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Full Length Research Paper

Chemical composition of Chinese palm fruit and chemical properties of the oil extracts

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The proximate composition, mineral concentration of fleshy mesocarp, palm meat (PM) and palm kernel (PK) of oil palm fruit (*Elaeis guineensis* S.L.*Dura*) produced in Hainan, China were investigated. The fatty acid composition, chemical properties and minor constituents of palm oil (PO) and palm kernel oil (PKO) were also studied. The crude fat of PM and PK were 68.09±3.57% and 49.36±2.61%, respectively. The PM and PK were found to be good sources of minerals. The acid value (AV) and free fatty acid (FFA) of PO extracted from fresh PM were much higher. If the fresh PM were heated at 100ºC for 30 min, the AV and % FFA could be reduced to 4.62±0.04 mgKOH/g and 2.72±0.002%, respectively. The major fatty acid of PO was palmitic acid 39.93±1.66% and that of PKO was lauric acid 48.01±0.69%. Tocopherol isomer (α-, (β+γ)- and δ-) contents in PO were 68.8±1.84, 22.8±0.54 and 11.8±0.12 mg/kg, respectively. The β-carotene content in PO was 901.5±11.95 mg/kg. The content of sterols in PO and PKO were 880.0±5.23 and 858.0±4.37 mg/kg, respectively. PO and PKO exhibited good chemical properties and could be used as edible oils and for industrial applications. There are almost no data about Chinese palm fruit now and this study systematically researched on it, which can provide useful information for Chinese oil palm industry.

Key words: Chemical composition, palm fruit, palm oil, palm kernel oil, chemical properties.

INTRODUCTION

Oil palm is a monocotyledon belonging to the genus *Elaeis*. It is a perennial plant and has the highest production per hectare among oil crops, yielding an average of 3.7 tons of oil per hectare per year in Malaysia (Sundram et al., 2003). The yield of oil palm per hectare is seven to eight times of peanut's and 9 to 10 times of soybean's yield, hence, it has the reputation of "the world oil king".

Currently, most of the world's production of palm oil (PO) comes from Southeast Asia, in particular Indonesia and Malaysia. China is the largest PO importing country in the world and all of the POs consumed in China rely on importing. The importing quantity of PO was over 5 million tons from 2006 and the consumption quantity was up to 25% among the total plant oil consumption value in China.

The crop produces two types of oil. The fleshy mesocarp, palm meat (PM) produces PO and the palm kernel (PK) which produces palm kernel oil (PKO) (Prada et al., 2011). PO is unique in that it contains 50% saturated fatty acids, 40% unsaturated fatty acids and 10% polyunsaturated fatty acids (Wattanapenpaiboon and Wahlqvist, 2003). The properties and fatty acid composition of PKO and coconut oil (CNO) are very similar, the two oils are called lauric oil because lauric acid among the fatty acids is the major component accounting for about 50%, while no other major oil contains more than about 1% (butter fat contains 3%) (Pantzaris and Ahmad, 2002). Palm fruit also contains components that can provide the oil with nutritional and

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Abbreviations: PM, Palm meat; **PK,** palm kernel; **PO,** palm oil; **PKO,** palm kernel oil; **AV,** acid value **FFA,** free fatty acid

health beneficial properties. These phytonutrients include vitamin E, carotenoids, squalene, sterols, phospholipids and glycolipids (Sambanthamurthi et al., 2000). Crude palm oil (CPO) contains high quantities of vitamin E and is one of the major sources of tocopherols and tocotrienols in the range of 600 to 1000 ppm (Sanagi et al., 2005).

The quality of PO is determined by different factors and free fatty acid (FFA) is one of the most frequently used quality indices during production, storage and marketing; the price of PO in the market is dictated by FFA content (Saad et al., 2007). Other parameters that dictate the price of a palm oil product include moisture, impurities and iodine value (IV). Many researchers have reported FFA content (Saad et al., 2007) and IV (Haryati et al., 1997) of PO, but most of the material of PO were refined PO, not extracted from fresh PM. The fatty acid components of PO (Sundram et al., 2003) and PKO (Kritchevsky et al., 2000), the tocopherol and carotene content of PO (Ping et al., 2002) were also studied.

