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Fatty Acids and Tocopherols Contents of Cameroon Oil Palm from Three Varieties of *Elaeis guinensis jack*

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Abstract: This study aimed at evaluating fatty acids and tocopherol contents of oil palm extracted from fruits of three varieties of *Elaeis guinensis jacq* namely *Tenera, Dura* and *Pisifera*. Oil was extracted from mesocarp of cooked palm nuts using continuous device of soxhlet. Fatty acids contents were determined by gas chromatography of methyl esters and tocopherols were measured through High Pressure Liquid Chromatography (HPLC). Results showed that unsaturated fatty acids contents was more than 52% in crude oils from the first cycle palm oil and decrease significantly (P< 0, 05) in *Dura* second cycle oil. Changes occurred in fatty acids profile of *Tenera* and *Dura*. Ratio of polyunsaturated fatty acids over saturated fatty acids was higher in *Pisifera* (0.40). Total tocopherol contents of palm oil were more than 738 mg/Kg but decreased when passing from first to second cycle of the different varieties. Gamma-tocopherol was the most abundant isomer.

Keywords: Palm Oil, Selection, Fatty Acids, Tocopherol

1. Introduction

Palm oil extracted from mesocarp of *Elaies guineensis* jacq is a food product frequently consumed in many parts of Africa, Asia and Eastern Europe. It is the most widely used vegetable oil in the world which serves as raw material for both food and non-food products [1]. In 2011 oil palm cultivation all over the world produced over 53 million metric tons of palm oil on 16 million hectares [2]. Currently, palm oil is the most produced vegetable oil in the world. The produced volume has increased from 15.2 million tons in 1995 to 54 million tons in 2011[3]. In Cameroon, palm oil meets 80% of total edible oil needs and it is estimated that 30% of crude palm oil production is provided by none industrial oil mills [4]

Besides various stages of selection, improvement of palm oil yield went through many steps. In 1960, a process of reciprocal recurrent selection of palm tree was introduced. *Tenera, Dura and Pisifera* varieties were included in this process. A cycle of selection proceeds by crossing seedlings from different origins and auto fecundation of hybrids [5]. This selection lays on the principle that oil yield and quality of fruits are controlled by many quantitative factors whose effects are additive. Hybrids obtained at the end of this process are more productive thanks to a good combination of factors [6]. Some improvement factors obtained from the sixties include reduction in height, appearance of disease tolerant strains and increase of oil yield [7]. As a matter of fact, oil yields shifted from 2t/ha to 3.3t/ha in the first cycle [8, 9]. Second cycle material included best crossings with a yield 15% higher as compared to that of cycle one [10]. It appears necessary to investigate on possible chemical changes in oils resulting from different selection processes. Palm oil plays an important dietary role in Cameroon and many. It is therefore important to evaluate nutritional quality of oil produced by the three different varieties resulting from cycle one and cycle two reciprocal recurrent selections of palm trees in Cameroon. So, In this work, we determine and compare fatty acids and tocopherol contents of oil produced by *Tenera, Dura and Pisifera* varieties of *Elaies guinensis jack* from cycle one and cycle two reciprocal recurrent selections of this specie.

2. Material and Methods

2.1. Oil Extracts

Fruits from *Tenera*, *Dura* and *Pisifera* strains were used in these experiments. They belong to the first and second cycle of reciprocal recurrent selection and were harvested in an experimental farm of the National Research Centre on Palm Oil held by the Institute of Agronomic Research for Development (IRAD) of Dibamba (sea level, 4°7'60" North and 10°6'0" East) (Republic of Cameroon). Fruits were brought down in dry weather at midday, vapour cooked for 35 minutes and pulped. Pulps were then crushed and oil extracted during 5 hours in hexane (Merck) using Soxhlet continuous extractor (at 65- 71°C). Solvent was eliminated by vacuum evaporation at 40°C. After cooling in a desiccator, oil was transferred in small dark bottles and conserved away from light until analysis.

2.2. Fatty Acids and Tocopherols Composition

Analysis of methyl esters of fatty acids were carried out using a gaseous phase chromatograph AGILENT 6890 HP, equipped with a column SUPELCOWAX, 30 m length, 0.32 mm internal diameter and a film of 0.25 µm. Separations were performed in the following conditions: Helium was used as gas carrier with a flow rate of 1mL/mn at 250°C. Flame ionization detector was at 270°C. Flow rate was 35 ml/mn and 350 ml/mn respectively for Hydrogen and air. Time required and the volume injected were respectively 20 mn injected and 1µL. Temperature was programmed as follows: 185°C for 2 mn followed by an increase from 4°C/mn up to 225°C which remained until the end of required time (20mn). Identification of peaks was done on the basis of fatty acids profiles as well known in olive oil, palm oil and sunflower oil that were injected under the same operating conditions.

Tocopherols analysis was performed by HPLC in normal phase. The column used was Hypersil Si 60.5µm; 4.6 x 250 mm (Phenomenex, France). The solvent used under isocratic conditions was a mixture of hexane and isopropanol.

