

PERFORMANCE OF *Elaeis oleifera* FROM PANAMA, COSTA RICA, COLOMBIA AND HONDURAS IN MALAYSIA

Keywords: *Elaeis oleifera*, Panama, Costa Rica, Colombia, Honduras, yield, bunch components, vegetative traits, fatty acid composition, iodine value, total carotene.

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The performance of *Elaeis oleifera* from Panama, Costa Rica, Colombia and Honduras was evaluated in a trial at PORIM Research Station, Kluang, Johor, Malaysia. FFB yield, bunch components, vegetative traits, fatty acid composition, iodine value (I.V.) and total carotene were analysed. Among the *oleifera* progenies, the highest fresh fruit bunch (FFB) yield was 101.4 kg palm⁻¹ yr⁻¹, total oil to bunch (TOTB) was highest at 9.0%, height increment rate (HTI) lowest at 4.6 cm yr⁻¹, I.V. highest at 96.7 and total carotene highest at 3455.5 ppm. There were significant differences between the four countries for the yield components: average bunch weight (ABWT), parthenocarpic bunch components: mean fruit weight (MFW), oil to wet mesocarp (OTWM) and oil to bunch (OTB), fertile bunch components: MFW, mean nut weight (MNW) and shell to fruit (STF), vegetative traits: petiole cross section (PCS), rachis length (RL), leaflet length (LL), leaflet width (LW), height (HT) and leaf area (LA), component fatty acids: C14:0, C16:0, C16:1, C18:0, C18:1 and C18:2, I.V. and total carotene.

INTRODUCTION

E*laeis oleifera* (HBK) Cortes is the South/Central American counterpart of the commercially propagated African oil palm, *E. guineensis* Jacq. In nature, it occurs in poorly drained or occasionally flooded places in its centre of origin (de Blank, 1952). Among the traits of interest of this species are its low HTI, high I.V. (Hardon, 19691, tolerance against some major diseases (Meunier, 1987) and high caro-

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tene content (Choo et al., 1997; Choo and Yusof, 1996).

A programme to collect *E. oleifera* in the natural groves of Costa Rica, Panama and Colombia was initiated by the United Brands Company in Central America in 1967. This species was collected for evaluation and utilization. Collections in Colombia, Panama and Costa Rica and subsequent introductions to Malaysia were made by oil palm breeders from Socfin, Oil Palm Genetics Laboratory (OPGL) and United Plantations Berhad (UPB) in 1967, 1969 and 1980, respectively. Between October 1981 and February 1982, the Palm Oil Research Institute of Malaysia (PORIM) collected samples in Suriname, Honduras, Nicaragua, Panama, Costa Rica, and Colombia (Rajanaidu, 1983; Rajanaidu et al., 1989).

The performance in terms of yield, bunch components, vegetative traits of the palms and the fatty acid composition, I.V. and total carotene content of the oil of the PORIM *E. oleifera* collections from Panama, Costa Rica, Colombia and Honduras is presented in this paper.

MATERIALS AND METHODS

The *oleiferas* collected from open-pollinated families in Panama, Costa Rica, Honduras and Colombia in 1982 were planted in a completely randomized design (CRD) in three replications at PORIM Research Station, Kluang, Johor, Malaysia in May 1986. A total of 77 to 93 proge-

nies/replication at eight to ten palms/progeny were laid out in the field in a triangular planting pattern of 8.4 m spacing.

Recording of yield and its components commenced from the fifth year after planting and continued for six years. The number and weight of harvested fruit bunches from each palm were recorded during each seven- to ten-day interval harvesting round. From the fifth to eighth year of the trial, individual fruit bunches were also analysed in the laboratory to determine the composition of bunches and their oils. The bunch analysis technique adopted was that developed by Blaak et al. (1963) at NIFOR and modified by Rao et al. (1983) for standard use in Malaysia. Fatty acid composition, I.V. and total carotene of mesocarp oil were also analysed using established techniques (PORIM, 1995). Vegetative traits were measured in the eleventh year using the non-destructive methods recommended by Corley and Breure (1981).