There are few reports on the proximate compositions, mineral concentrations of PM and PK, most of the data about PO and PKO is from Indonesia, Malaysia, etc. There are almost no data about Chinese oil palm. So, the present study reports the proximate composition, mineral concentration of PM and PK of oil palm fruit (*Elaeis guineensis*- S.L.*Dura*) produced in Hainan, China. This study also reports the fatty acid composition, chemical properties and minor constituents of PO and PKO. We also found the influencing factor of acid value (AV) and FFA content when extracting PO.

EXPERIMENTAL PROCEDURES

Materials

Mature oil palm fruits were harvested from the oil palm (*Elaeis guineensis*-S.L.*Dura*) in the experimental farm in Wenchang, Hainan, China. Six samples with each sample from different tree planted for 20 years were collected from the center (two samples) and the four corners of the farm (one sample).

β-carotene, α-tocopherol (purity 95%), β-tocopherol (purity 95%), δ-tocopherol (purity 95%) and γ-tocopherol (purity 95%) were purchased from Sigma Chemical Co. (St. Louis, MO, USA). Other reagents were of analytical or high-performance liquid chromatography (HPLC) grade.

Sample preparation and oil extraction

After harvesting, each sample was processed within one day. PM was pared and the flinty shell was broken; the kernel was removed, the meat and the kernel were then ground separately. Each ground sample was extracted 2.0 h by stirring with hexane (the ratio of material and the solvent was 1:5) for three times at ambient temperature (28 °C) and filtering through Whatman No.1 filter paper, the solvent of the combined extract was evaporated under reduced pressure (-0.07 to -0.08 MPa) using a rotary vacuum-evaporator at 50 °C, while the oil was collected and stored at -20 ºC in darkness (Ping et al., 2002).

Analysis of PM and PK

The recommended methods of the Association of Official Analytical Chemists (AOAC, 1984) were adopted to determine the levels of moisture and ash. Moisture content was determined by heating 2.0 to 3.0g of each fresh sample to a constant weight in a crucible placed in an oven (PYX-DHG-9101-25A, KELI Experiment Instrument Co., Ltd., Guangdong, China), maintained at 105°C for 3.5 h. Ash was determined by the incineration of 1.0 g samples placed in a muffle furnace (SX-4-10, HuYue Science Experiment Instrument Company, Shanghai, China), maintained at 550°C for 5 h. Crude protein (% total nitrogen × 5.30) (Onyeike and Acheru, 2002) was determined by Distillation and Titration Unit (UDK 152, Goodwill (HK) Technology Co., Ltd.), using 0.8 g dried samples for PM and 0.4g dried samples for PK. Crude fat was obtained by exhaustively extracting 3.0g of each dried sample in a solvent extractor (SER 148, Goodwill (HK) Technology Co., Ltd.) using ether as the extractant. The minerals, potassium, calcium, sodium, magnesium, copper, iron, zinc and manganese were determined by atomic absorption spectrophotometry (AA-6300, Shimadzu Corporation, Kyoto, Japan) with specific cathode lamps. The instrument was calibrated after every 10 samples by use of standard solutions containing known amounts of the eight minerals. 1.0 g dried samples, in triplicate, were dry-ashed in a muffle furnace at 550 °C for 5 h until a white residue of constant weight was obtained. The minerals were extracted from ash by adding 2.0 mL of 50.0% HCl, and this was transferred quantitatively to a 25 mL volumetric flask, the solution was used to determine the contents of sodium, copper, iron, zinc and manganese. Then the solution was diluted 50 times with deionised water, stored in 50 mL volumetric flask and potassium, calcium and magnesium were determined using this solution. All volumetric flasks were rinsed in dilute hydrochloric acid (0.10 M HCl) to stop microbial action which may affect the concentrations of the anions and cations in the samples. The results are expressed in mg/100 g sample. Phosphate (PO_4^{3-}) was determined by the molybdenum blue method using stannous chloride as the reducing agent; the absorbance was measured at 700 nm (Allen et al., 1974). Each sample was determined for three times.

Analysis of chemical properties of PO and PKO

The AV, %FFA, saponification value (SV), IV and peroxide value (PV) were determined by the method of AOCS Cd 3d-63 (1993), AOCS Ab 5-49 (1993), AOCS Cd 3b-76 (1993), AOCS Cd 1b-87 (1996) and AOCS Cd 8b-90 (1996). Unsaponifiable matter was obtained by the procedure of AOCS (1973). Each sample was determined for three times.