Statistical analysis: Each value is presented as mean ± standard deviation for three replicates. Statistical analyses were carried out using Statistica version 6.0 sofware. Values were compared using Duncan test. Statistical significance was attained when a p-value was less than 0.05.

3. Results and Discussion

Unsaturated Fatty Acids (UFA) contents found in first cycle palm oil were greater than 52% and there were no significant difference (P> 0.05) between *Tenera,* and *Pisifera* varieties whatever be the selection cycle (Tables 1 and 2). UFA contents of *Dura* palm oil decreased significantly from 52.82% to 47.45% when passing from first to second selection cycle. The ratio of polyunsaturated (PUFA) to saturated fatty acids (SFA) was almost twice higher in *Pisifera* (0.40) than in the two other varieties. Significant differences in fatty acids contents between first and second selection cycle were observed in *Dura* and *Tenera* palm oil. When passing from first to second reciprocal recurrent selection cycle. There was a significant increase in contents of myristic acid (C14: 0) palmitic acid (C16: 0) and linoleic acid (C18: 2) for *Dura* variety. Stearic acid (C18: 0) and oleic acid (C18: 1) contents decreased at the same time. However, the oleic acid, linolenic acid and arachidonic acid decrease significantly for *Tenera* variety (table 3). Palmitoleic acid (C16: 1) appears in both cycles of *Pisifera* and was no detected in *Tenera* and *Dura* first cycle palm oil.

Table 1. *Fatty acids content of first cycle oil palm.*

	First cycle oil palm varieties		
Fatty acids (%)	***Tenera***	***Dura***	***Pisifera***
C14:0	0.42±0.65	0.64±0.51	0.51±0.01
C16:0	37.13±0.33	39.74±1.38	34.12±0.10
C16:1	ND	ND	0.10±0.01
C18:0	5.88±0.26	6.24±0.20	8.75±0.08
C18:1	45.10±0.50	42.12±1.12	37.76±0.09
C18:2	10.23±0.02	10.13±0.17	17.35±0.27
C18:3	0.33±0.03	0.35±0.021	0.39±0.04
C20:0	0.68±0.04	0.56±0.07	0.83±0.06
C20:1	0.21±0.03	0.22±0.02	0.19±0.02
UFA	55.87	52.82	55.69
PUFA/SFA	0.24	0.22	0.40

UFA: Unsaturated Fatty Acids
PUFA/SFA: Polyunsaturated fatty acid/ Saturated fatty acid
ND: Non Detected

Table 2. *Fatty acids content of second cycle oil palm.*

	Second cycle oil palm varieties		
Fatty acids (%)	***Tenera***	***Dura***	***Pisifera***
C14:0	0.41±0.02	1.23±0.03	0.54±0.02
C16:0	37.74±0.30	44.27±0.56	34.41±0.07
C16:1	0.09±0.01	0.10±0.01	0.11±0.01
C18:0	6.43±0.08	5.46±.01	8.84±0.06
C18:1	44.62±0.72	35.91±1.22	37.76±0.06
C18:2	9.83±0.19	11.32±0.15	17.08±0.05
C18:3	0.31±0.02	0.36±0.01	0.35±0.04
C20:0	0.58±0.01	0.53±0.01	0.76±0.02
C20:1	0.20±0.01	0.16±0.02	0.18±0.01
UFA	55.05	47.85	55.48
PUFA/SFA	0.22	0.23	0.39

UFA: Unsaturated Fatty Acids
PUFA/SFA: Polunsaturated fatty acid/ Saturated fatty acids

Pisifera total tocopherol contents were higher than *Tenara*'s and *Dura*'s. Individual tocopherol isomers (α, β, γ and δ) content generally decreases from the first to the second reciprocal recurrent selection cycle (table 4).

