Variability in coconut cultivars for lipid and fatty acid composition of oil

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Eighteen cultivars of coconut (*Cocos nucifera* L.) were screened for oil quality for specific industrial purposes and from a human health point of view. The cultivars included local talls, released and promising hybrids, and geographically distinct cultivars. The per cent oil concentration varied from 64–70% among the cultivars. The neutral lipids formed the major fraction (about 94%), followed by the glycolipids (3.5%) and phospholipids (2.5%) and the concentration varied with cultivar. In general, hybrids had lower concentrations of neutral lipids (90–94%), while they were greater in talls. However, the glycolipid fraction in general was higher in the hybrids. The hybrids had lower concentrations of saturated fatty acids and correspondingly low ratios of saturated to unsaturated fatty acid concentrations. The talls had higher values for these parameters, but in cv. WCT, the ratio was lower. The saturated fatty acid concentration correlated negatively with the concentrations of glyco- and phospho-lipids, whereas it correlated positively with that of the neutral lipids. A predominant presence of unsaturated fatty acids among glyco- and phospho-lipids was evident from the study. The results indicated the presence of variability in coconut germplasm for fatty acid composition of oil indicating the possibility of further improvement by breeding for oil quality for specific uses.

Keywords: Coconut; Oil quality; Fatty acids; Lipids; Industrial purposes; Cultivar; Variability

Coconut oil, the major high value product of coconut (*Cocos nucifera* L.), is used in the manufacturing of soaps, dyes, lubricants, margarine, bakery products, detergents, pharmaceuticals, cosmetics, toiletries, edible oil, and hair oil (Maftei, 1998; Naresh Kumar *et al.*, 2000).

Copra contains an average of 65–69% of oil. The main component of coconut oil is lauric acid (≈48%) with the balance being other longer chain fatty acids like myristic and palmitic acids (Ohler, 1984). The significant physical property, which sets it apart from other oils, is its narrow range of melting point. It is one of the few vegetable oils which can be utilized in a wide range of applications, and is often preferred to synthetic or petroleum-oil-based materials because of its unique characteristics. The presence of a high content of lauric acid makes it highly suitable for making quality soaps, detergents, surfactants, and shampoos. The present thrust in India is on product diversification, and it is important to study the levels of saturated fatty acids like lauric, myristic, and palmitic acids in elite germplasm collected from indigenous and exotic sources, so that varieties can be selected for specific industrial purposes (Naresh Kumar *et al.*, 2000; Naresh Kumar and Rajagopal, 2000). Since the level of unsaturation is important for human health, it is also necessary to screen and identify the elite lines for low saturation to unsaturation ratio of oil for consumptive use. Although the fatty acid and triglyceride compositions of coconut oil have been studied extensively (Bezard *et al.*, 1971; Oo and Stumpf, 1979; Krishnamurthy and Chandrasekhara, 1983; Balachandran *et al.*, 1985), variations in lipid composition and fatty acid profile among the elite germplasm lines have not received much attention. More recently, a study of fatty acids (FAs) and tri acyl glyceryl (TAG) composition of oils of nine coconut hybrids revealed that the lauric acid concentration among hybrids varied from 47.3 to 50.5% in the oil samples and that TAG also varied between cultivars (Rodriguez *et al.*, 1998). Apart from this, no extensive work on similar lines has so far been reported in coconut. In view of the currently limited knowledge on the quality of coconut oil, an analytical study was undertaken to screen the elite germplasm for oil quality for specific industrial purposes as well as for human consumption.