Analysis of fatty acid composition of PO and PKO by gas chromatography-mass spectrophotometry (GC-MS)

Fatty acids were transformed to their methyl esters (FAME), following the standard method ISO 5509: 2000, IDT. GC analyses were performed on HP 5890 instrument (Agilent Technologies, Palo Alto, CA, USA) equipped with a flame ionization detector (FID) and a fused silica capillary column HP-5 (30 m × 0.32 mm i.d. × 0.25 µm film thickness). Temperature was programmed from 150 to 280 °C with the increase rate of 3 °C/min. Both the temperatures of detector and injector were 250 °C. Nitrogen was used as a carrier gas at 1.5 mL/min. 1 µL of the fully saponified oil was injected in split mode using a 1/50 split ratio. FAME was positively identified by matching their retention time data and mass spectra with those of the standards. The fatty acid composition was calculated from the total identified fatty acid area. Each sample was determined for three times.

Table 1. Proximate composition (%) of PM and PK produced in China[a].

Constituent	PM	PK
Moisture content	29.32±1.02	21.39±0.64
Ash[b]	1.11±0.01	1.77±0.10
Crude protein[b]	2.03±0.10	7.59±0.80
Crude fat[b]	68.09±3.57	49.36±2.61

[a]Values are means±standard deviations of six samples with each triplicate determinations. PM, palm meat; PK, palm kernel. [b]Based on dry matter.

Table 2. Mineral concentrations (mg/100g) of PM and PK (based on dry matter) produced in China[a].

Mineral	Concentration	
	PM	PK
Potassium	326.40±8.19[b]	509.79±18.87[c]
Calcium	203.48±8.12[b]	210.10±8.42[b]
Sodium	21. 94±0.59[b]	21.42±1.85[b]
Magnesium	85.27±0.49[b]	156.42±1.24[c]
Iron	3.19±0.11[b]	4.59±0.10[c]
Copper	1.30±0.02[b]	1.61±0.02 [b]
Zinc	0.55±0.01[b]	2.28±0.12[c]
Manganese	0.14±0.01[b]	2.62±0.11[c]
Phosphate	30±0.01[b]	400±0.07[c]

[a]Values are means±standard deviations of six samples with each triplicate determinations. Values in the same row sharing the same letters are not significantly different at the 5% level. PM, palm meat; PK, palm kernel.

Determination of tocopherol content by HPLC

Vitamin E content was analysed by an HPLC system (HP1100 Series, Santa, Clara, CA) equipped with a Kromaxil C18 column (4.6 mm × 250 mm × 5 µm, Hewlett-Packard, Palo Alto, CA) and a UV-vis detector (Hewlett-Packard, Palo Alto, CA) at 215 nm. The solvent used was methanol at a flow rate of 1.0 mL/min. For sample analysis, 1.0 g oil was saponified according to AOAC method (1993), the saponified oil was transferred quantitatively to a 10 mL volumetric flask and 20 µL of the sample was applied on HPLC. Calibrations of standard curves were done by using standard α-tocopherol, (β+γ)-tocopherol and δ-tocopherol solutions in the range of 10 to 100 µg/mL. Each sample was determined for three times.

Determination of β-carotene content by HPLC

β-Carotene content was analysed by an HPLC system (HP1100 Series, Santa, Clara, CA) equipped with a Kromaxil C18 column (4.6 mm × 250 mm × 5 µm, Hewlett-Packard, Palo Alto, CA) and a UV-vis detector (Hewlett-Packard, Palo Alto, CA). The solvent system methanol/tetrahydrofuran in a ratio of 90:10 (vol/vol) at a flow rate of 1.0 mL/min was used. Peaks were detected at 448 nm. Calibrations of standard curves were done by using standard β-carotene solutions in the range of 10-100 µg/mL. For sample analysis, 10 g oil was extracted repeatedly using petroleum ether/acetone (80:20, vol/vol) until the upper layer was colorless, the extracting solution was combined and rotarily-evaporated (RE-52; Yarong Biochemical Instrument Plant, Shanghai, China). The evaporated sample was dissolved using petroleum ether and volume made to 100 mL. The sample was filtered with 0.45 µm microfiltration membrane and the 20 µL of the filtrate was applied on HPLC. Each sample was determined for three times.