RESULTS AND DISCUSSION

The trial mean of the 95 *oleifera* progenies was 76.5 kg palm⁻¹yr⁻¹ for FFB yield with 7.5 bunches and 10.1 kg ABWT. *Oleiferas* from Panama were the highest for FFB (79.2 kg palm⁻¹ yr⁻¹) and bunch number or BNO (7.9 bunches palm⁻¹ yr⁻¹) whereas *oleiferas* from Colombia were highest for ABWT at 10.8 kg (Table 1a). The individual progeny with the highest FFB (101.4 kg palm⁻¹ yr⁻¹) was from Honduras, whereas the progeny

TABLE 1a. MEANS, RANGES AND STANDARD DEVIATIONS OF YIELD (and components) OF *Oleifera* PROGENIES FROM FOUR COUNTRIES

Trait	Colombia			Panama			Costa Rica			Honduras			Trial mean
	Mean	Range	S D	Mean	Range	SD	Mean	Range	S D	Mean	Range	SD	
FFB (kg palm ⁻¹ yr ⁻¹)	77.7a	41.6-98.0	13.3	79.2a	52.5-100.1	11.8	61.8a	23.7-81.2	16.6	74.4a	55.2-101.4	15.20	76.5
BNO (No. palm ⁻¹ yr ⁻¹)	7.1a	3.8-9.1	1.2	7.9a	6.0-9.5	0.9	7.1a	2.7-9.7	1.8	7.1a	5.6-9.1	1.20	7.5
ABWT (kg)	10.8a	9.2-13.9	0.9	9.7a	8.0-10.8	0.7	9.8a	7.1-17.4	2.0	9.9a	9.2-10.7	0.50	10.1

Notes:
 Means with the same letter in the same row are not significantly different at P<0.05 by Duncan's Multiple Range Test (DMRT).
 Number of progenies (n) = 28, 24, 38 and 5 for Colombia, Panama, Costa Rica and Honduras, respectively.
 Recorded from 1991 to 1997 in Trial 0.211, planted in 1986 in Kluang.

FFB fresh fruit bunch.
 BNO bunch number.
 ABWT average bunch weight.

TABLE 1b. MEAN SQUARES, VARIANCE COMPONENTS AND HERITABILITY ESTIMATES FROM NCM1 ANALYSIS FOR YIELD COMPONENTS

Source	df	FFB	BNO	ABWT
Replication	2	491 334.20	4 211.68	78.34
country (C)	3	5 336.05	43.91	249.74**
Progeny/Country (P/C)	72	2 983.30	23.32	20.49**
C x R	6	1 814.90	12.51	9.57
P/C x R	144	2 304.08	18.04	4.31
Palms (W)	1 782	1 971.09	16.53	4.61
Pooled error (WP)	1 926	1 995.99	16.64	4.58
σ_c^2		10.40 (0.50)	0.20 (1.14)	0.82 (13.43)
$\sigma_{p/c}^2$		26.43 (1.28)	0.21 (1.20)	0.63 (10.32)
σ_{cr}^2		0 (0)	0 (0)	0.06 (0.98)
$\sigma_{(p/c)r}^2$		38.87 (1.88)	0.18 (1.02)	0 (0)
σ_w^2				
σ_{wp}^2		1 995.99 (96.35)	16.64 (96.65)	4.58 (75.33)
h_c^2		2.00	4.56	53.72
h_p^2		5.12	4.80	41.28
h_{c+p}^2		3.56	4.68	47.50

Notes:

*, ** Significant at $P \leq 0.05$ and $P \leq 0.01$ respectively, otherwise non-significant.

()+ Variance component as percentage of phenotypic variance.

Harmonic mean for palms in progeny/rep (\bar{n}) and P/C (\bar{p}) = 5.09 and 3.18, respectively

Negative estimate for which the most reasonable value is zero.