Materials and Methods

The study was conducted for three years (1996–97) at Central Plantation Crops Research Institute, Kasarogod, India. Eighteen cultivars of

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0041-3216/2004/010034-07

coconut (*C. nucifera* L.) of approximately 30 years of age were selected for the study. The cultivars included local talls which are popularly grown in India and are also used in several breeding programmes in India [West Coast Tall (WCT), Laccadive Ordinary Tall (LCT), Andaman Ordinary Tall (ADOT), and Benaulim Tall (BENT)]; released and promising hybrids which are high nut and copra yielders and their fatty acid profiles are unknown (COD × WCT, WCT × COD, LCT × COD, LCT × GBGD, MYD × WCT, and WCT × GBGD); and geographically distinct cultivars used in breeding programmes at CPCRI, Kasaragod, and selected based on drought tolerance and high copra and oild yield [Fiji Tall (FIJT), Philippines Ordinary Tall (PHOT), Strait Settlement Green Tall (SSGT), San Ramon Tall (SNRT), West African Tall (WAT), Zanzibar Tall (ZANT), Java Tall (JVT), and Federated Malay States Tall (FMST)]. The palms were grown in the red sandy loam soils (Arenic Paleustults) of the Institute under irrigated conditions and recommended agronomic practices. The palms received N_2:P_2O_5:K_2O fertilizers at 500:320:1200 g palm^{-1} yr^{-1} in two split doses, i.e., one-third during May–June and the remaining two-thirds during September–October. The experiment was a completely randomized design, replicated thrice.

Four mature nuts (12 months old) from each palm and three palms per cultivar were taken for the study. Earlier, bunches were tagged for determining the nut age. Oil was extracted from copra by crushing in a micro-expeller. Clear oil was obtained after the debris had settled and filtered through glass wool. For estimating the oil concentration in copra, oil was extracted using the soxhlet apparatus with petroleum ether as the solvent. The oil quality was estimated using the standard parameters like peroxide value (PV), acid value (AV), and free fatty acids (FFA) according to Cox and Pearson (1962), and saponification value (SV) as described by Horowitz (1975).

Column chromatography

The silicic acid column (20-cm length and 1-cm diameter) chromatography was performed to obtain the neutral lipid (chloroform fraction), glycolipid (acetone fraction), and phospholipid (methanol fraction) from the 500-mg sample in chloroform. The column temperature was maintained at 25°C and the rate of mobile phase flow was maintained at 5 drops min^{-1}. Quantification of the lipid fractions was made by gravimetry (Rouser *et al.*, 1967).

Gas–liquid chromatography (GLC) analysis for fatty acid profile

The oil samples (500 mg) were methylated by adding 5% HCl reagent (prepared freshly by adding 8.3 mL acetyl chloride to 100 mL absolute methanol). After vortexing thoroughly, the samples were incubated at 70°C for 10 h and were allowed to cool. To these, 5 mL double distilled water and 1 mL hexane was added and vortexed. When the two layers were separated, the hexane layer was aspirated into the appendorfs for storage at 4°C until the GLC was performed following the method of Padua-Resurrection and Banzon (1979). Esterified sample in hexane (0.5 mL) was injected using tapered-end Hemilton syringes into the Auto system GC (Perkin Elmer Corp., U.S.A.) fitted with a suitable packed column. The conditions set were N_2 carrier flow rate at 60 mL min^{-1}, H_2 flow rate at 25 mL min^{-1}, and airflow rate was at 30 mL min^{-1}. Column temperature was programmed at 80–190°C at the rate of 24°C min^{-1} increase with initial time of 1 min and on reaching 190°C, it ran isothermally. Peaks were detected in FID and by the 15th min, detection was shut off. Peaks were recorded on the computer compatible PE Nelson 1022 GC Plus integrated system. Fatty acid methyl ester standards (Sigma Chemicals Co., U.S.A.) were injected under the same conditions. The per cent concentration of each fatty acid was calculated by dividing the area of the fatty acid by the sum of all peak areas of the fatty acids. The results were compared with the retention times of standards for identifying specific fatty acids.

Each analysis was carried out in triplicate and mean values are reported. Data were statistically analyzed according to a completely randomized design. Critical Difference at 5% level of significance was used for comparing the means.

Results and Discussion

The per cent oil concentration varied from 64–70% among the cultivars (Table 1). Cultivars LCT and LCT × GBD had the highest oil concentration, while FMST had the lowest oil concentration. However, oil yield per hectare, calculated based on the copra yield per hectare multiplied by 175 palms ha^{-1}, was highest in cv. COD × WCT and was lowest in cv. WAT. These variations were attributed to the variations in the copra yield per hectare and oil concentration in copra. Variations in oil quantity among the cultivars were also reported by Louis and Ramachandran (1981).

