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Effects of Palm Oil Consumption on Lipid Profile among Rural Ivorian Youth

Ake Ake Alexandre[1, 2], Monde Absalome[2], Edjeme-Ake Angèle[3, 4], Bahi Gnogbo Alexis[4], Djaman Allico Joseph[4] & Yapo Angoué Paul[1]

[1]Laboratory of Animal Physiology, Pharmacology and Pharmacopoeia, Department of Natural Sciences, Nangui Abrogoua University, Abidjan, Côte d'Ivoire

[2]Laboratory of Medical Biochemistry, Department of Medical Sciences, University of Félix Houphouet Boigny, Abidjan, Côte d'Ivoire

[3]Laboratory of Biochemistry, Department of Pharmaceutical and biological sciences, University of Félix Houphouet Boigny, Abidjan, Côte d'Ivoire

[4]Laboratory of Medical and Fundamental Biochemistry, Institut Pasteur, Abidjan, Côte d'Ivoire

Correspondence: Monde Absalome, Laboratory of Medical Biochemistry, Department of Medical Sciences, University of Félix Houphouet Boigny, Abidjan, Côte d'Ivoire. Tel: 225-0573-7067. E-mail: monde_abs@yahoo.fr

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Abstract

As palm oil has been qualified as atherogen, we have studied the impact of its consumption on changes of lipid and lipoprotein profiles of young Ivorian healthy subjects living in rural areas. It is a descriptive cross-sectional analytical study of about 120 Ivorian subjects aged 18 to 30 years, including 65 regular consumers of palm oil and 55 subjects consuming that oil periodically as control subjects. Serum concentrations of triglycerides, total cholesterol, HDL, LDL cholesterols and lipoprotein (a) were measured by enzyme conventional methods. The TC serum varied not significantly in both subjects' groups as the triglycerides and HDL-C did. In addition, 58.46% of palm oil consumers had hypoLDLemia. The serum concentration of lipoprotein (a) was not significantly elevated (p> 0.05) with consumers compared to controls: 33.85% versus 29.09%, p = 0.55. The percentage of subjects with normal serum concentrations is higher in all the studied parameters, with both that is the consumers and the controls, except LDL cholesterol, of which the percentage of subjects with a lower value is the highest (58.46% for consumers and 52.73% for controls). This study has shown that the consumption of palm oil did not alter the lipid and lipoprotein profile of the consumer, on the contrary, this consumption revealed a decrease in cholesterol levels with these subjects.

Keywords: HDL-Cholesterol, LDL-Cholesterol, palm oil, total cholesterol, triglycerides