Recorded from 1991 to 1997 in Trial 0.211, planted in 1986 in Kluang.

with the highest BNO (9.7 palm-i yr⁻¹) and that with the highest ABWT (17.4 kg) were from Costa Rica. Analysis of the variation showed significant differences between the *oleiferas* from the four countries for ABWT, but not for FFB and BNO (**Table 1b**). The heritability values, h_c^2 based on countries as populations were 2.0%, 4.6% and 53.7% for FFB, BNO and ABWT, respectively.

For bunch components, values for oil to dry mesocarp (OTDM) at 31.4%, OTWM at 10.5% and fruit to bunch (FTB) at 16.8% of parthenocarpic fruits compared to fertile fruits with OTDM at 35.1%, OTWM at 15.7% and FTB at 31.6% gave a lower parthenocarpic OTB at 1.5% than fertile OTB at 1.8% in the 62 *oleifera* progenies (**Table 2a**). The absence of nut and

kernel in parthenocarpic fruits meant smaller fruits at a MFW of 1.2 g compared to fertile MFW at 3.2 g. The *oleiferas* were generally thick-shelled with the STF ranging from 43.3% to 61.1%. Analysis of variance showed significant differences between the four countries for parthenocarpic MFW, OTWM and OTB, with h_c^2 of 13.9%, 16.9% and 10.8% respectively (**Table 2b**). Significant differences were observed for fertile MFW, MNW and STF, with h_c^2 of 14.1%, 30.2% and 40.1%, respectively.

Oleiferas from Costa Rica gave the highest TOTB, oil palm⁻¹ yr⁻¹ (OPY), kernel palm-i yr⁻¹ (KPY), total economic product (TEP) and total oil (TOTOIL) with values of 3.9%, 2.9, 3.4, 5.0 and 4.7 kg palm⁻¹ yr⁻¹ respectively (**Table 3**). The best progenies for TOTB, OPY, KPY,

TABLE 2a. MEANS, RANGES AND STANDARD DEVIATIONS OF FERTILE AND PARTHENOCARPC BUNCH COMPONENTS OF *Oleifera* PROGENIES FROM FOUR COUNTRIES

Trait	Colombia			Panama			Costa Rica			Honduras mean	Trial mean
	Mean	Range	SD	Mean	Range	SD	Mean	Range	SD		
Fertile fruits:											
MFW (g)	3.1b	1.6-4.5	0.5	3.3ab	2.1-5.4	0.8	3.4ab	2.1-4.1	0.6	4.1a	3.2
MNW (g)	2.0b	1.1-3.1	0.4	2.1b	1.4-3.6	0.5	2.1b	1.3-2.7	0.4	2.9a	2.0
MTF (%)	35.8a	29.6-42.1	3.2	34.4ab	27.4-39.4	2.9	36.1a	29.7-48.8	4.4	29.91	35.5
KTF (%)	16.2a	10.5-17.5	1.8	13.2a	10.4-17.2	1.7	13.9a	8.0-35.4	5.3	15.6a	14.1
STF (%)	48.0a	44.8-55.1	2.5	52.4a	48.3-61.1	2.6	51.4a	43.3-56.3	2.9	54.5a	51.2
OTDM (%)	33.9a	18.6-44.2	7.2	36.0a	20.7-49.9	6.9	38.2a	27.9-51.6	5.8	33.5a	35.1
OTWM (%)	14.6a	5.9-22.3	5.1	17.2a	6.0-32.2	5.8	17.1a	8.5-26.9	4.5	13.8a	15.7
FTB (%)	29.0a	16.7-40.7	7.3	30.1a	20.3-38.5	6.0	32.2a	14.9-50.6	8.7	29.2a	31.6
OTB (%)	1.5a	0.5-2.9	0.7	2.1a	0.5-3.8	0.8	3.9a	0.9-3.7	0.8	1.2a	1.8
KTB (%)	4.6a	1.9-6.6	1.3	3.9a	2.5-5.7	0.9	2.0a	1.6-12.9	2.4	4.6a	4.5
Parthenocarpic fruits:											
MFW (g)	1.2a	0.7-1.6	0.2	1.2a	0.6-2.2	0.4	1.4a	0.9-2.2	0.3	1.2a	1.2
OTDM (%)	29.9a	12.4-44.6	8.3	32.5a	19.6-46.2	7.1	34.1a	18.0-53.3	7.4	23.9a	31.4
OTWM (%)	9.6a	2.6-19.1	4.6	11.4a	4.9-22.2	4.3	11.6a	4.1-23.3	4.4	6.6a	10.5
FTB (%)	16.2a	5.3-28.0	6.0	16.5a	10.6-23.1	3.6	19.9a	7.2-31.5	6.4	21.1a	16.8
OTB (%)	1.3a	0.2-4.0	1.1	1.6a	0.6-4.1	0.8	1.9a	0.6-5.3	1.1	1.2a	1.5

