











Research Article

Impact of Palm Oil Consumption on Hypercholesterolemia in Ivorian Subjects

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Abstract

Palm oil is widely consumed in Côte d'Ivoire and is accused of causing hypercholesterolemia, which justifies the evaluation of the impact of its consumption on the increase in total cholesterol in Ivorian people. This was a prospective cross-sectional analytical study involving 2862 palm oil consumers over a 11-month period. The study was carried out in the health districts of Côte d'Ivoire and in the medical biochemistry laboratory from medical Teaching School. The majority of subjects in this study consumed palm oil i.e. 98.8% of the 2862 surveyed. A lipid profile was performed: total cholesterol, triglycerides, HDL cholesterol and LDL cholesterol in these subjects. Female are predominant (51.1%) and the mean age was 39.75 ± 14.31 years. Palm oil consumption was reported by 82.9% of individuals with hypercholesterolemia and 85.0% of those without hypercholesterolemia, showing no significant difference ($p = 0.720$). They had a mean total cholesterol level of 1.8 ± 0.5 g/L and an atherogenicity index of 4.3 ± 1.6 . However, there was no significant correlation with the quantity of palm oil consumed. In this dataset, palm oil consumption does not appear to be a significant predictor of hypercholesterolemia in the Ivorian population. Overall, although no statistically significant association was found between palm oil consumption and hypercholesterolemia, it is essential to consider other potential factors that may affect cholesterol levels. Given its beneficial biochemical properties and various health benefits, regular consumption of this oil should still be encouraged.

Keywords

Palm Oil, Hypercholesterolemia, Atherogenicity Index, Total Cholesterol, LDL Cholesterol, HDL Cholesterol, Ivorian

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1. Introduction

Hypercholesterolemia is one of the dyslipidemias that represents a real public health problem, with a prevalence of over 30% in Western countries [1]. In sub-Saharan Africa, prevalence varies from region to region, and exceeds 50% in countries such as Nigeria [2]. In Côte d'Ivoire, the rate of dyslipidemia was 63.7% [3]. Several factors are involved in the onset of hypercholesterolemia, including genetic factors (familial hypercholesterolemia) [4], certain pathologies (hyperthyroidism, diabetes), environmental factors, age, and lifestyle (notably a diet rich in fats and oils), which is a major factor today [5]. Palm oil is a vegetable oil produced from the pulp of the ripe fruit of the oil palm. It is composed of saturated fatty acids (50%), unsaturated fatty acids (50%), vitamins, carotenoids and other minor phytonutrients [6]. However, the proportion of saturated fatty acids in palm oil is the source of much controversy concerning its nutritional use, and in particular its atherogenic effect, due mainly to hypercholesterolemia and fatty acids [7-9]. Some studies claim that palm oil consumption increases serum total cholesterol levels and is responsible for the onset of certain cardiovascular pathologies. A 2018 meta-analysis reported that palm oil consumption significantly increased LDL cholesterol levels compared to other vegetable oils low in saturated fats. This effect was observed in randomized trials (0.31 mmol/L; 95% CI: 0.20; 0.42 mmol/L) but not in non-randomized trials [10]. Epidemiological, observational and nutritional intervention studies have also revealed an inverse association between saturated fatty acid intake and the progression of atherosclerosis [11]. It is against this backdrop that, in Côte d'Ivoire over the past few years, the consumption of palm oil has often been prohibited in certain patients due to its presumed atherogenicity [10, 12]. In Côte d'Ivoire, work has been undertaken to demonstrate the protective potential of palm oil consumption on the health of the population, in particular the absence of any significant disturbance of lipid and lipoprotein parameters in patients with heart disease who consume this oil [11, 13-15]. However, the real impact of hypercholesterolemia following palm oil consumption has not been studied. This justifies the present work to find out whether palm oil consumption was really the cause of hypercholesterolemia in Ivorian subjects.

2. Materials and Methods

2.1. Study Setting and Participants

This study was conducted at the Biochemistry Laboratory of the Faculty of Medical Sciences, Felix Houphouët-Boigny University, Cocody (Abidjan, Côte d'Ivoire), in collaboration

with all health districts of the thirty-one (31) administrative regions of Côte d'Ivoire.

The target population consisted of individuals living in households, aged 18 years or older, of both sexes, and in apparent good health. Sample size was calculated using the Schwartz formula (1969).

Informed consent was obtained from each participant.