The results indicated variations among the cultivars for oil quality in terms of PV, AV, and FFAs content, and SV (Table 1). The PV and AV were maximum in hybrids, COD × WCT, WCT × COD, and LCT × COD. The cv. BENT had the lowest PV while cv. JVT had the lowest AV. The presence of FFAs was lowest in cross MYD × WCT and cv. ZANT and highest in WCT × COD and LCT × COD. However, all values were within the limits of standard values prescribed for a good quality

Table 1 Oil content and quality of samples from different cultivars

Cultivar[1]	Oil content		Oil quality parameters			
	Oil concentration (%)	Oil yield (t ha^{-1})	Peroxide value (millieq. peroxide kg^{-1} sample)	Acid value (mg KOH g^{-1} oil)	Free fatty acids (%; lauric acid equivalent)	Saponification value (mg KOH g^{-1} oil)
Local talls						
WCT	68	2.01	0.63	0.38	0.104	252
LCT	70	2.12	0.64	0.38	0.114	236
ADOT	66	2.26	0.52	0.41	0.123	234
BENT	65	2.50	0.40	0.43	0.115	242
Released and promising hybrids						
COD × WCT	68	2.97	0.82	0.52	0.155	251
WCT × COD	68	2.02	0.87	0.58	0.174	253
LCT × COD	69	2.57	0.86	0.54	0.163	240
LCT × GBD	70	2.58	0.79	0.48	0.143	240
MYD × WCT	65	2.26	0.47	0.37	0.096	252
WCT × GBD	69	2.62	0.62	0.45	0.131	243
Geographically distinct cultivars						
FJIT	65	2.28	0.62	0.35	0.104	251
PHOT	66	2.77	0.48	0.43	0.135	262
SSGT	67	2.49	0.57	0.40	0.121	238
SNRT	68	2.09	0.68	0.39	0.118	241
WAT	68	1.70	0.47	0.39	0.115	246
ZANT	68	1.88	0.47	0.36	0.096	255
JVT	66	2.80	0.53	0.34	0.105	267
FMST	64	2.28	0.57	0.35	0.103	252
$CD_{0.05}$	0.25	0.30	0.052	0.040	0.010	4.34

[1]West Coast Tall (WCT); Laccadive Ordinary Tall (LCT); Andaman Ordinary Tall (ADOT); Benaulim Tall (BENT); Chowghat Orange Dwarf (COD); Ganga Nondam Dwarf (GGD); Malayan Yellow Dwarf (MYD); Philippines Ordinary Tall (PHOT); State Settlement Green Tall (SSGT); San Ramon Tall (SRNT); West African Tall (WAT); Zanzibar Tall (ZANT); Java Tall (JVT) and Federated Malayan States Tall (FMST)
CD, Critical Difference

coconut oil (Agmark Standards, 2004) indicating that the oil quality was good. The SV varied between 234 and 267 depending on the cultivar.

The lipid fractionation by silicic acid column chromatography indicated that the neutral lipids formed the major fraction followed by the glycolipids and phospholipids (Table 2). The lipid fraction content varied with cultivar. The neutral lipid (storage lipid) fraction was more in WCT, LCT, MYD × WCT, JVT, FIJT, and PHOT, whereas it was least in ZANT. In general, the hybrids had lower concentrations of neutral lipids (90–94%) compared to those in the local Talls and geographically distinct cultivars. The glycolipid fraction, in general, was higher in the hybrids than the other two groups of cultivars, the maximum being in WCT × GBD and ZANT. This fraction was minimum in the oil samples from JVT, FMST, and WCT. The phospholipid fraction was maximum in FMST and WAT and minimum in FIJT.