Notes:

Means with the same letter in the same row are not significantly different at $P < 0.05$ by Duncan's Multiple Range Test (DMRT). Number of progenies(n) = 22, 18, 21 and 1 for Colombia, Panama, Costa Rica and Honduras, respectively (1-2 analyses per palm). Recorded from 1991 to 1994 in Trial 0.211, planted in 1986 in Kluang.

MFW mean fruit weight.

MNW mean nut weight.

MTF mesocarp to fruit.

KTF kernel to fruit.

STF shell to fruit.

OTDM oil to dry mesocarp.

OTWM oil to wet mesocarp.

FTB fruit to bunch.

OTB oil to bunch.

KTB kernel to bunch.

TABLE 2b. MEAN SQUARES, VARIANCE COMPONENTS AND HERITABILITY ESTIMATES OF NCM1 ANALYSIS FOR BUNCH COMPONENTS OF PARTHENOCARPC FRUITS

Source	df	MFW	OTDM	OTWM	FTB	OTB
country (C)	3	0.28*	188.48	58.80*	16.61	2.24*
Progeny/country (P/C)	58	0.15*	86.63	27.91	8.13	1.32*
Palms (W)	61	0.09	74.23	19.69	6.92	0.70
σ^2_c		0.004	3.60	1.05	0.30	0.03
		(3.48)	(4.27)	(4.22)	(3.80)	(2.70)
$\sigma^2_{p/c}$		0.03	6.36	4.21	0.62	0.32
		(26.28)	(7.55)	(16.89)	(7.86)	(30.59)
σ^2_w		0.09	74.23	19.69	6.92	0.70
		(70.24)	(88.18)	(78.89)	(88.34)	(66.71)
h^2_c		13.92	17.08	16.88	15.21	10.79

Notes:

*, ** Significant at $P \leq 0.05$ and $P \leq 0.01$ respectively, otherwise non-significant.

()[†] Variance component as percentage of phenotypic variance.

Negative estimate for which the most reasonable value is zero.

Recorded from 1991-1994 in Trial 0.211, planted in 1986 in Kluang.

TABLE 2c. MEAN SQUARES, VARIANCE COMPONENTS AND HERITABILITY ESTIMATES OF NCM1 ANALYSIS FOR BUNCH COMPONENTS OF FERTILE FRUITS

Source	df	MFW	MNW	MTF	KTF	STF	OTDM	OTWM	FTB	OTB	KTB
country (C)	3	1.27*	0.86**	36.84	9.20	43.14*	150.02	86.72	43.10	2.03	0.14
Progeny/Country (P/C)	58	0.70*	0.34**	18.65	6.09	11.14	77.85	45.80	98.54	0.96	2.72
Palms (W)	61	0.18	0.08	15.09	5.03	9.41	81.58	33.95	68.50	0.82	1.86
σ^2_c		0.02 (3.52)	0.02 (7.55)	0.63 (3.60)	0.10 (1.84)	1.15 (10.02)	2.65 (3.15)	1.39 (3.35)	0 (0)	0.04 (4.03)	0 (0)
$\sigma^2_{p/c}$		0.27 (57.30)	0.13 (59.30)	1.82 (10.39)	0.54 (9.57)	0.89 (7.76)	0 (0)	6.08 (14.68)	15.40 (18.35)	0.07 (7.66)	0.44 (19.01)
σ^2_w		0.18 (39.18)	0.08 (33.16)	15.09 (86.01)	5.03 (88.59)	9.41 (82.21)	81.58 (96.85)	33.95 (81.97)	68.50 (81.65)	0.82 (88.31)	1.86 (80.99)
h^2_c		14.09	30.18	14.38	7.34	40.09	12.59	13.40	0	16.13	0

