Caramel flavour is a special topic in milk chocolate manufacturing. Typical sugar degradation volatiles, such as furaneol, maltol, furfural and furfuryl alcohol, which are associated with a sweet caramel-like aroma, may be generated during conching, when temperature and humidity are slightly increased. But due to the much lower water contents and moderate temperatures in a conche when compared to the crumb process it is not possible to develop a similarly intense caramel flavour. It is well-known that a greater portion of lactose is amorphous in dry milk. This amorphous matrix is hygroscopic and tends to absorb water from air humidity or other chocolate ingredients. Absorbed water increases the mobility within the lactose structure ("glass transition") and may induce its crystallisation (Jouppila and Roos, 1994). In the course of crystallisation, water is set free and may start chemical reactions of lactose resulting in caramel flavor (Danzl and Ziegleder, 2011, 2014b). In general, recrystallising amorphous sugars show an increased Maillard reactivity due to the suddenly released water (Davies and Labuza, 1997), and this was proved in particular for lactose in whole milk powder (Thomsen *et al.*, 2005a, b). Caramelisation may start in the milk powder particles, where free water as well as reactive amorphous lactose are available (Figure 8.14). Critical parameters for glass transition in milk chocolate masses are for example 55 °C (121 °F) at a water content of 1.2%, respectively 60 °C (140 °F)/0.9%, or 65 °C(149 °F)/0.5%. Caramelisation in milk chocolates occurs at about 70 °C (158 °F; Stauffer, 2000; Danzl and Ziegleder, 2011, 2014b). While lactose crystallisation is often accompanied by an agglomeration, the intense shear forces during conching help to avoid any agglomeration and thickening (Ziegleder *et al.*, 2004). In detail, different types of chocolate were produced when the cover of a conche was opened or closed during the process. With an open cover, water could evaporate more rapidly and lactose remained amorphous; under a closed cover, humidity forced lactose crystallisation and caramelisation. In these studies, amorphous lactose within the milk chocolate masses was detected via dynamic vapour sorption, and the caramel flavour was verified by means of GC-MS, using maltol, furfuryl alcohol, 2-acetylfurane and furfural as indicative compounds (Danzl and Ziegleder, 2011). Of course, the type of milk powder is of influence. So, lactose had higher tendency for caramelisation in whole milk powders when compared to skim milk powders (Danzl and Ziegleder, 2011, 2014b).

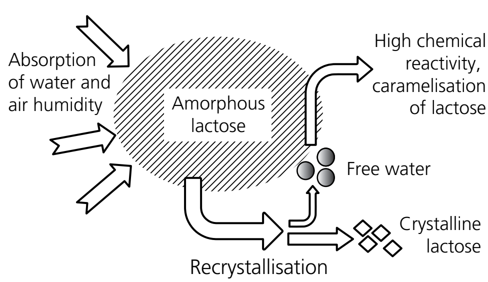

Figure 8.14 Recrystallisation of amorphous lactose (within dry milk particles) and release of water as the starting mechanism of caramelisation of lactose (schematic).

8.7 Flavour release in chocolate

Chocolates are semi-solid suspensions of about 70% in total of fine solid particles of sugar and cocoa (and milk, depending on type) in a continuous fat phase. When eating chocolate it becomes liquid in the mouth, giving a smooth suspension of particulate solids in cocoa butter. Then, flavour is released into the mouth headspace and perceived by human retronasal detectors. The perceived flavour characteristics are due to a combination of the taste, imparted by the non-volatile components, and the smell, imparted by the volatile components during consumption (Beckett, 2003). There is a complex interrelation between melting, salivation and mastication, flow properties and sensory impressions of the chocolate (Figure 8.15). So, chocolate flavour perception is time-dependent, as its structure changes during eating because of several factors (Beckett, 2003). The shape of chocolate pieces can affect flavour and texture perception, too (Lenfant *et al.*, 2013). The dynamic behaviour of perceived sensory attributes in combination with the effect of melting on taste and flavour in chocolates has been investigated using retronasal flavour release and time-intensity methods (Daget and Vallis, 1994; Ziegler *et al.*, 2001). An overview about the aspects of flavour release and flavour perception in chocolate was given by Afoakwa (2010).

Particles must be small enough not to taste rough (usually <25 μm) and indeed below this size the mouth is able to detect differences of about 3 μm in average. Each time a cocoa particle is broken it produces more surface for flavour release. If the same dark chocolate is milled to a finer particle size then the cocoa intensity will increase and the flavour release be enhanced (Beckett, 2006; Afoakwa *et al.*, 2009). The finer the particles are ground the more fat is required to coat the surfaces to enable them to flow past each other. So, the range of particle sizes has

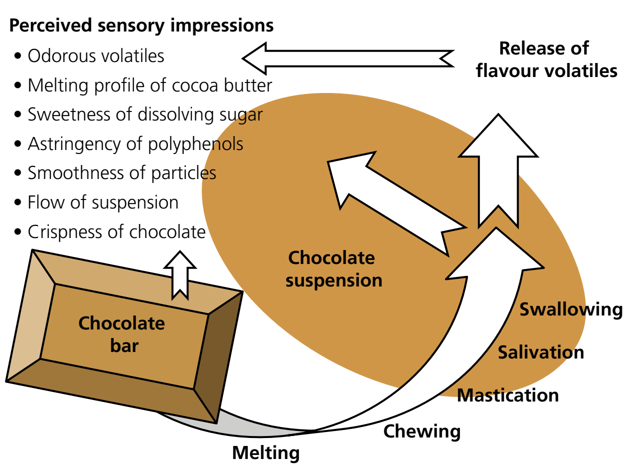

Figure 8.15 Mechanisms of flavour release and perceived taste during consumption of chocolate (schematic).