Mean value of the analyzed crude palm oils was 53.79% and 46.21% respectively for unsaturated and saturated fatty acids. Other authors also found that oil palm is richer in UFA than in saturated fatty acids [11, 12]. According to FAO/WHO standards' unsaturated fraction of palm oil must be higher than 50% [13]. Polyunsaturated fatty acids contents is higher in *Pisifera* variety (more than 17%) (Table 2). It can therefore been use as a potential source of these essentials nutrients. Polyunsaturated fatty acids are essential for many functions in the body: they can lower risk of heart desease, stroke and myocardial ischaemia. They also provide nutrients to help develop and maintain body cells. Oils rich in polyunsaturated fats also contribute vitamin E (a cell antioxidant vitamin) to the diet [14]. Increasing levels of saturated fatty acids was observed in *Dura* second cycle oil as a consequence of increase in palmitic acid content. Palmitoleic acid (C16: 1) was either absent or appeared in very small quantities only in the second cycle oil of *Tenera*and *Dura*. This low content may be due to a weak detection as was observed by Cochard and co-workers [9]. It has been shown that purified palmitoleic acid has lipid-lowering and anti-inflammatory benefits in open label, epidemiologic, and animal studies [2]. Significant difference in fatty acids levels between first and second cycle indicated that strain selection in affects fatty acids profile of Dura and Tenera varieties. First cycle of reciprocal recurrent selection was launched on a rather broad genetic basis while second cycle selection used intrafamilial autofecundation based on a narrow genetic pool [15, 16]. As a result, currently cultivated palm trees derived from a small gene pool [17]. Palm tree in industrial plantations of Cameroon are D*ura*/*Pisifera* hybrids coming from parents selected for their agronomic performance and characterized by the absence of consanguinity depression [18]. The rather long duration of a generation and type of pollinisation hamper genetic improvement of palm tree [19]. However, introduction of third cycle materials which implies evaluation of plants from 444 crossings [20] could reinforce genetic pool of oil palm. Total tocopherols levels display mean values similar to those of Nagendra and co-workers [12] but higher than those found in some wild oilseeds plants from Democratic Republic of Congo [21]. δ-tocopherol stands for less than 26% of total tocopherols (table 4) which is lower than the value of 36% found in Malaysia palm oil [22]. Gamma-tocopherol appears as the major isomer with an average content of 364.5 mg/Kg. Significant increase in tocopherol in second cycle oil would be due to increased synthesis from precursors such as squalene. It has been found that alpha-tocopherol mainly inhibits the production of new free radicals, while gamma-tocopherol traps and neutralizes the existing free radicals [23]. Thus, they might help to prevent or delay chronic diseases associated with reactive oxygen species molecules. This work shows that selection of oil palm tree resulted in some changes in chemical composition particularly in fatty acids and tocopherols.

Table 3. *Comparison between first and second cycle's oil palm.*

	Tenera		*Dura*		*Pisifera*	
Fattyacids (%)	**Cycle 1**	**Cycle 2**	**Cycle 1**	**Cycle 2**	**Cycle 1**	**Cycle 2**
C14:0	0.42±0.65a	0.41±0.02a	0.64±0.51b	1.23±0.03c	0.51±0.01d	0.54±0.02d
C16:0	37.13±0.33a	37.74±0.30a	39.74±1.38c	44.27±0.56d	34.12±0.10e	34.41±0.07e
C16:1	ND	0.09±0.01	ND	0.10±0.01	0.10±0.01b	0.11±0.01b
C18:0	5.88±0.26a	6.43±0.08b	6.24±0.20b	5.46±.01a	8.75±0.08c	8.84±0.06c
C18:1	45.10±0.50a	44.62±0.72b	42.12±1.12c	35.91±1.22d	37.76±0.09e	37.76±0.06e
C18:2	10.23±0.02a	9.83±0.19 b	10.13±0.17a	11.32±0.15c	17.35±0.27d	17.08±0.05d
C18:3	0.33±0.03a	0.31±0.02 a	0.35±0.02a	0.36±0.01a	0.39±0.04 a	0.35±0.04 a
C20:0	0.68±0.04a	0.58±0.01a	0.56±0.07a	0.53±0.01a	0.83±0.06b	0.76±0.02b
C20:1	0.21±0.03a	0.20±0.01 a	0.22±0.02a	0.16±0.02a	0.19±0.02 a	0.18±0.01a
UFA	55.87	55.05	52.82	47.85	55.69	55.48
PUFA/SFA	0.24	0.22	0.22	0.23	0.40	0.39

Line values with the same letter are not significatively different at 5% threshold.
UFA: Unsaturated Fatty Acids
PUFA/SFA: Polyinsaturated acids/Saturated fatty acids
ND: Non detected

Table 4. *Tocopherol isomers content of oil palm varieties.*

	Tenera		*Dura*		*Pisifera*	
Tocophérol (mg/Kg)	**Cycle 1**	**Cycle 2**	**Cycle 1**	**Cycle 2**	**Cycle 1**	**Cycle 2**
	211.33 (1.53)a	202.00 (2.00) b	185.33 (1.53)c	110.33 (1.53)d	195.67 (3.05)e	181.34 (1.53)f
	287.33 (2.52)a	240.34 (2.52)b	320.33 (1.15)c	206.35 (1.53)d	327.34 (1.53)e	315.67 (1.15)f
	355.66 (2.08)a	340.67 (0.58 b	345.00 (3.00)c	333.67 (1.15)d	414.67 (1.15)e	402.67 (1.53)f
	30.33 (1.53)a	18.00 (1.00)b	39.67 (1.53)c	87.66 (0.58)d	116.34 (1.53)e	98.34 (0.57)f
Totals	884.65	801.01	890.33	738.01	1054.02	998.02

Line values with the same letter are not significantly different at 5% threshold.
Values in brackets are ± standard deviations

4. Conclusion

The three varieties of *Elaeis guinensis* generally have high contents of unsatured fatty acids and gamma tocopherol which do not varie significatively according to selection cycle. Genetic selection so far applied on palm tree which has passed through two cycles of reciprocal recurrent selection has not significantly altered fatty acids balance but led to some significant changes in fatty acids and tocopherols profiles of oil palm.

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