2.2. Methods

This was a retrospective, descriptive, and analytical study conducted over 11 months. Pre-established questionnaires collected data on sociodemographic, anthropometric, palm oil consumption, and biological variables. Blood samples were collected from the antecubital vein of subjects who had fasted for at least twelve hours.

Blood was collected in two 5 ml dry "vacutainer" tubes (red top). Total cholesterol, triglycerides, and HDL cholesterol were measured using the Cobas integra 400 automated analyzer by classic enzymatic methods. LDL cholesterol was calculated using the Friedewald formula. The atherogenic index was calculated as the ratio of total cholesterol to HDL cholesterol.

2.3. Ethical Considerations

The protocol was approved by the National Ethics Committee for Research (NECR) under number 142/MSHP/CNER-kp.. Both verbal and written consent was obtained from each participant.

2.4. Statistical Analysis

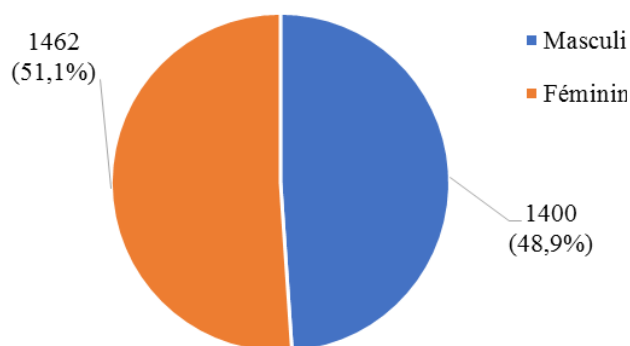
Statistical tests used included Chi-square, Student's t-test, and Pearson correlation with a significance level of alpha less than $\alpha < 5\%$.

3. Results

In this study, 2862 subjects were enrolled. Women accounted for 51.1% and men 48.9%, giving a sex ratio of 0.96. The mean age was 39.75 ± 14.31 years. The mean BMI was 24.74 ± 5.5 kg/m². Almost all study subjects reported consuming palm oil, i.e. 98.8%**. The mean value of palm oil (PO) consumed per person/day was 29.44 ± 31.40 ml. The mean total cholesterol level was 1.8 ± 0.50 g/L, and 15% had a high level. The mean atherogenicity index was 4.3 ± 1.6 , of which 38.1% were abnormal (Table 1 and figure 1).

Table 1. Mean values of palm oil consumption, lipid profile and anthropometric parameters.

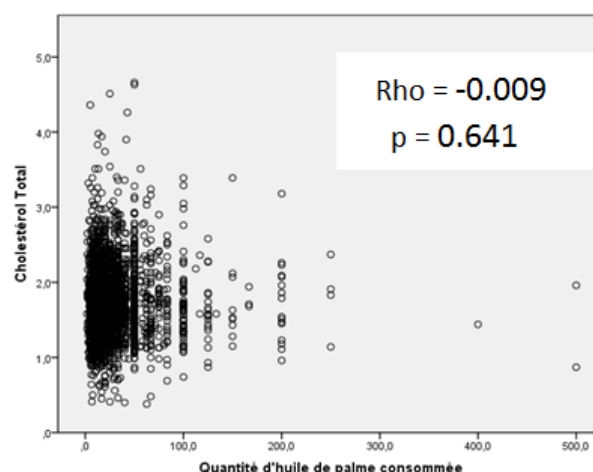
	Parameters	Average \pm SD
Lipids and lipoprotein parameters	Triglyceride (TG [g/L])	1.0 \pm 0.50
	Total Cholesterol (TC [g/L])	1.8 \pm 0.50
	HDL Cholesterol (HDL [g/L])	0.4 \pm 0.20
	LDL Cholesterol (LDL [g/L])	1.1 \pm 0.40
	Atherogenicity Index (AI)	4.3 \pm 1.60
Anthropometric parameters	Age (years)	39.75 \pm 14.31
	Body mass index (kg/m ²)	24.74 \pm 5.50
Palm oil consumption	Palm oil quantity consumed/person/day (ml)	29.44 \pm 31.40

**Figure 1.** Distribution of the study population by gender.

There was no significant correlation between total cholesterol and palm oil consumption ($Rho = -0.009$; $p = 0.641$) (Figure 2).

The frequency of palm oil consumption had no influence on the presence or absence of hypercholesterolemia ($p = 0.68$). The same was true for the form and quantity of palm oil

consumed. Whatever the form and quantity of palm oil consumed, there was no influence on the presence or absence of hypercholesterolemia (Table 2).