Notes:

*, ** Significant at $P \leq 0.05$ and $P \leq 0.01$ respectively, otherwise non-significant.

()[†] Variance component as percentage of phenotypic variance.

Negative estimate for which the most reasonable value is zero.

Recorded from 1991-1994 in Trial 0.211, planted in 1986 in Kluang.

TABLE 3. MEANS, RANGES AND STANDARD DEVIATIONS OF OIL AND KERNEL YIELD OF *Oleifera* PROGENIES FROM FOUR COUNTRIES

Trait	Colombia			Panama			Costa Rica			Honduras		Trial
	Mean	Range	SD	Mean	Range	SD	Mean	Range	SD	mean	mean	
TOTB (%)	2.9a	0.8-6.5	1.5	3.4a	1.3-6.1	1.3	3.9a	1.7-9.0	1.5	2.4a	3.4	
OPY (kg palm ⁻¹ yr ⁻¹)	2.4a	0.6-4.5	1.0	2.7a	1.1-4.6	1.0	2.9a	1.2-7.7	1.3	1.7a	2.6	
KPY (kg palm ⁻¹ yr ⁻¹)	3.3a	1.4-5.5	1.1	3.1a	1.4-5.0	1.0	3.4a	1.4-8.8	1.7	3.3a	3.3	
TEP (kg palm ⁻¹ yr ⁻¹)	4.2a	1.9-6.5	1.3	4.6a	2.3-6.9	1.3	5.0a	2.6-8.9	1.5	3.8a	4.6	
TOTOIL (kg palm ⁻¹ yr ⁻¹)	3.9a	1.6-6.0	1.2	4.2a	2.2-6.5	1.2	4.7a	2.3-8.7	1.4	3.4a	4.3	

Notes:

Means with the same letter in the same row are not significantly different at $P < 0.05$ by Duncan's Multiple Range Test (DMRT).

Number of progenies (n) = 22, 18, 21 and 1 for Colombia, Panama, Costa Rica and Honduras, respectively.

Planted in 1986 in Trial 0.211, Kluang.

TOTB total oil to bunch.

OPY oil palm⁻¹ yr⁻¹.

WY kernel palm⁻¹ yr⁻¹.

TEP total economic product.

TOTOIL total oil.

TABLE 4a. MEANS, RANGES AND STANDARD DEVIATIONS OF VEGETATIVE TRAITS OF *Oleifera* PROGENIES FROM FOUR COUNTRIES

Trait	Colombia			Panama			Costa Rica			Honduras			Trial
	Mean	Range	SD	Mean	Range	SD	Mean	Range	SD	Mean	Range	SD	
PCS (cm ²)	16.5a	12.7-18.8	1.4	16.4a	14.4-17.9	0.8	16.6a	12.6-32.5	3.2	16.5a	15.4-17.6	0.8	16.5
RL (m)	4.3a	3.8-4.6	0.1	4.2a	4.0-4.5	0.1	4.1a	3.6-4.8	0.3	4.1a	3.6-4.3	0.2	4.2
LL (cm)	107.1a	92.0-116.4	4.7	111.2a	100.0-120.6	5.1	106.4a	89.4-118.0	6.3	112.1a	104.2-119.8	5.1	108.7
LW (cm)	5.3a	4.4-5.7	0.3	5.2a	4.9-5.6	0.2	5.1a	4.4-5.9	0.3	5.0a	4.2-5.3	0.4	5.2
LN (No.)	128a	110.0-135.0	5.0	128a	115.0-137.0	5.0	130a	117.0-147.0	6.9	129a	123.0-133.0	4.4	129.0
HT (cm)	66.0a	42.0-81.0	0.1	75.0a	59.0-90.0	0.1	83.0a	54.0-141.0	0.2	68.0a	59.0-84.0	0.1	75.0
HTI (cm yr ⁻¹)*	7.4b	4.6-9.0	1.0	8.3ab	6.6-10.0	0.9	9.2a	6.0-15.7	1.8	7.6ab	6.6-9.3	1.0	8.3
LA (cm ²)	8.4a	6.3-9.6	0.7	8.6a	7.4-9.6	0.6	8.2a	6.2-9.4	0.8	8.2a	6.5-9.7	1.1	8.4