Determination of plant sterol content by GC-MS

Plant sterols content were detected by GC-MS on HP6890GC/5973iMS (Agilent Technologies, Palo Alto, CA, USA). GC conditions: A fused silica capillary column AB-5MS (30 m × 0.25 mm × 0.25 µm) was used and the temperature was programmed from 100 to 280 °C with the increase rate of 15 °C/min. The temperature of injector was 280 °C. Helium was used as a carrier gas at 1.2 mL/min. 2.0 g sample was diluted to 10 mL using hexane in a 10 volumetric flask and 0.2 µL of the sample was injected in split mode using a 1/10 split ratio. MS conditions: ionization type, EI; electric power, 70 eV; transmission line temperature, 250 °C; source block temperature, 230 °C; quadrupole rods temperature, 150 °C; and mass scan range, 29-550 m/z. Cholesterol was used as the standard and the treatment was as same as the sample. Each sample was determined three times.

Statistical analysis

The data were statistically analyzed using SPSS 10.3 software package (SPSS, Shanghai, China) and reported as mean ± SD. The differences among the experimental groups were identified by one-way analysis of variance (ANOVA) using Duncan's multiple range test. The statistical significance was accepted at $P < 0.05$.

RESULTS AND DISCUSSION

The proximate compositions of PM and PK

The proximate compositions of PM and PK analyzed are presented in Table 1. The ash concentration of PM and PK were 1.11±0.01% and 1.77±0.10%, respectively. The dry material and crude protein contents of PK were significantly higher than that of PM. The crude protein was 2.03±0.10% of PM and 7.59±0.80% of PK based on dry weight. The moisture and crude fat contents of PM were higher than that of PK. PM is easily spoiled after harvesting since higher moisture content could lead to food spoilage through increased microbial action (Onyeike et al., 1995). The crude fat concentration was 68.09±3.57% in PM and 49.36±2.61% in PK. These values indicate that fat is the main constituent of PM and PK and oil palm is a good oil crop.

Mineral concentrations of PM and PK

Mineral concentrations of PM and PK are shown in Table 2. The mineral concentrations in PK were higher than in PM on the whole. Values for calcium, sodium, iron and copper concentrations in PM and PK were not different at the 5% level, but the concentrations of potassium, magnesium, zinc, manganese and phosphate were all significantly higher in PK than in PM. Potassium was

Table 3. Chemical properties of PO and PKO produced in Hainan, China[a].

Parameter	PO	PKO
AV (mg KOH/g)	51.65±2.16 c	1.97±0.05 b
SV (mg KOH/g)	199.82±4.84 b	239.43±0.85 c
IV (g/100 g)	54.85±0.49 c	20.15±0.21 b
% FFA	24.30±0.99 c	0.70±0.02 b
PV (meq/kg)	3.22±0.08 c	1.48±0.05 b
Unsaponifiable matter (%)	0.36±0.021 b	0.22±0.01 b

The FFA content was expressed as a percentage based on palmitic acid for PO and lauric acid for PKO. [a]Values are means±standard deviations of six samples with each triplicate determinations. Values in the same row sharing the same letters are not significantly different at the 5% level. AV, Acid value FFA, free fatty acid; SV, saponification value; IV, iodine value; PV, peroxide value; PO, palm oil; PKO, palm kernel oil.

highest both in PK and in PM, the content was 509.79±18.87 mg/100g and 326.40±8.19 mg/100 g, respectively. Zinc and manganese contents were 2.28±0.12 mg/100g and 2.62±0.11 mg/100g in PK, respectively and very low, 0.55±0.01 mg/100g and 0.14±0.01 mg/100g in PM, respectively. Magnesium content of PK, 156.42±1.24 mg/100g was about two times of that in PM, 85.27±0.49 mg/100g and phosphate content was more than 10 times in PK than that in PM, which were 400±0.07 mg/100g and 30±0.01 mg/100 g in PK and PM, respectively. The contents of iron, copper, zinc, potassium, sodium and phosphate in PK are higher than that Onyeike and Acheru reported (2002). PM and PK are in general, good sources of minerals such as potassium, calcium, phosphate, sodium, iron and zinc, and are therefore recommended for use in the preparation of diets of individuals with low levels of these cations and anions.

