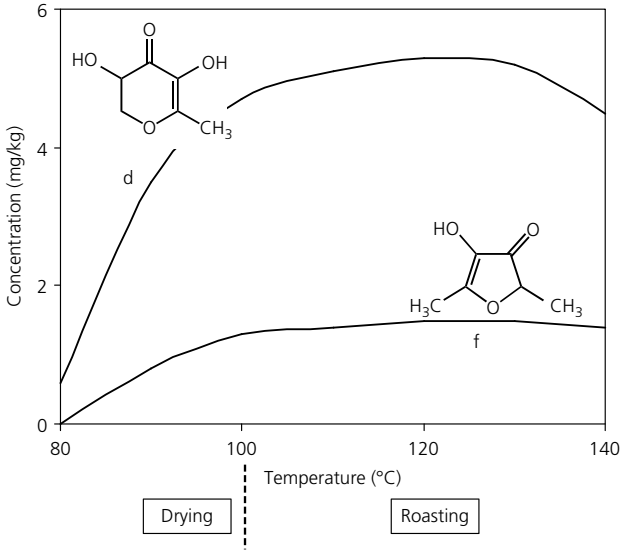

Figure 8.10 Influence of processing temperature on the formation of the sugar degradation products dihydro-hydroxy-maltol (d) and furaneol (f); according to Ziegleder (1991b).

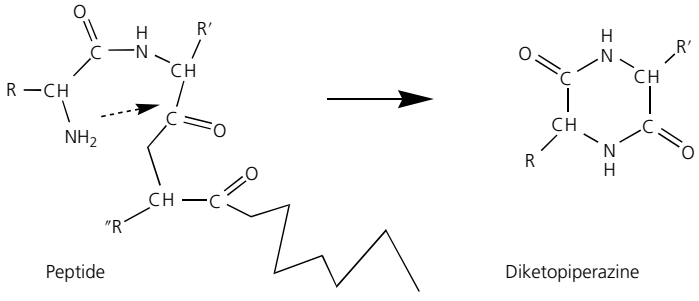

Figure 8.11 Heat-induced formation of diketopiperazines from peptides.

and the sensorially perceived bitter intensity, however, led to the conclusion that further studies are necessary to understand the typical bitter taste of roasted cocoa (Bonvehi and Coll, 2000). Application of chromatographic separation and taste dilution analyses of cocoa extracts recently revealed N-phenylpropenoyl amino acids as powerful astringent components in cocoa. Besides procyanidins a series of different N-phenylpropenoyl amino acids appear to be key contributors to the astringency and bitter taste of non-fermented cocoa beans as well as roasted cocoa nibs (Stark *et al.*, 2005, 2006; Stark and Hofmann, 2005).

The predominant odour-active compounds in cocoa mass and their odour notes (FD factors 32 and higher) as found by aroma extract dilution analysis (AEDA; Schnermann and Schieberle, 1997) are shown in Table 8.2. AEDA is a very good method of screening the most odour-active volatiles in food. It is

Table 8.2 Some selected compounds of the most odour-active volatiles in cocoa mass: their odour quality and FD factors. Source: Schnermann and Schieberle (1997). Reprinted with permission of American Chemical Society.

Odorant	Odour quality	FD factor
2- and 3-Methylbutanoic acid	Sweaty	2048
3-Methylbutanal	Malty	1024
Ethyl 2-methylbutanoate	Fruity	1024
2-Methoxy-isoproyplpyrazine	Earthy, beany	512
Hexanal	Green	512
2-Methyl-3-(methyldithio)furan	Cooked meat-like	512
2-Octenal	Fatty, waxy	512
2-Ethyl-3,5-dimethylpyrazine	Potato chip-like	256
2,3-Diethyl-5-methylpyrazine	Potato chip-like	256
2-Nonenal	Green, fatty	256
Phenylacetaldehyde	Sweet, honey-like	64
4-Heptenal	Sweet, biscuit-like	64
δ-Octenolactone	Sweet, coconut-like	64
γ-Decalactone	Sweet, peach-like	64
Dimethyl trisulfide	Sulfurous	32
Nonanal	Soapy	32
Trimethylpyrazine	Earthy, potato-like	32
2-Ethyl-3,6-dimethylpyrazine	Nutty, earthy	32
2-Phenylethanol	Sweet, yeast-like	32
Ethyl 2-methylpropionate	Fruity	32
2-Decenal	Fatty, green	32
2,4-Nonadienal	Fatty, waxy	32
Ethyl cinnamate	Sweet, cinnamon-like	32
3-Hydroxy-4,5-dimethyl-2(5H)-furanone	Seasoning-like, spicy	32
3-Hydroxy-5-ethyl-4-methyl-2(5H)-furanone	Seasoning-like, spicy	32

based on the extraction of flavour components from food, separation by means of capillary gas chromatography, identification via mass spectrometry coupled with a so-called "sniffing port" to characterise odorants. After several extract dilution steps, only the most potent odorants may be detected at the sniffing port. The number of dilution steps to reach the odour threshold is defined as the FD factor. In general, the odour efficacy of a flavour component is dependent on the ratio of concentration level and specific odour threshold values. Several constituents, that have been previously mentioned, have very significant odours: 3-methylbutanal (malty odour), ethyl-2-methylbutanoate (fruity), 2-and 3-methylbutanoic acid (sweaty) and different pyrazines (earthy, potato-like, nutty, beany; Table 8.2). Although trimethyl pyrazine contributes medium odour intensity, it is relatively less than that provided by other pyrazines with mixed substitutes. The majority of the potent odorants seem to arise from lipid precursors (hexanal, 2-octenal, 2-nonenal, nonanal, 4-heptenal, nonalactone, octenolactone, 2-decenal, 2,4-nonadienal) and carry green, fatty, tallowy, biscuit-like or waxy notes (Schnermann and Schieberle, 1997).