Notes: Means with the same letter in the same row are not significantly different at P<0.05 by Duncan's Multiple Range Test (DMRT).

*HTI = (height at year t)/(t-2), according to Breure and Powell (1988) where t = 11 for Trial 0.211.

Number of progenies (n) = 28, 24, 38 and 5 for Colombia, Panama, Costa Rica and Honduras, respectively.

Recorded in 1997 in Trial 0.211, planted in 1986 in Kluang.

PCS - petiole cross section.
 RL - rachis length.
 LL - leaflet length.
 LW - leaflet width.
 LN - leaflet number.
 HT - height.
 HTI - height increment rate.
 LA - leaflet area.

TEP and TOTOIL were also from Costa Rica with values of 9.0%, 7.7, 8.8, 8.9 and 8.7 kg palm-i yr⁻¹ respectively.

For vegetative traits, among the 95 *oleifera* progenies, the smallest PCS at 12.6 cm², RL at 3.6 cm, LL at 89.4 cm and LA at 6.2 cm² were recorded by progenies from Costa Rica. Progenies from Colombia recorded the smallest leaflet number (LN) at 110 and lowest HTI at 4.6 cm yr⁻¹ whereas progenies from Honduras recorded the smallest LW at 4.2 cm (Table 4a). Statistical analysis showed significant differences between countries for PCS, RL, LL, LW, HT and LA with h² of 7.8%, 11.6%, 14.0%, 1.4%, 21.1% and 7.8%, respectively (Table 4b).

Progenies from Colombia recorded the highest palmitoleic acid (C16:1) content at 1.6% among the 85 *oleifera* progenies screened. The highest lauric (C12:0) at 1.0%, stearic (C18:0) at 2.9%, linoleic (C18:2) at 26.9% and arachidic (C20:0) acids at 1.2% were recorded in progenies from Panama. Progenies from Costa Rica recorded the highest myristic (C14:0), palmitic (C16:0), oleic (C18:1) and linolenic (C18:3) acids with values of 1.0%, 24.1%, 68.7% and 1.9%, respectively. The highest I.V. at 96.7 and carotene content at 3455.5 ppm were recorded in progenies from Panama and Costa Rica, respectively (Table 5a). Except for the C12:0, C18:3 and C20:0 acids, statistical analysis showed significant differences between countries for C14:0, C16:0, C16:1, C18:0, C18:1, C18:2, I.V. and carotene, with h² of 12.0%, 34.9%, 8.1%, 10.1%, 59.1%, 25.8%, 13.3% and 16.1%, respectively (Table 5b).

CONCLUSION

This comparative study showed significant differences between *E. oleifera* collected from Panama, Costa Rica, Colombia and Honduras for the yield components, ABWT, parthenocarpic fruit weight and oil content, fertile fruit and nut weight, shell thickness, frond and leaflet traits as well as HT, principal fatty acids (C14:0, C16:0, C16:1, C18:0, C18:1 and C18:2), I.V. and total carotene content.