1. Introduction

Palm oil, which is extracted from the *Elaeis guineensis* oil palm fruit, is the most widely consumed vegetable oil in the world since 2005 (Maatschappelijk Verantwoord Ondernemen [MVO], 2010). Apart from the phytonutrients called minors (vitamin E, carotenoids), it is composed of 50% unsaturated fatty acids and 50% saturated fatty acids, of which 44% palmitic acid (Edem, 2002), making it an oil Which is known to be pro-atherogenic and which would be responsible for cardiovascular complications (Aranceta & Perez-rodrigo, 2012; Assmann et al., 2014; Berger, 2014; Mancini et al., 2015). Almost 60% of all deaths in 2005 were related to these diseases, 80% of which occurred in developing countries (Kennedy, 2005; Organisation Mondiale pour la Santé [OMS], 2005). Several studies attribute the increased risk of cardiovascular disease to high serum cholesterol and its fractions (Keys, Anderson, & Grande, 1965; Kromhout et al., 1995; Odia, Ofori, & Maduka, 2015). This elevation of cholesterol seems to derive from edible fats and oils including palm oil, which is the most cited. Indeed, Tholstrup et al. (2011) reported that palm oil significantly increased LDL cholesterol (p <0.001) with 32 subjects compared with olive oil (Tholstrup, Hjerpsted & Raff, 2011). However, this oil is common in African and Asian food habits, mainly in rural areas where it is used in raw form (Ong & Goh, 2002; Oluba & Oyeneke, 2009; Onyeali, Onwuchekwa, Monago & Monanu, 2010; Oyewole & Amosu, 2010). We conducted a study with 2240 healthy subjects aged 18 years and more to verify the effect of palm oil consumption on anthropometric parameters (weight and height). It was found that the regular and normal consumption of palm oil by this population did not increase the weight of the subjects consuming it (Aké Aké et al., 2015). In addition, several studies have also shown the health benefits of palm oil consumption (Hornstra, 1988; Zhang, Ping, Chunrong, Shou, & Keyou, 1997; Sundram, Sambanthamurthi & Tan, 2003; Lecerf, 2013). Thus, Voon et al. (2011) found a non-significant difference ($p > 0.05$) between the impact of palm oil consumption and olive oil consumption on serum concentrations of LDL cholesterol (Voon, Ng, Lee, & Nesaretnam, 2011). In Côte d'Ivoire, we studied changes in lipid profile in farm chickens fed with different varieties of vegetable oils, including palm oil which had a cholesterol-lowering effect (Mondé et al., 2016). This study also indicated that consumption of this oil decreased serum levels of triglycerides and LDL cholesterol but increased HDL cholesterol. Another study carried out on 120 subjects suffering from ischemic heart disease reported no disturbance of lipid and lipoprotein parameters with these subjects who consumed palm oil after four weeks (Mondé et al., 2017). Several other works of our team on the benefits of palm oil have been carried out for the most part in hypertensive, obese, diabetic, cancerous subjects or suffering from ischemic cardiopathies (Djohan et al., 2010; Béké, 2015; Coulibaly, 2015; Léga, 2015; Yapo, 2015; Mondé et al., 2017), but not with healthy subjects. Knowing that some apparently healthy subjects have an apprehension about palm oil, we found it interesting to study the impact of palm oil consumption on healthy young people in rural areas in order to see whether there are or not lipid and lipoprotein anomalies related to this consumption.

2. Subjects, Material and Methodology

2.1 Subjects and Palm Oil Consumption Criteria

It is a descriptive cross-sectional and analytical study carried out with 120 apparently healthy young volunteers aged between 18 and 30 years with the same dietary habits apart from the palm oil quantity consumed. The recruitment of the study population was carried out following the results of a food survey carried out in Grand-Alepé, a village about 35 km north-east from Abidjan, the economic capital of Côte d'Ivoire. In this survey, we identified 535 young people aged 18 to 30 years as our target population. Among these 535 young people, we selected 120 subjects (22.43%) who accepted to participate to the study to whom we determined the lipid parameters. Regarding the oil consumption, the recommended intakes were calculated as previously described (Mondé et al, 2017). According to the nutritional recommendations, the average adult (total metabolism of 2,500 kcal) should consume about 100 grams of fat per day (i.e. 20% to 30% of the total daily intake). Indeed, 65 active young people consuming an average of 5 tablespoons of palm oil corresponding to 65 g per day and per subject during six weeks (Apports Nutritionnels de Référence [ANREF], 2006; Agence Nationale de Sécurité Sanitaire de l’alimentation [ANSES], 2016) and 55 others (controls) with an average palm oil consumption of 2 tablespoons meaning 25 g of palm oil per day and per subject, during the same period.

2.2 Material and Methodology

2.2.1 Food Survey

The previous food survey showed that palm oil was a major part of the diet in this rural population as described above.

2.2.2 Blood Sampling

In each subject, a blood sampling by venipuncture at the elbow crease was performed after 12 hours of fasting. The blood was collected in 5 ml (red cap) vacutainer tubes (*IMPROVE* ^{R}) and immediately sent to the laboratory of the Alepe General Hospital to obtain the serum after centrifugation at 3000 rpm for 5 min. The serum aliquots collected were stored by freezing (≤ -20 °C) until the number of samples required for the study was reached. Once the required number of samples was reached, they were sent to the Laboratory of Medical and Fundamental Biochemistry of the Institute Pasteur of Côte d'Ivoire for analysis.