Gas chromatography on oil samples indicated that coconut oil mainly contained the saturated fatty acids, viz., 6C:0 (caproic), 8C:0 (caprylic), 10C:0 (capric), 12C:0 (lauric), 14C:0 (myristic), 16C:0 (palmitic), 18C:0 (stearic), and 20C:0 (arachidic) acids (Table 3). It also contained the unsaturated fatty acids viz., 18C:1 (oleic) and 18C:2 (linoleic) in smaller quantities. Lauric acid formed the major component of the saturated fatty acids (approximately 46%). A comparison of fatty acid profiles of the major vegetable oils indicated that coconut and palm kernel oils are the major sources of lauric acid (van der Vossen and Umali, 2001). Lauric acid is mainly used in the soap, pharmaceuticals, and dye industries. Similarly, these oils are rich in myristic acid, which is widely used in the cosmetic industry (Naresh Kumar *et al.*, 2000). Cultivars ADOT and SSGT had maximum lauric acid concentrations while a minimum was found in cv. FMST. Myristic acid was maximum in cv. BENT and least in cross LCT × GBD. The cultivars with higher levels of saturated FAs, viz., caproic, caprylic, and capric acids as well as in palmitic and stearic acids are indicated in Table 3. Among the unsaturated fatty acids, oleic acid was maximum in cross LCT × GBD and minimum in cv. ADOT. Linoleic acid, an essential fatty acid, was maximum in cvs WCT and BENT and minimum in cvs LCT and ADOT. Among the cultivars, its concentration varied significantly ranging from 0.55% to 2.71%. Arachidic acid, found in traces, was maximum in cv. WCT and minimum in cross MYD × WCT.

The ranking of cultivars based on different criteria indicated wide variations among cultivars

Table 2 Lipid fractions of oil samples from different coconut cultivars

Cultivar[1]	Lipid fractions (%)		
	Neutral lipids	Glycolipids	Phospholipids
Local talls			
WCT	97.10	0.85	2.05
LCT	97.80	1.12	1.08
ADOT	96.40	1.98	1.62
BENT	94.99	3.19	1.82
Released and promising hybrids			
COD × WCT	93.10	3.85	3.05
WCT × COD	92.80	4.31	2.89
LCT × COD	94.10	4.15	1.75
LCT × GBD	93.20	3.92	2.88
MYD × WCT	97.12	1.33	1.55
WCT × GBD	90.12	8.41	1.33
Geographically distinct cultivars			
FJIT	98.31	0.99	0.71
PHOT	97.31	1.54	1.16
SSGT	96.90	1.73	1.37
SNRT	96.50	1.74	1.76
WAT	94.16	2.70	3.15
ZANT	88.41	8.86	2.73
JVT	98.10	0.75	1.15
FMST	95.33	0.78	3.89
$CD_{0.05}$	1.31	1.43	0.86

[1]West Coast Tall (WCT); Laccadive Ordinary Tall (LCT); Andaman Ordinary Tall (ADOT); Benaulim Tall (BENT); Chowghat Orange Dwarf (COD); Ganga Nondam Dwarf (GGD); Malayan Yellow Dwarf (MYD); Philippines Ordinary Tall (PHOT); State Settlement Green Tall (SSGT); San Ramon Tall (SRNT); West African Tall (WAT); Zanzibar Tall (ZANT); Java Tall (JVT) and Federated Malayan States Tall (FMST)
CD. Critical Difference

Table 3 Fatty acid composition of oil samples from different cultivars and hybrids of coconut

