Table 7.1 Typical fatty acid compositions of cocoa butter. Compiled from Lipp and Anklam (1998) and Foubert *et al.* (2004).

West Africa						
Fatty acid	**Ghana**	**Ivory Coast**	**Ivory Coast**	**Ivory Coast**	**Nigeria**	**West Africa**
C16:0	25.3	25.8	25.6	26.4	26.5	26.2
C18:0	37.6	36.9	36.5	36.5	37.1	36.6
C18:1	32.7	32.9	34.1	33.5	33.1	33.6
C18:2	2.8	2.8	2.8	2.7	2.3	2.7

Asia				
Fatty acid	**Malaysia**	**Malaysia**	**Indonesia**	**Java**
C16:0	24.9	25.7	26.1	24.1
C18:0	37.4	37.1	37.3	37.3
C18:1	33.5	33.7	33.3	34.3
C18:2	2.6	2.4	2.7	2.7

The Americas						
Fatty acid	**Ecuador**	**Ecuador**	**Brazil**	**Brazil**	**Brazil**	**San Domingo**
C16:0	25.6	27.1	25.1	25.1	24.9	26.9
C18:0	36.0	35.4	33.3	34.3	32.9	34.4
C18:1	34.6	33.7	36.5	36.4	37.6	34.8
C18:2	2.6	2.6	3.5	3.4	3.7	2.9

Table 7.2 Typical triglyceride compositions of cocoa butter. Compiled from Chaiseri and Dimick (1989).

Country	**POP**	**POSt**	**StOSt**	**POO**	**StOO**
West Africa					
Ivory Coast	19.0	39.6	28.5	1.9	3.9
Nigeria	17.9	38.8	27.8	2.3	5.2
Cameroon	17.9	38.3	27.7	3.0	5.8
Ghana	17.8	39.0	27.5	2.2	4.9
Asia					
Indonesia	19.9	40.6	28.1	1.6	3.6
Malaysia	18.4	40.0	31.1	1.2	2.9
South America					
Brazil	17.9	37.1	26.0	3.9	6.7
Colombia	20.4	39.4	25.0	3.3	4.4
Ecuador	19.2	38.4	26.9	3.0	5.4
Dominican Republic	18.4	38.2	26.5	3.3	6.1

Table 7.3 Solid fat contents[a] (by pNMR) of cocoa butters from different origins. Reprinted with the permission of Loders Croklaan.

Temperature		Brazil	Ghana	Malaysia
°C	°F			
20	68	66.3	76.2	81.2
25	77	60.1	70.4	76.2
30	86	36.9	45.1	54.8
32.5	90	6.6	13.3	19.7
35	95	2.0	0.0	0.0

[a] Tempered at 26 °C (79 °F) for 40 h prior to solid fat content measurement.

that contain higher levels of unsaturated fatty acids melt at lower temperatures. Therefore, South American cocoa butters do, in general, have lower solid fat contents than Asian or West African cocoa butters. These differences can be seen in Table 7.3.

7.2.2 Polymorphism

The relatively simple triglyceride composition of cocoa butter (with approximately 80% of its triglycerides all being of the SOS type; i.e. POP, POSt and StOSt) means that cocoa butter remains hard (high in solid fat) until it reaches a temperature of between 25 and 30 °C (77 and 86 °F). Then it melts very sharply, effectively being completely liquid by 35 °C (95 °F). Another consequence of this simple triglyceride composition is that cocoa butter is a highly polymorphic fat.

Polymorphism is the ability of a molecule to crystallise in a number of different crystal packing configurations. While polymorphism is present in most fats, those rich in symmetrical monounsaturated triglycerides such as SOS are highly polymorphic. This high degree of polymorphism is found not only in cocoa butter but also in those SOS-rich fats used in cocoa butter equivalents (Section 7.3 below).

Historically, six different polymorphic forms have been identified for cocoa butter. Traditionally, the confectionery industry has considered the polymorphism of cocoa butter to be that as defined by Wille and Lutton (1966) in which six forms are given the names Form I to Form VI. In the oils and fats industry the convention is to use the Greek letters α, β, β′ and γ to define polymorphic forms. While Wille and Lutton were using Form I to Form VI to define the polymorphism of cocoa butter, Larsson (1966) was using this Greek letter nomenclature. In general, as we move from γ to α to β′ to β the stability and the melting point of the polymorphic form increases. In tempering chocolate it is necessary to crystallise the cocoa butter in as stable a polymorphic form as possible.

Later work by van Malssen *et al.* (1999), however, suggested a different interpretation of cocoa butter polymorphism from that of both Wille and Lutton and Larsson; both in the assignments of polymorphic form and in the melting points