb

It has been recognised for some time (Hanlon, 1984) that Maillard reactions (Davies and Labuza, 1998) are responsible for the development of flavour in milk chocolate crumb. This flavour is difficult, if not impossible, to replicate by

**Table 6.1** Composition of typical chocolate crumbs. All values are percentages.

| Ingredient | Full milk crumb | Quarter mass crumb | White crumb |
|---|---|---|---|
| Sucrose | 59 | 67 | 55 |
| Full cream milk solids | 25 | 28 | 44 |
| Cocoa solids | 15 | 4 | |
| Water | 1 | 1 | 1 |
| Lactose | 8.9 | 10.0 | 15.6 |
| Milk protein | 6.4 | 7.2 | 11.3 |
| Milk fat | 8.0 | 8.9 | 14.0 |
| Cocoa butter | 8.3 | 2.2 | |
| Total fat | 16.2 | 11.1 | 14.0 |

conching for long times at high temperatures because of the much lower water contents at this stage of chocolate making (see Chapters 8 and 10).

The Maillard reaction is essentially a reaction between a reducing sugar (containing a reactive aldehyde group) and a free amino group on a protein. In the case of milk crumb the reducing sugar is lactose from the milk (see also Chapter 5). The main source of free amino groups comes from lysine and arginine, which are amino acids in the milk proteins. There is also a significant contribution from the cocoa proteins: where cocoa is added in the crumb process there is a definite effect on the final flavour.

Some manufacturers, rather than relying just on flavour development during the crumb process, will pre-treat sweetened condensed milk to caramelise it first. This is a well-known technique to many home cooks, who place a tin of sweetened condensed in a pan of boiling water for up to 2 h to caramelise it before making "banoffee pie".

A much simplified version of Hodge's original Maillard reaction scheme (Hodge, 1953) as it applies to crumb making is presented in Figure 6.2. The initial reaction takes place between protein and sugar to give Amadori rearrangement products. Further reaction then takes place alone or with sugar and amino acids to give the range of flavour volatiles described.

One of the final products is the characteristic brown pigment which explains why the reaction is often called a Maillard or non-enzymatic browning reaction.

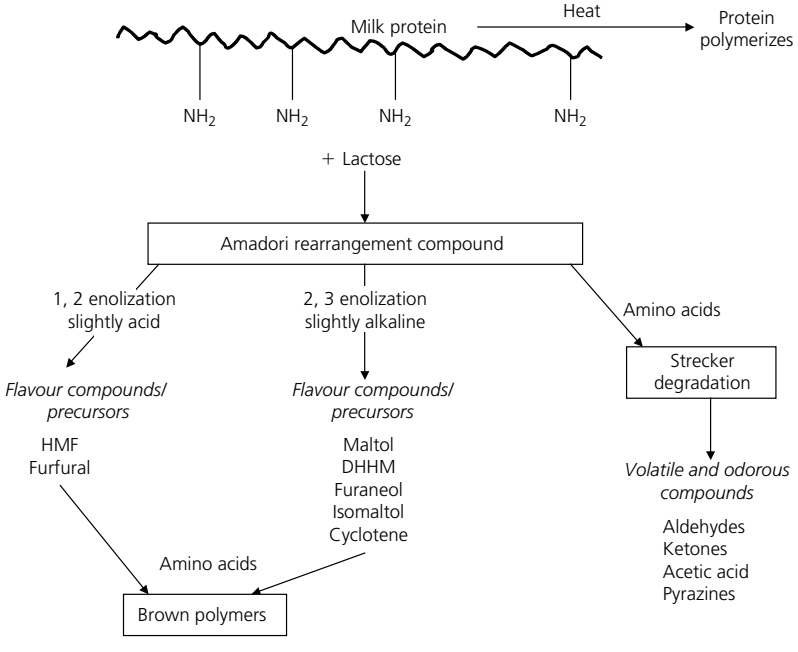


**Figure 6.2** Schematic diagram of Maillard reaction.