Cultivar[1]	Fatty acid composition						
	6C[2] Caproic	8C Caprylic	10C Capric	12C Lauric	14C Myristic	16C Palmitic	18C group (Stearic, Oleic, and Linoleic)
Local talls							
WCT	0.47	6.07	5.10	44.07	20.61	10.61	12.93
LCT	0.50	6.53	7.32	48.90	17.30	9.40	9.95
ADOT	0.58	8.04	7.03	49.00	18.40	8.08	8.67
BENT	0.46	5.32	4.71	45.73	22.45	10.13	11.14
Released and promising hybrids							
COD × WCT	0.60	8.44	6.55	47.10	16.70	7.41	13.09
WCT × COD	0.50	6.55	8.04	46.05	17.50	8.26	13.03
LCT × COD	0.50	7.53	5.93	47.90	17.90	8.60	11.55
LCT × GBD	0.40	7.10	6.15	48.20	16.40	8.05	13.56
MYD × WCT	0.25	5.04	4.86	45.40	21.03	10.32	13.09
WCT × GBD	0.39	5.90	5.10	45.20	20.80	11.10	11.49
Geographically distinct cultivars							
FJIT	0.52	7.71	5.33	48.30	18.40	8.53	11.12
PHOT	0.45	5.50	5.30	45.70	19.92	11.01	12.00
SSGT	0.40	7.00	5.30	49.00	18.50	9.29	9.83
SNRT	0.50	7.81	6.30	47.20	17.50	8.70	12.03
WAT	0.54	7.09	5.67	44.80	21.91	9.07	10.86
ZANT	0.42	5.65	5.17	46.45	20.65	10.19	11.43
JVT	0.34	5.70	5.23	46.48	20.61	10.45	11.15
FMST	0.36	5.50	5.40	43.99	21.23	10.72	12.77
$CD_{0.05}$	0.35	6.08	0.41	0.50	0.61	0.70	0.41

[1]West Coast Tall (WCT); Laccadive Ordinary Tall (LCT); Andaman Ordinary Tall (ADOT); Benaulim Tall (BENT); Chowghat Orange Dwarf (COD); Ganga Nondam Dwarf (GGD); Malayan Yellow Dwarf (MYD); Philippines Ordinary Tall (PHOT); State Settlement Green Tall (SSGT); San Ramon Tall (SRNT); West African Tall (WAT); Zanzibar Tall (ZANT); Java Tall (JVT) and Federated Malayan States Tall (FMST)
[2]Carbon
CD. Critical Difference

Table 4 Saturated and unsaturated fatty acid content in oil from different coconut cultivars and ranking of cultivars based on various criteria

Cultivar[1]	Fatty acid concentration(%)		Saturated/ unsaturatedfatty acids		MCFAs[4]		Rank low sat/unsat FAs[5] + high MCFAs	Rank for low sat./ unsat. FAs + high lauric acid content	6–10C (%)	Rank for high conc. of 6–10C FAs	Rank for high lauric acid content
	Sat.[2] (%)	Unsat.[3] (%)	Ratio	Rank for low ratio	Concen-tration (%)	Rank for high MCFAs					
Local talls											
WCT	89.4	10.6	8.5	6	55.7	15	8	9	11.4	11	16
LCT	92.5	7.5	12.3	14	63.3	2	6	6	14.4	5	2
ADOT	93.4	6.6	14.2	15	64.7	1	6a	6a	15.7	1	1
BENT	91.0	9.0	10.1	11	56.2	14	11	10	10.2	16	11
Released and promising hybrids											
COD × WCT	88.6	11.4	7.7	2	62.7	3	1	2	15.6	2	7
WCT × COD	88.9	11.0	8.1	3	61.1	8	4	4	15.1	3	10
LCT × COD	89.1	10.9	8.2	4	61.9	4	3	2a	14.0	6	5
LCT × GBD	87.2	12.8	6.8	1	61.9	5	2	1	13.7	7	4
MYD × WCT	89.4	10.6	8.4	5	55.6	16	8a	8	10.2	17	13
WCT × GBD	90.7	9.3	9.8	10	56.6	13	9	12	11.4	13	14
Geographically distinct cultivars											
FJIT	90.2	9.8	9.2	8	61.9	4	5	3	13.6	8	3
PHOT	90.3	9.7	9.3	9	56.9	12	8b	9a	11.3	14	12
SSGT	91.2	8.8	10.4	12	61.7	7	7	5	12.7	10	1a
SNRT	91.4	8.6	10.6	13	61.8	6	7a	7	14.6	4	6
WAT	91.2	8.8	10.4	12a	58.1	9	8c	10a	13.3	9	15
ZANT	90.8	9.2	9.8	10a	57.7	11	8d	8a	11.2	15	9
JVT	91.0	9.0	10.1	11a	57.8	10	8e	8b	11.3	12	8
FMST	89.7	10.3	8.7	7	55.3	17	10	11	11.3	13	17
$CD_{0.05}$	0.60	0.42	0.31	—	0.50	—	—	—	0.80	—	—