TABLE 4b. MEAN SQUARES, VARIANCE COMPONENTS AND HERITABILITY ESTIMATES OF NCM1 ANALYSIS FOR VEGETATIVE TRAITS

Source	df	PCS	RL	LL	LW	LN	HT	LA
Replication (R)	2	1 810.55	22.31	35 473.26	153.94	22 898.35	6.97	827.17
country (C)	3	93.68*	3.45**	3 562.29**	7.18**	705.88	2.24**	58.14**
Progeny/Country (P/C)	72	24.98*	0.46	569.83**	0.78	420.03	0.20	8.52
C x R	6	3.89	0.73*	424.76	1.00	729.08	0.20	18.48*
P/C x R	144	13.00	0.30	166.04	0.60	454.05	0.11	5.17
Palms (W)	1 757	14.19	0.31	267.33	0.68	529.21	0.13	6.62
Pooled error (WP)	1 901	14.10	0.30	259.66	0.68	523.51	0.12	6.51
σ^2_c		0.29 (1.94)	0.009 (2.90)	10.12 (3.50)	0.002 (0.34)	0.04 (0)	0.007 (5.27)	0.14 (1.94)
$\sigma^2_{p/c}$		0.47 (3.18)	0.007 (2.28)	15.91 (5.50)	0.007 (1.04)	0 (0)	0.003 (2.56)	0.13 (1.91)
σ^2_{cr}		0 (0)	0.005 (1.60)	2.87 (1.00)	0.004 (0.65)	3.06 (0.58)	0.001 (0.73)	0.15 (2.13)
$\sigma^2_{(p/c)r}$		0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
σ^2_w								
σ^2_{wp}		14.10 (94.88)	0.30 (93.23)	259.66 (90.00)	0.68 (97.98)	523.51 (99.41)	0.12 (91.44)	6.51 (94.02)
h^2_c		7.76	11.60	14.00	1.36	0	21.08	7.76
h^2_p		12.72	9.12	22.00	4.16	0	10.24	7.64
h^2_{c+p}		10.24	10.36	18.00	2.76	0	15.66	7.70

Notes:

*, ** Significant at $P \leq 0.05$ and $P \leq 0.01$ respectively, otherwise non-significant.

()⁺ Variance component as percentage of phenotypic variance.

Harmonic mean for palms in progeny/rep (n') and P/C (p') = 4.98 and 3.29, respectively.

Negative estimate for which the most reasonable value is zero.

Recorded in 1997 in Trial 0.211, planted in 1986 in Kluang.

TABLE 5a. MEANS, RANGES AND STANDARD DEVIATIONS OF FATTY ACID COMPONENTS, IODINE VALUE AND CAROTENE CONTENT OF *Oleifera* PROGENIES FROM FOUR COUNTRIES

Trait	Colombia			Panama			Costa Rica			Honduras			Trial mean
	Mean	Range	SD	Mean	Range	SD	Mean	Range	SD	Mean	Range	SD	
C12:0 (%)	0.0a	0.0-0.2	0.0	0.1a	0.0-1.0	0.2	0.0a	0.0-0.1	0.0	0.0a	0.0-0.1	0.0	0.0
C14:0 (%)	0.1a	0.1-0.3	0.0	0.2a	0.1-0.6	0.1	0.2a	0.1-1.0	0.2	0.2a	0.2-0.3	0.0	0.2
C16:0 (%)	16.9b	15.0-19.8	1.3	18.6ab	13.3-24.1	2.1	17.8b	16.4-24.1	1.6	20.7a	19.4-21.7	0.9	17.9
C16:1 (%)	1.1a	0.7-1.6	0.2	0.9a	0.0-1.3	0.2	1.1a	0.7-1.5	0.2	1.0a	0.9-1.1	0.1	1.0
C18:0 (%)	0.9a	0.4-1.5	0.2	1.1a	0.0-2.9	0.6	0.9a	0.4-1.7	0.2	1.3a	1.1-1.6	0.2	1.0
C18:1 (%)	62.9a	58.1-68.0	2.0	60.1a	53.7-65.2	2.5	60.4a	56.4-68.7	2.5	55.5b	53.5-57.3	1.7	60.9
C18:2 (%)	17.8a	14.4-19.9	1.4	19.0a	13.7-26.9	2.4	19.2a	11.9-23.5	2.4	20.8a	19.0-22.2	1.2	18.8
C18:3 (%)	0.7a	0.1-1.2	0.2	0.8a	0.4-1.1	0.2	0.9a	0.0-1.9	0.3	0.9a	0.5-1.1	0.2	0.8
C20:0 (%)	0.2a	0.0-1.0	0.3	0.2a	0.0-1.2	0.4	0.2a	0.0-1.1	0.3	0.4a	0.1-1.2	0.5	0.2
Others (%)	0.2a	0.0-0.4	0.1	0.2a	0.0-0.6	0.1	0.2a	0.0-0.8	0.2	0.1a	0.0-0.3	0.1	0.2
Iodine value	87.2a	82.5-90.1	1.9	86.4a	76.0-96.7	3.7	87.7a	74.9-93.6	3.5	86.0a	83.5-87.6	1.6	81.1
Carotene content (ppm)	444.9ab	791.2-3003.5	525.4	710.3a	644.6-2858.8	563.9	727.8a	379.7-3455.5	630.9	112.7b	328.6-1654.0	561.5	609.3