2.2.3 Anthropometry

The weight of all subjects studied was measured with an electronic scale (*SCALE* ^{R}). Measurement of the size was made using a tape measuring more than 2 m. The body mass index was calculated from the following formula:

$$\textbf{BMI (kg/m}^2\textbf{) = Subject mass (kg) / [Subject size (m)]}^{2}$$

The limits of the BMI used were according to the official classification accepted by the World Health Organization (OMS, 2003): 18.5-24.9 kg / m^2 for normal subjects, <18.5 Kg / m^2 for the undernourished and ≥ 25.0 kg / m^2 for overweight and obese subjects.

2.2.4 Determination of Biochemical Parameters

Serum concentrations of total cholesterol and triglycerides were determined by Trinder's enzyme colorimetric method (Abell, Levy & Kendall, 1958; Trinder, 1969). HDL cholesterol was assayed by direct method (Sugiuchi, 1995). LDL cholesterol was estimated using the Friedewald formula (Friedewald, Levy & Fredickson, 1972):

$$\text{LDL Cholesterol (g / L)} = \text{Total Cholesterol} - \text{HDL Cholesterol} - \text{Triglycerides} / 5$$

The lipoprotein (a) was determined by immuno-turbidimetry (Simó *et al.*, 2003). The atherogenicity index (AI) was calculated by the ratio:

$$\text{IA} = \text{Total Cholesterol} / \text{HDL Cholesterol}$$

The determination of the biochemical parameters was carried out on the Cobas C 311 automaton (*Roche* ^{R}).

2.2.5 Ethical Considerations

We obtained informed consent from all subjects who participated in the study.

2.2.6 Statistical Analysis

The results were expressed by means associated with their standard deviation. For the study parameters, the Student t-test and the Mann-Whitney non-parametric test were used to compare averages by using the Graph Pad Prism 6 software. The different proportions of the biochemical parameters observed were compared by the likelihood test G or test log Likehood ratio with the software R.2.0.1 version Windows. The significance threshold was defined for a value of p less than 0.05 (Ihaka & Gentleman, 1996; Statsoft, 2005).

3. Results

3.1 Anthropometric Parameters

The analysis of the anthropometric characteristics summarized in Table 1 indicates that the population studied generally has a normal BMI average which is 22.09 ± 3.68 kg / m^2 and also about age that is 23, 35 ± 4.74 years. The major consumers of palm oil weight average was higher but it was not statistically significant compared to controls: 61, 90 ± 10, 53 kg versus 59,55 ± 11,60 kg, p=0,163. The controls had an average value of BMI not significantly greater than the one of the major consumers: 22,16 ± 3,92 Kg/m^2 versus 22,02 ± 3,50 Kg/m^2, p=0,820.

Table 1. Anthropometric characteristics of the general population

Anthropometric Parameters	Consumers (n=65)	Controls (n=55)	p-value
Ages (years) 23,35 ± 4,74	23,49 ± 4,89	23,18 ± 4,60	0,83 (NS)
Height (m) 1,66 ± 0,08	1,68 ± 0,08	1,64 ± 0,09	0,015 (S)
Weight (Kg) 60,82 ± 11,05	61,90 ± 10,53	59,55 ± 11,60	0,163 (NS)
BMI (Kg/m^2) 22,09 ± 3,68	22,02 ± 3,50	22,16 ± 3,92	0,820 (NS)

BMI: Body mass index n: effectif S: Student-Fisher ($p < 0,05$) NS: Student-Fisher ($p > 0,05$)

Consumers: 450 kcal / day via palm oil Controls: 150 kcal / day via palm oil n: real