[1]West Coast Tall (WCT); Laccadive Ordinary Tall (LCT); Andaman Ordinary Tall (ADOT); Benaulim Tall (BENT); Chowghat Orange Dwarf (COD); Ganga Nondam Dwarf (GGD); Malayan Yellow Dwarf (MYD); Philippines Ordinary Tall (PHOT); State Settlement Green Tall (SSGT); San Ramon Tall (SRNT); West African Tall (WAT); Zanzibar Tall (ZANT); Java Tall (JVT) and Federated Malayan States Tall (FMST)
[2]Saturated fatty acids
[3]Unsaturated fatty acids
[4]Medium chain fatty acids
[5]Fatty acids
CD, Critical Difference

for the fatty acid composition (Table 4). The ratio of saturated to unsaturated fatty acid concentration was lowest in cross LCT × GBD and highest in cv. ADOT. The hybrids, in general, had lower concentrations of saturated fatty acids and correspondingly low ratios of saturated to unsaturated fatty acid concentrations. Talls had higher values for this parameter. However, cv. WCT had the lower ratio.

The correlation analysis indicated that the saturated fatty acids concentration correlated negatively with glyco- and phospho-lipids but positively with neutral lipids (Table 5). The ratio of saturated:unsaturated fatty acids decreased with increase in phospholipid concentration. The results indicated a predominant presence of unsaturated fatty acid in glyco- and phospho-lipids. However, the neutral lipids also contained a 16C (palmitic) fraction. The short and medium chain fatty acids (6–10C) were present in the phospholipids and lauric acid was mostly present in the neutral lipid fraction. Krishnamurthy and Chandrasekhara (1983) also reported that the neutral lipids contained high concentrations of saturated fatty acids whereas glyco- and phospho-lipids had major portions of unsaturated fatty acids. The neutral lipids contained all fatty acids, whereas, glycolipids lacked 6C and phospholipids lacked 6C to 12C fatty acids. The correlations observed in this study also indicated that there were greater contents of saturated fatty acids in the neutral lipids than in the glyco- and phospho-lipids, whereas, the trend was reversed for the contents of unsaturated fatty acids. Increase in the neutral lipid fraction coincided with decrease in the glycolipid fraction followed by that of the phospholipid. Interestingly, short and medium chain fatty acids (MCFAs), viz., 6C, 8C, and 10C correlated negatively with 14C, 16C, and 18C:2 but positively with 18C and 20C. The 14C fatty acid correlated positively with 16C and 18C:2, but negatively with 16C, 18C, and 20C fatty acids. All fatty acids that were present in coconut oil, correlated differently among one another indicating the possibility of

Table 5 Correlation coefficients of various parameters of coconut oil quality

Sl.No.	Parameters	1	2	3	4	5	6	7	8	9
1	Sat.[1] FAs[2]	—								
2	Unsat[3] FAs	-0.99	—							
3	Sat./Unsat.	0.98	-0.98	—						
4	MCFAs[4]	0.18	-0.18	0.30	—					
5	6–10 C FAs	0.07	-0.07	0.20	0.88	—				
6	N-lipids[5]	0.27	-0.27	0.27	0.16	-0.01	—			
7	G-lipids[6]	-0.15	0.15	-0.16	-0.09	-0.04	-0.95	—		
8	P-lipids[7]	-0.44	0.44	-0.40	-0.21	0.12	-0.52	0.23	—	
9	6C:0	0.21	-0.22	-0.28	0.65	0.78	-0.04	0.02	0.09	—
10	8C:0	0.03	-0.33	0.14	0.81	0.90	0.04	-0.06	0.04	0.76
11	10C:0	0.07	-0.07	0.20	0.72	0.86	-0.04	-0.02	0.19	0.56
12	12C:0	0.26	-0.26	0.36	0.87	0.61	0.20	-0.07	-0.42	0.34
13	14C:0	0.25	-0.22	0.10	-0.86	-0.82	-0.05	0.04	0.05	-0.44
14	16C:0	0.22	-0.21	0.08	-0.84	-0.89	0.02	0.02	-0.14	-0.58
15	18C:0	0.12	-0.13	0.21	0.50	0.63	0.13	-0.18	0.07	0.33
16	18C:1	-0.94	0.94	-0.93	0.05	0.16	-0.20	0.09	0.39	-0.05
17	18:C-2	-0.16	0.17	0.27	-0.93	-0.86	-0.17	0.12	0.20	-0.57
18	20C:0	0.15	-0.15	0.19	0.55	0.52	0.40	-0.37	-0.22	0.76
19	Oil (%)	-0.23	0.23	-0.17	0.26	0.34	-0.34	0.39	-0.01	0.05