Notes:

Means with the same letter in the same row are not significantly different at $P < 0.05$ by Duncan's Multiple Range Test (DMRT).

Number of progenies (n) = 21, 24, 30 and 4 for Colombia, Panama, Costa Rica and Honduras, respectively (1-2 analyses per palm).

Recorded from 1991 to 1991 in Trial 0.211, planted in 1986 in Kluang.

C12:0 lauric acid.

C14:0 myristic acid.

C16:0 palmitic acid.

C16:1 palmitoleic acid.

C18:0 stearic acid.

C18:1 oleic acid.

C18:2 linoleic acid.

C18:3 linolenic acid.

C20:0 arachidic acid.

TABLE 5b. MEAN SQUARES, VARIANCE COMPONENTS AND HERITABILITY ESTIMATES OF NCM1 ANALYSIS FOR FATTY ACID COMPONENTS, IODINE VALUE AND CAROTENE CONTENT

Source	d f	C12:0	C14:0	C16:0	C16:1	C18:0	C18:1	C18:2	C18:3	C20:0	I.V.	Carotene
country (C)	3	0.003	0.10*	155.50**	1.48*	1.92*	754.31**	127.00**	0.50	0.01	443.22*	7.00**
Progeny/Country (P/C)	81	0.002		12.48	0.41	0.49	36.81	15.72	0.32	0.04	96.02	1.22*
Palms (W)	399	0.003	0.02	13.11	0.46	0.49	36.14	13.69	0.30	0.04	85.42	1.21*
σ^2_c		0.00001 (0.35)	0.001 (3.00)	1.25 (8.74)	0.01 (2.02)	0.01 (2.53)	6.25 (14.77)	0.97 (6.45)	0.001 (0.48)	0 (0)	3.01 (3.34)	50663 (4.02)
$\sigma^2_{p/c}$		0 (0)	0.0004 (1.90)	0 (0)	0 (0)	0.0002 (0.03)	0.12 (0.28)	0.36 (2.41)	0.004 (1.38)	0 (0)	1.89 (2.10)	1060.35 (0.08)
σ^2_w		0.003 (99.65)	0.02 (95.09)	13.11 (91.26)	0.46 (97.98)	0.49 (97.44)	36.14 (84.95)	13.69 (91.14)	0.30 (98.15)	0.04 (100.00)	85.42 (94.58)	1209265 (95.90)
h^2_c		1.38	12.01	34.94	8.08	10.11	59.08	25.82	1.90	0	13.34	16.07

Notes:

*, ** Significant at $P \leq 0.05$ and $P \leq 0.01$ respectively, otherwise non-significant.

() * Variance component as percentage of phenotypic variance.

Negative estimate for which the most reasonable value is zero.

Denotes ms value $\times 10^6$.

Recorded from 1991-1997 in Trial 0.211, planted in 1986 in Kluang.

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