3.2 Lipid and Lipoprotein Parameters

3.2.1 General State of Lipid and Lipoprotein Parameters

Mean serum concentrations of all lipid and lipoprotein parameters (Table 2) in the two study groups were normal except for LDL cholesterol (1.00 ± 0.31 g / L) which was lower than the normal values with consumers. The results of comparison between the two groups showed that, overall, mean concentrations varied not-significantly (p> 0.05) for all parameters. In this sense, triglycerides were higher in palm oil consumers than controls: 0.81 ± 0.42 g / L versus 0.77 ± 0.32 g / L, p = 0.746. Conversely, serum total cholesterol, HDL cholesterol and LDL cholesterol levels were 1.67 ± 0.46 g / L, 0.43 ± 0.19 g / L and 1.08 ± 0, 39 g / L, with controls compared to consumers with values of 1.58 ± 0.37 g / L, 0.42 ± 0.15 g / L and 1.00 ± 0.31 g / L, respectively. The index of atherogenicity in the two groups was on average normal with a non-significant superiority with the consumers compared to the controls: 4.18 ± 1.57 versus 4.17 ± 1.24, p = 0.978. The mean concentration of lipoprotein (a) was not significantly higher with palm oil consumers compared to controls: 0.29 ± 0.2 g / L versus 0.25 ± 0.18 g / L, p = 0.093.

Table 2. Comparison of Lipid and Lipoprotein parameter Means of the Two Groups of the Study population

Lipid and lipoprotein parameters	**Consumers (n=65)**	**Controls (n=55)**	p-value **(p<0,05)**
TC (g/L)	1,58 ±0,37	1,67 ±0,46	0,348
Trigl (g/L)	0,81 ±0,42	0,77 ±0,32	0,746
HDL C (g/L)	0,42 ±0,15	0,43 ±0,19	0,971
LDL C (g/L)	1,00 ±0,31	1,08 ±0,39	0,251
AI= TC/ HDL C (g/L)	4,18 ±1,57	4,17 ±1,24	0,978
Lp (a) [g/L]	0,29 ±0,2	0,25 ±0,18	0,093

n: real TC: total Cholestrol AI: atherogenicity Index LP(a): Lipoprotein (a) Trigl: Triglycerides HDL C: High Density Lipoprotein cholesterol LDL C: Low Density Lipoprotein cholesterol p: Student-Fisher

3.2.2 Comparison of the Proportions of the Lipid and Lipoprotein Parameters According in the Two Groups

3.2.2.1 Distribution of the Proportions of the BMI

Analyses of the comparative proportions of the biochemical parameters by the G-test revealed general variations in both groups of studies. It was found that those with a lower BMI were 10.77% and 10.91%, respectively, and those with a normal BMI were 81.54% and 70.91%. The subjects suffering from over-nutrition were 7.69% and 18.18% respectively in consumers and controls (Figure 1).

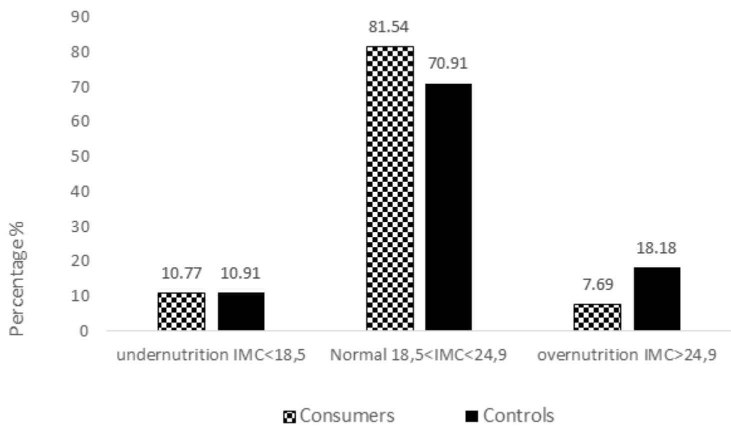

Figure 1. Distribution of BMI proportions

3.2.2.2 Distribution of the Proportions of Total Cholesterol and Its Fractions Hdl / Ldl

96.92% of consumers had normal serum total cholesterol compared with 92.72% of controls (Figure 2A) and 67.7% and 58.18%, respectively, with normal HDL cholesterol values (Figure 2B). Total hypercholesterolemia observed with controls (3.64%) was statistically higher (p = 0.024) than that of consumers (0%). No consumer had serum total cholesterol (Figure 2A) and higher than normal HDL cholesterol (Figure 2B). Furthermore, LDL cholesterol had a different behavior with 58.46% and 52.73% respectively of consumers and controls below normal compared with 35.38% and 38.18%, respectively, with normal serum concentrations. The percentage of controls with a high LDL cholesterol value was not significantly (p = 0.451) higher than that of consumers (Figure 2C).

