

Palm Oil Sterols

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Sterols comprise a major proportion of the unsaponifiable matter of most oils. They exist as free sterols and sterol esters of fatty acids although sterol glycosides and acylated sterol glycosides are also present. The majority of vegetable oils contain 100 to 500 mg sterol per 100 g oil. Notable exceptions are corn, rice bran and sesame seed oils, which respectively contain 1.4, 3.2 and 2.9 g phytosterol per 100 g (Wihrauch *et al.*, 1978).

The influence of refining on the content and composition of vegetable sterols in oils has been studied by several workers (Gutfinger *et al.*, Johansson *et al.*, 1979; Ghimenti, 1974a; Ghimenti, 1974b and Kaufmann *et al.*, 1970). Generally the total sterols and the content of individual sterols decrease gradually during the various refining stages. The relative proportions of the sterols remain unchanged. Other investigators (Homborg, 1975 and Tan *et al.*, 1981) have reported that bleaching gives rise to sterol artefacts and partly modifies the individual sterols, and that sterol esters may be deacylated.

The average percentage of unsaponifiable matter in crude palm oil was 0.41% (Table 1). The range was from 0.38%–0.48%, while Tan *et al.* (1981) reported 0.15% to 0.99%. The sterols formed 0.02% to 0.06% of the oil. Similar values were reported by Downes (1982a). The levels found for some other oils in previous studies (Downes, 1982a; Downes 1984a and Downes, 1984b) showed ranges of 0.09%–0.28% for groundnut oil, 0.25%–0.52% for sunflower oil, 0.31%–0.37% for soybean oil and 0.48%–0.92% for rapeseed oil. Fractionation of palm oil resulted in a migration of the unsaponifiable matter into the olein fraction. Processing resulted in a decrease in the unsaponifiable matter and in the percentage sterol in the unsaponifiable matter. More of the unsaponifiables and sterols were lost during the deodorization stage than during the bleaching stage. The amount lost varied from one refinery to another and no doubt depends on the processing operations.

The sterol composition of crude and refined oils and the fractionated products are shown in Tables 2 and 3. The major sterols, β -

sitosterol and campesterol, formed about 88% and stigmasterol 10%–11% of the sterols in crude oils. Cholesterol is present at less than 2.5% of the sterols and ranged from 2.7 to 13 ppm in crude oils. Cholesterol values ranging from 13–19 ppm were reported (Downes, 1982a) in crude palm oils from various origins. In other studies (Itoh *et al.*, 1973; Mannino *et al.*, 1975 and Prevot *et al.*, 1976) cholesterol was reported at 1% to 8% of the total sterols, but no figures were given on the total sterol content in the oils investigated. Downes (1982b; 1984a; 1984b; 1983a; 1983b; 1985a; 1985b; 1985c) reported the cholesterol content in vegetable oils at levels of 5–108 mg/kg (Table 4).

The cholesterol contents of refined palm oil and its fractions are lower than that of the crude oil. Although the percentage concentrations of the different sterols in the crude oil, refined oil and fractionated products were generally similar, there appeared to be a preferential removal of cholesterol against sitosterol during refining as shown by the higher sitosterol:cholesterol ratios. Similarly too the stigmasterol:campesterol ratios indicated a preferential removal of campesterol compared with stigmasterol. These ratios have been used by various workers in the detection of adulteration.

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TABLE 1. UNSAPONIFIABLE MATTER IN PALM OIL PRODUCTS

Sample		% Unsaponifiable matter in oil	% Sterol in unsaponifiable oil matter	% Sterol in oil
n= 4				
Crude palm oil	Mean	0.41	11	0.05
	Min-max	0.38 – 0.47	4.7– 13.6	0.02 – 0.06
Degummed bleached palm oil	Mean	0.35	9.7	0.03
	Min-max	0.34 – 0.41	9.3 – 13.7	0.02 – 0.05
Refined palm oil	Mean	0.29	7.3	0.02
	Min-max	0.28 – 0.32	2.5 – 10.8	0.01– 0.03
n=2				
Crude olein	Mean	0.56	6.7	0.04
	Min-max	0.48 – 0.66	4.1– 9.5	0.03 – 0.05
Degummed bleached olein	Mean	0.39	4.7	0.02
	Min-max	0.35 – 0.43	3.7 – 5.7	0.02 – 0.02
Refined palm olein	Mean	0.24	5.5	0.01
	Min-max	0.22 – 0.26	4.3-6.7	0.01-0.01
n=1				
Refined palm stearin		0.18	10.7	0.02

TABLE 2. STEROL COMPOSITION OF CRUDE AND REFINED PALM OIL (ppm)

	Cholesterol	Campesterol	Stigmasterol	Sitosterol	Unknown	Total
Crude palm oil						
Mean	9.6	118.5	56.7	296.4	15.3	496.5
Min - Max	2.7-13	46.4-150	26.3-65.7	120-369.5	2-21	210-620
n (4)						
Degummed bleached palm oil						
Mean	8.1	97	38.5	222	1.9	367.5
Min - Max	4.8-9.9	49.4-116	22.0-51.2	113.8-285.7	nil-7.5	190-470
n (4)						
Refined palm oil						
Mean	4.2	35.7	25.5	142.3	3.5	211.2
Min - Max	1.2-5.5	15.3-65.4	8.5-36.9	45-198	nil-10.5	70-316
n (4)						

continue on pg. 23

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TABLE 3. STEROL COMPOSITION OF FRACTIONATED PALM OIL PRODUCTS (ppm)

	Cholesterol	Campesterol	Stigmasterol	Sitosterol	Unknown	Total
Crude palm oil						
Mean	6.9	80.3	40.5	201.0	26.4	355.1
Min - Max n (2)	6.2-7.5	56.7-103.8	29.9-51.0	149-253	24.6-28.1	270-440
Degummed bleached olein						
Mean	3.5	39.7	23.3	111.0	2.6	180.1
Min - Max n (2)	3.2-3.8	36.2-43.2	21.4-25.2	99-123	nil - 5.2	160-200
Refined olein						
Mean	2.3	28.0	17.9	90.9	0.6	139.7
Min - Max n (2)	2.1-2.4	25.6-30.4	12.4-23.3	67.7-114	nil - 1.2	109-170
Crude palm stearin n (2)	7.4	90.3	42.0	210	-	350

TABLE 4. CHOLESTEROL CONTENT IN CRUDE OILS AND FATS (mg/kg)

	Range	Average	References
Coconut	5-24	14	Downes, MJ (1985a)
Palm kernel	9-40	17	Downes, MJ (1985b)
Rape	25-80	49	Downes, MJ (1983a)
Maize	18-95	50	Downes, MJ (1983b)
Soya	20-35	28	Downes, MJ (1984b)
Sunflower	8-44	17	Downes, MJ (1984a)
Palm oil	13-19	18	Downes, MJ (1982a)
Cottonseed	28-108	44	Downes, MJ (1985c)
Cocoabutter	not available	30	Wihrauch, J L <i>et al.</i> , (1978)

TABLE 5. STEROL RATIOS FOR PALM OIL PRODUCTS

	Stigmasterol	Sitosterol	Stigmasterol + Campesterol	Sitosterol
	Campesterol	Cholesterol	Sitosterol	Stigmasterol
Crude palm oil	0.48	30.8	0.59	5.2
Refined palm oil	0.71	33.9	0.43	5.6
Crude palm olein	0.50	29.1	0.60	5.0
Refined palm olein	0.63	39.5	0.57	5.1
Crude palm stearin	0.46	28.4	0.50	5.0

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