

**Table 7.7** Typical fatty acid and triglyceride compositions of shea oil. *Source:* Lovett (2015). Reproduced with permission of Elsevier.

Country	Fatty acid composition				Triglyceride composition <sup>a</sup>			
	C16:0	C18:0	C18:1	C18:2	SSS	S <sub>2</sub> U	SU <sub>2</sub>	UUU
Gambia	3.8	37.0	49.2	7.7				
Senegal	5.0	39.0	47.0	6.5				
Nigeria	3.9	40.8	46.6	7.1	0.2	45.4	31.6	22.8
Guinea	4.5	41.3	47.3	5.5				
Mali	3.8	42.4	45.5	6.9	0.1	45.6	33.1	21.3
Burkina Faso	3.8	44.1	44.0	6.4	0.0	47.5	32.8	19.7
Ghana	4.0	45.6	43.3	6.3				

<sup>a</sup>S = saturated; U = unsaturated; S<sub>2</sub>U includes SUS and SSU; SU<sub>2</sub> includes SUU and USU.

Countries such as Gambia and Senegal produce shea with a much higher level of oleic acid compared to stearic acid (and hence a lower level of StOst), whereas in Burkina Faso and Ghana there is greater parity between the oleic acid and stearic acid levels and hence a greater amount of StOst. Despite this there are still considerable levels of the softer SU<sub>2</sub> and UUU triglycerides in shea oil. This means that shea too has to be fractionated to concentrate the StOst triglycerides to a level suitable for use in CBEs. Unlike palm oil, though, shea oil contains minimal levels of SSS and so a single fractionation stage to separate the StOst-rich stearine fraction from the more unsaturated triglycerides in the oleine fraction is all that is needed.

### 7.3.1.3 Illipe

Just as the botanical name for shea oil has caused confusion, there has also been historical confusion over the botanical name for illipe. The one quoted in the EU regulation (European Union, 2000) of *Shorea* spp. is correct but still ambiguous because it implies that all *Shorea* species are illipe when it is clear from the botanical definition of sal oil as *Shorea robusta* that this is not the case. The full botanical name of illipe is *Shorea stenoptera*. There is also confusion in that the name illipe has also been used for the species *Madhuca longifolia*, also called mowrah butter, which is a completely different fat (although one that can potentially also be used in CBEs – see Section 7.3.2). Illipe (*Shorea stenoptera*) grows in Borneo – hence its alternative name of Borneo tallow – and, like shea, is a forest crop. Of all the fats used in CBEs, either in the EU or elsewhere, illipe has the triglyceride composition closest to that of cocoa butter and so could be considered to be the “perfect” CBE component. Unfortunately, availability is unpredictable, largely because it flowers only every six to seven years and availability can vary between 2000 and 25 000 t (Shukla and Nielsen, 1989).

Typical fatty acid and triglyceride compositions of illipe are shown in Table 7.8.

**Table 7.8** Typical ranges of fatty acid and triglyceride compositions of illipe.  
Source: Talbot (2015). Reproduced with permission of Elsevier.

Fatty acid	Range (%)	Triglyceride	Range (%)
C12:0	0.0–0.7	Total SSS	3.1
C14:0	0.0–0.3	POP	6.6–13.2
C16:0	13.6–21.9	POSt	34.3–48.8
C16:1	0.2–0.6	StOSt	39.1–49.3
C18:0	37.2–46.0	AOSt	3.5–5.7
C18:1	35.0–38.6	Total SSO	0.4
C18:2	0.1–1.1	POO	2.2
C20:0	0.1–2.9	StOO	6.0
		Other unsaturated triglycerides	2.9

**Table 7.9** Typical ranges of fatty acid and triglyceride compositions of sal oil.  
Source: Talbot (2015). Reproduced with permission of Elsevier.

Fatty acid	Range (%)	Triglyceride	Range (%)
C16:0	3.6–10.5%	Total SSS	0.3–2.6
C18:0	32.6–49.3%	POP	4.8
C18:1	32.9–48.2%	POSt	7.4–16.0
C18:2	Trace to 3.8%	StOSt	26.2–44.0
C18:3	0.0–1.2%	AOSt	4.9–11.0
C20:0	3.1–10.0%	Total SSO	1.0
		POO	1.5–4.9
		StOO	10.6–25.8
		Other unsaturated triglycerides	2.0–11.8

Compared with palm oil and shea oil, there are only low levels of non-SOS triglycerides in illipe. This is what makes it so suitable for direct use in CBEs without the need for any further fractionation to remove unwanted harder or softer triglycerides.

#### 7.3.1.4 Sal oil

The sal tree, *Shorea robusta*, is indigenous to India, particularly to the Central Indian states of Orissa, Chattisgarh and Madhya Pradesh. The tree has great cultural significance to both Hindus and Buddhists with it being said that Buddha was born and died beneath a sal tree. The kernels contain between 14 and 18% of sal oil and, like shea, sal seeds produce an oil rich in both oleic and stearic acid, but also with an appreciable amount of arachidic acid (C20:0). Typical fatty acid and triglyceride compositions are shown in Table 7.9.