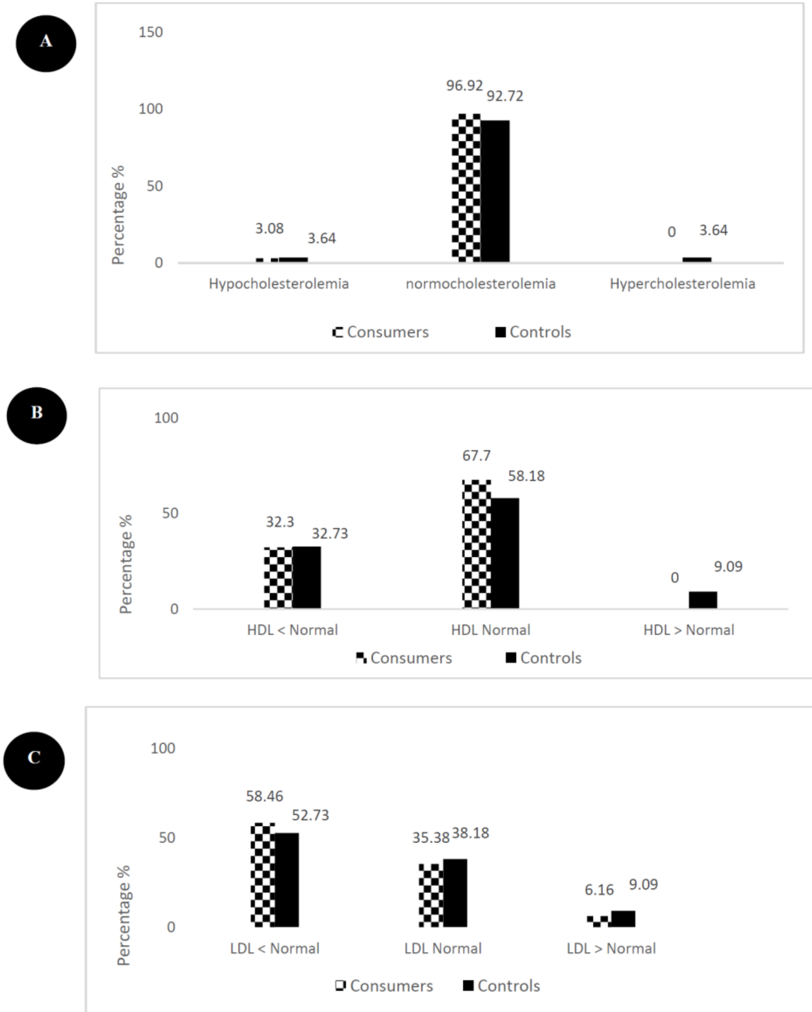

Figure 2 (A, B, C). Distribution of Serum total Cholesterol (A) and its fractions HDL (B) / LDL (C) levels according to the two groups

3.2.2.3 Distribution of Triglyceride Proportions

90.77% of consumers and 96.36% of controls had normal serum concentrations of triglycerides and 7.69% and 3.64% respectively had hypertriglyceridemia. This hypertriglyceridemia was not-significantly ($p = 0.223$) higher with consumers than controls (Figure 3).