Chemical characteristics of PO and PKO

The results of some chemical characteristics of PO and PKO analyzed are presented in Table 3. The AV was higher in PO 51.65±2.16 mg KOH/g than in PKO 1.97±0.05 mg KOH/g. AV is a measure of total acidity of the lipid, involving contributions from all the constituent free fatty acids. The higher value of PO may be due to the fresh PM which was not destroyed during the heating process to make the lipase inactive before extraction. If the fresh PM was heated at 100 °C for 30 min, the AV of extracted PO could be reduced to 4.62±0.04 mgKOH/g. The % FFA was much higher in PO, 24.30±0.99% than in PKO, 0.70±0.02%. This may be due to the higher content of unsaturated fatty acid and higher AV of PO. The nutritional value of a fat is partly affected by the amount of free fatty acids which develop during fruit storage and processing, indicating degradation. Low levels of % FFA in oils indicate that the oils are good edible oils that may store for a long time without spoilage via oxidative rancidity (Onyeike and Acheru, 2002). The % FFA could be reduced to 2.72±0.002% when the fresh PM was heated at 100 °C for 30 min before extraction. The PV was 3.22±0.08 meq/kg in PO and in PKO, 1.48±0.05 meq/kg. It is a common measurement of lipid oxidation. Ojeh (1981) reported that oils with high PV are unstable and easily become rancid (having a disagreeable odour) (Ojeh, 1981). This may be due to the initial oxidation products that accumulate for example, hydroperoxides, which may subsequently break down to form lower-molecular weight compounds such as alcohols, aldehydes, free fatty acids and ketones, leading to autoxidative rancidity (Van et al., 1994), but Idris et al. (1992) reported that PV might not serve as a true indicator of the actual state of oxidative rancidity of an oil or fat. The relatively low iodine numbers in PKO, 20.15±0.21 g/100g, than in PO, 54.85±0.49 g/100g may be indicative of the presence of few unsaturated bonds in PKO and hence low susceptibility to oxidative rancidity. It is therefore reasonable to conclude that, PO with higher IV would undoubtedly contain more unsaturated bonds. The iodine numbers of PO is similar to that reported by Maclellan, 52.9 g/100 g (Maclellan, 1983) and that of PKO are in the range of that reported, 13 to 23 g/100 g by Young (1983). SV was significantly different between PO and PKO. Based on the fact that there is an inverse relationship between SV and weight of fatty acids in the oil, it can be inferred that the PKO contains a great number of fatty acids of low molecular weight. The SV of PO, 199.82±4.84 mgKOH/g is close to 196 mgKOH/g (Manorama and Rukmini, 1991) and that of PKO, 239.43±0.85 is in the range of 230 to 254 mgKOH/g (Lee and Akho, 1998).

Fatty acids composition of PO and PKO

The fatty acids content of PO and PKO are shown in Table 4. The major fatty acids of PO were palmitic acid (C16:0) 39.93±1.66%, oleic acid (C18:1) 35.99±0.95% and linoleic acid (C18:2) 14.53±0.84%. The main fatty acids of PKO were lauric acid (C12:0) 48.01±0.69%,

Table 4. Fatty acids content (%) of PO and PKO produced in Hainan, China[a].

Component	PO	Literature value (Sundram et al., 2003)	PKO	Literature value (Pantzaris and Ahmad, 2002; Alias and Tan, 2005)
C8:0	-	-	4.24±0.12	4.2 to 4.4
C10:0	-	-	3.56±0.14	3.5 to 6.0
C12:0	0.08±0.001	0 to 1	48.01±0.69	44.2 to 48.7
C14:0	1.15±0.04	0.9 to 1.5	16.59±0.32	14.4 to 15.6
C16:1	0.21±0.01	-	0.015±0.007	-
C16:0	39.93±1.66	39.2 to 45.8	7.80±0.21	7.5 to 8.2
C18:2	14.53±0.84	8.7 to 12.5	2.56±0.09	2.5 to 2.9
C18:1	35.99±0.95	37.4 to 44.1	14.80±0.50	14.8 to 16.9
C18:0	4.04±0.23	3.7 to 5.1	1.96±0.031	1.8 to 2.5
C20:1	0.19±0	-	0.13±0.005	-
C20:0	0.32±0.02	-	0.11±0.01	-
C22:0	0.055±0.002	-	0.025±0.001	-
C24:0	0.10±0.001	-	0.055±0.007	-

[a]Values are means±standard deviations of six samples with each triplicate determinations. PO, Palm oil; PKO, palm kernel oil.