Table 5 (cont'd) Correlation coefficients of various parameters of coconut oil quality

Sl.No.	Parameters	10	11	12	13	14	15	16	17	18
1	Sat.[1] FAs[2]									
2	Unsat.[3] FAs									
3	Sat./Unsat.									
4	MCFAs[4]									
5	6–10 C FAs									
6	N-lipids[5]									
7	G-lipids[6]									
8	P-lipids[7]									
9	6C:0									
10	8C:0	—								
11	10C:0	0.54	—							
12	12C:0	0.63	0.44	—						
13	14C:0	-0.73	-0.72	-0.73	—					
14	16C:0	-0.86	-0.69	-0.70	0.86	—				
15	18C:0	0.34	0.80	0.28	-0.61	-0.47	—			
16	18C:1	0.21	0.09	-0.06	-0.45	-0.43	0.08	—		
17	18:C-2	-0.81	-0.69	-0.88	0.86	0.87	-0.54	-0.10	—	
18	20C:0	0.52	0.39	0.23	-0.43	-0.35	0.32	-0.02	-0.42	—
19	Oil (%)	0.21	0.35	0.24	-0.46	-0.33	0.30	0.26	-0.25	-0.12

[1]Saturated fatty acids
[2]Fatty acids
[3]Unsaturated fatty acids
[4]Medium chain fatty acids
[5]Neutral lipids
[6]Glycolipids
[7]Phospholipids
Correlation coefficient values >0.53 are significant at $P = 0.05$

synthesis of one fatty acid at the expense of the other since the biosynthesis of fatty acids takes place in a sequential order (Oo and Stumpf, 1979). The results indicated that the MCFAs correlated negatively with the linolenic acid concentration, but correlated positively with those of 18C and 20C fatty acids. Linolenic acid is predominantly present in the glyco- and phospho-lipid fractions.

The unsaturated fatty acid concentration was positively correlated with oil concentration and it can be taken as one of the traits for selection for high oil yield. This also indicated the possibility of increasing both oil content and quality in coconut cultivars. Thus, the concentrations of neutral lipids, 14C and 16C fatty acids negatively correlated with oil concentration, whereas MCFAs positively correlated with oil concentration.

From these results, it can be concluded that variability exists among coconut germplasm for fatty acid composition of oil (Table 3), indicating the possibility of further improvement of coconut oil quality for specific industrial uses by breeding. In general, the hybrids showed lower saturated:unsaturated fatty acid ratios than

that of tall cultivars. Future work should aim to assess the impact of environment on the oil quality and also to find greater variability for fatty acid composition in the entire coconut germplasm towards the possibility of breeding for oil quality for specific uses.

Acknowledgements

The authors thank the Director, CPCRI, Kasaragod, for the encouragement and facilities provided. The help rendered by Dr M.J. Ratnambal, Sr Scientist, CPCRI, Kasaragod, and Dr John Zhacharia, Sr Scientist, IISR, Calicut, is profusely acknowledged. The authors are thankful to Mr John George, Technical Officer and Mr Siju Thomas, Senior Research Fellow, for assistance in the analysis.

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