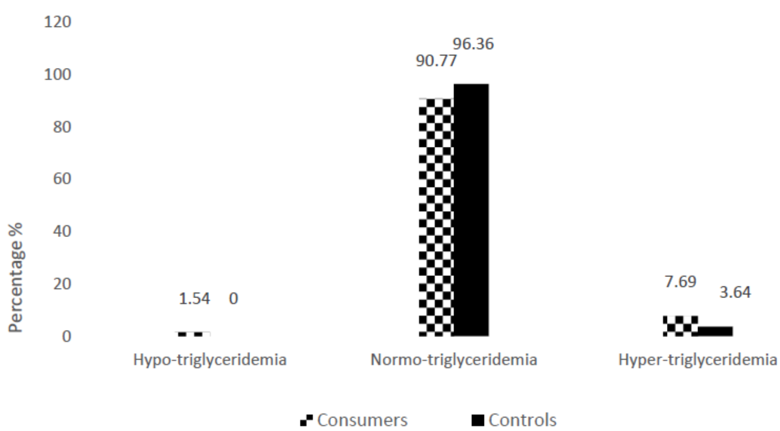

Figure 3. Distribution of triglyceride proportions

3.2.2.4 Distribution of the Proportions of the Ratio CT / HDL-C and the Lipoprotein (A)

The CT / HDL-C ratio (AI: atherogenicity index) varied the same way with the two groups. 83.08% of consumers had a normal atherogenicity index compared with 80% in controls (Figure 4A). 66.15% of consumers had normal serum lipoprotein (a) compared to 70.91% in controls. The elevated serum concentration of lipoprotein (a) was significantly higher (p = 0.548) with consumers compared to controls: 33.85% versus 29.09%, p = 0.55 (Figure 4B).

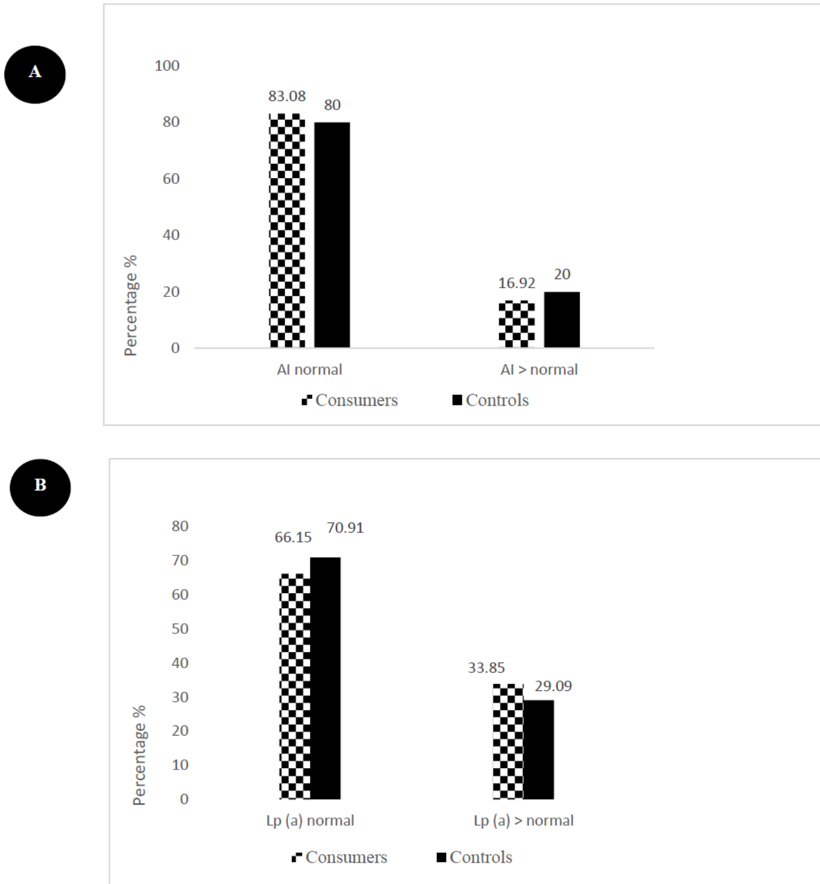

Figure 4 (A, B). Distribution of CT / HDL-C ratio (AI) and lipoprotein (a) [Lp(a)]