Table 5. Minor constituents (mg/kg) of PO and PKO produced in Hainan, China[a].

Component	PO	Literature value	PKO
α-Tocopherol	68.8±1.84	140 to 224	-
(β+γ)- Tocopherol	22.8±0.54	-	-
δ- Tocopherol	11.8±0.12	-	-
β-Carotene	901.5±11.95	272 to 380.8	-
Sterols	880.0±5.23	~300	858.0±4.37

[a] Values are means±standard deviations of six samples with each triplicate determinations. PO, Palm oil; PKO, palm kernel oil.

myristic acid (C14:0) 16.59±0.32% and oleic acid (C18:1) 14.80±0.50%. The fatty acid composition indicates that PO contains more unsaturated fatty acids than PKO and which has lower unsaturation degree. This agrees with their iodine numbers. PKO has lower percentage of unsaturated fatty acids with reported range of values from 17.4% (Pantzaris and Ahmad, 2002) to 19.8% (Alias and Tan, 2005). Due to lower unsaturation, PKO may be resistant to oxidative rancidity. Most of the fatty acids of PKO are short-chain and medium-chain fatty acids; this is consistent with its SV.

PO is used widely in many food products which include margarines, shortenings, cooking oils, confectionery fats, vanaspati, etc. (Mamat et al., 2005). It can be used without undergoing the hydrogenation process, which converts *cis*-double bonds to the *trans*-configuration (Wattanapenpaiboon and Wahlqvist, 2003). Due to its proper characteristics, PKO is used widely in coatings for confectionery and baked products, in the production of margarine, soap, detergents, foam boasters, lubricants, cosmetics and as medium-chain glycerides for medical uses (Pantzaris and Ahmad, 2002; Onyeike and Acheru, 2002).

The minor constituents of PO and PKO

The minor constituents of PO and PKO are shown in Table 5. The major tocopherol in crude PO were α-tocopherol (66.5%), (β+γ)-tocopherol (22.1%) and δ-tocopherol (11.4%), and their contents were 68.8±1.84, 22.8±0.54 and 11.8±0.12 mg/kg, respectively. The α-tocopherol content was slightly lower than that reported by Sundram et al. (2003). It may be due to part of tocopherol decomposition during the extraction process or the different oil palm variety. They did not report β-, γ-, and δ-tocopherol contents. Besides playing a beneficial biological role as radical quenchers *in vivo*, tocopherols are also antioxidants, which contribute to the stability of PO. Tocopherols can interrupt lipid oxidation by inhibiting hydroperoxide formation in the chain-propagation step, or the decomposition process by inhibiting aldehyde formation (Sundram et al., 2003). PO has a rich orange-red color due to its high content of carotene, the major

carotenoids in PO is β-carotene (Yap et al., 1997). The β-carotene content in PO was 901.5±11.95 mg/kg and much higher than that reported by Sundram et al. (2003). Carotenoids are the precursors of vitamin A, with β-carotene having the highest provitamin A activity. PO has 15 times more retinol equivalents (1 retinol equivalent = 6 µg β-carotene) than carrot and 300 times more than tomato. Sterols are tetracyclic compounds with generally 27, 28 or 29 carbon atoms. They make up a sizeable portion of the unsaponifiable matter in oil. The content of sterols in PO was 880.0±5.23 mg/kg and much higher than that reported by Sundram et al. (2003). Most of the sterols are relatively inert and do not appear to contribute to any important property to PO, such as antioxidation, preventing of cardiovascular disease, etc. (Sundram et al., 2003). The total sterol content in PKO was 858.0±4.37 mg/kg.

Conclusion

Based on the fact that the systematic investigation of Chinese oil palm is only just started, there is little information of Chinese oil palm. In this paper, the components of the fruit and the chemical composition of the oil extracts of Chinese oil palm (*E. guineensis*-S.L.*Dura*) produced in Hainan, China were studied in detail. PM and PK were found to be good sources of crude PO, PKO and minerals. We also found the influencing factor of AV and % FFA. The AV and % FFA were very high in PO extracted from fresh PM but if the fresh PM was heated at 100°C for 30 min, the AV and % FFA of PO could be largely reduced. PO was rich in minor constituents such as tocopherols, β-carotene and plant sterols. This study can provide useful information for the development of Chinese oil palm industry.

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