4. Discussion

In this study, the effect of regular consumption of palm oil was studied on serum lipid and lipoprotein levels of young subjects in a rural area in Côte d'Ivoire. The anthropometric parameters of the study population showed that the weight of palm oil consumers did not vary significantly compared to controls. Knowing that a high BMI is a major risk factor for chronic diseases (Yessoufou et al., 2012), the study population as a whole appeared not to be a population at risk for these diseases. Hornstra (1988), studying the effects of palm oil and cardiovascular disease observed that this oil was cholesterol-lowering. This observation corroborates our findings, which showed that no total and HDL hypercholesterolemia were observed with consumers compared to controls of whom 3.64% and 9.09% respectively suffered. In addition, the percentage of consumers with normal total cholesterol was higher than the one of controls. Furthermore, the results of our study showing a high serum concentration of bad cholesterol (LDL) with controls compared to consumers would suggest that the controls would be more exposed to atherosclerosis. These results are opposed to other authors' work (Tholstrup et al., 2011; Voon et al., 2011), who indicated that palm oil increased LDL cholesterol compared to olive oil.

Indeed, the excess LDL cholesterol is captured by the macrophages of the vascular wall thus inducing the formation of foam cells which play an essential role in atherogenesis (Hennen, 1996; Febbraio, Podrez & Smith, 2000; Leoni, 2001; Ducobu, Heller & Van, 2003). Another study carried out on 120 Chinese consumers of palm oil showed a decrease in LDL cholesterol (Zhang et al., 1997). In addition, Temme et al. (1996) showed that a diet rich in palmitic acid increased LDL cholesterol (Temme, Mensink & Hornstra, 1996) compared to oleic acid.

The palmitic acid content of nearly 44% in palm oil (Sambanthamurthi, Sundram & Tan, 2000; Sundram *et al.*, 2003) may therefore be responsible of this LDL cholesterol elevation. However, other authors have shown that the bioavailability of palmitic acid was less than 15% of the fatty acids in palm oil (Zock, De Vries, De Fouw, & Katan, 1995; Graille, 2005; Forsythe, French, Goh, & Clandinin, 2007). This would explain the high percentage (58.46%) of low LDL cholesterol observed in palm oil consumers of our study. It would therefore be important to be careful in the statement of the problematic about the hypercholesterolemia effect of palm oil basing on its high concentration of saturated fatty acids. Hypertriglyceridemia and elevated lipoprotein (a) were not significantly higher with consumers than cwith ontrols. These results could lead us to assert that the consumption of palm oil would therefore have no influence or would have a negligible impact on triglyceridemia and lipoproteinemia (a) in these consumers. This would be in favor of non-atherogenicity of palm oil, contrary to the observations of certain studies (Anitschkow, 1983; Tholstrup et al., 2011; Voon et al., 2011). Our work is comparable to that reported by Lecerf (2013), showing that palm oil consumption induced a stable lipid profile compared to partially hydrogenated vegetable fats (Lecerf, 2013). In addition, another study showed that palmitic acid is not hypercholesteremic, starting with a threshold of more than 4.5% of linoleic acid. On the other hand, total cholesterol and its fractions (LDL and HDL) increase if linoleic acid is low (French, Sundram, & Clandinin, 2002), fortunately, palm oil contains 10% (Sambanthamurthi et al., 2000; Sundram et al., 2003). This could explain that slight increase of the mean concentration in these parameters, observed with controls compared to consumers of palm oil in our study. The consumption of that palm oil at low cost, accessible and with undeniable nutritional qualities due to its recognized antioxidant properties, should be encouraged (Chow, 1992; Sutapa & Analava, 2009; Mondé et al., 2010).

5. Conclusion

There is a relevant dissension between several authors about the consumption of palm oil due to its poorly or partially known nutritional aspect. This study showed the beneficial influence of palm oil consumption on the lipid and lipoprotein profile of a young population living in rural areas. It was found that the percentage of subjects with normal serum concentrations was higher with TC, HDL-C, triglycerides, Index Atherogenicity and lipoprotein (a), in both consumers and controls, except LDL cholesterol of which the percentage of lower than normal value was the highest (58.46% for consumers and 52.73% controls). The lipid and lipoprotein profile with consumers of palm oil was not disturbed with the subjects studied. On the other hand, the effects of palm oil on health can not only be summarized by saturated fatty acid effects, but especially by its antioxidant and nutritional properties.

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