**Figure 2.** Correlation between total cholesterol and quantity of palm oil consumed.**Table 2.** Relationship between hypercholesterolemia and palm oil consumption in univariate analysis.

		Hypercholesterolemia		P
		No	Yes	
		N (%)	N (%)	
Palm oil consumption	Yes	2404 (85.0%)	423 (15.0%)	0.720
	No	29 (82.9%)	6 (17.1%)	
Consumption form	Crude palm oil	71 (88.8%)	9 (11.3%)	0.122
	Refined palm oil	230 (81.3%)	53 (18.7%)	

		Hypercholesterolemia		P
		No	Yes	
		N (%)	N (%)	
Consumption frequency	2 forms	2103 (85.3%)	361 (14.7%)	0.682
	3 to 4 times a week	514 (84.7%)	93 (15.3%)	
	Every day	1691 (84.9%)	300 (15.1%)	
	Rarely	98 (89.1%)	12 (10.9%)	
Amount consumed (ml)	< 150	1773 (85.2%)	308 (14.8%)	0.303
	150 – 300	556 (85.0%)	98 (15.0%)	
	300 – 450	25 (73.5%)	9 (26.5%)	
	≥ 450 ml	50 (86.2%)	8 (13.8%)	

On the other hand, there was no significant correlation between increased cholesterol levels and the amount of palm oil consumed per person per day, or the atherogenicity index. (Table 3).

Table 3. Quantity of palm oil consumed per person and lipid profile.

		BMI	TC	TG	HDL	LDL	AI
Quantity of palm oil consumed per day per person	Pearson correlation	0.020	-0.009	-0.027	0.023	-0.013	-0.022
	p	0.282	0.641	0.143	0.11	0.489	0.238

4. Discussion

This study showed the relationship between palm oil consumption and the hypercholesterolemia. There was a predominance of females in the study, with a sex ratio of 0.96. This could be explained by the fact that most of the meal preparation was carried out by housewives who volunteered to take part in the survey, especially as most of the men were at work. These results were in line with those of Bataïet *et al.* [16], who observed a predominance of women in the lipid profile of a palm oil-consuming population in Jacqueville, southern Côte d'Ivoire. The average age was 39.75 ± 14.31 years, with 29.50% aged between 30 and 39 and 3.20% under 20. This could be explained by the fact that the Ivorian population is predominantly composed of young subjects [17]. Our results differ from those reported by Sable *et al.* whose average age was 43.7 years [3]. The mean BMI was 24.74 ± 5.5 kg/m² in our context. This BMI of the respondents was normal in 53.6%. This could be explained by the youthfulness of the Ivorian population [17]. Chenyan *et al.* conducted a study of 88 young Chinese adults consuming palm oil over 16 weeks [18]. The results showed that there was no significant difference in BMI when palm oil

was consumed. Crude palm oil was consumed daily by the population of the village of Grand Alépé (Côte d'Ivoire) and did not appear to significantly increase consumers' BMI [19]. The mean serum total cholesterol concentration in the study population was normal (1.80 g/L). And there was no significant correlation between palm oil consumption and total cholesterol levels. We find the same results in the literature, in whom palm oil consumption, in terms of form, quantity and frequency, did not significantly influence total cholesterol concentration (1.43 ± 0.30 g/l) [16]. The atherogenicity index was normal, with an average of 4.3 g/L, and there was no significant difference in the correlation between this atherogenicity index and palm oil consumption. An oil is thus characterized not only by its overall FA composition, but also by its molecular species composition. Molecular species may be defined by the nature of the fatty acids esterified in the external (sn-1 or sn-3) or internal (sn-2) positions of the glycerol [20]. Studies have shown that the atherogenicity of palmitic acid is greater when it is located in the sn2 position of dietary triglycerides. It is this position, which, on the one hand, ensures maximum intestinal absorption and, on the other hand, enables it to remain in the same position in plasma lipids, thereby increasing its atherogenic potential. With regard to unsaturated fatty acids, the bioavailability of

linoleic acid as a precursor of essential fatty acids correlates with its sn2 proportion in triglycerides; that of long-chain polyunsaturated fatty acids depends on their digestibility, which is poor when they are located in the sn1 and sn3 positions, respectively in the sn2 position [20, 21]. These results confirm the findings of our previous work in which the atherogenicity index was normal (TC / HDL) in both palm oil consumers and non-consumers, with an insignificant difference (62 and 61.5% respectively) [11]. There was no significant correlation between increased cholesterol levels and the amount of palm oil consumed per person per day. Consequently, palm oil consumed as a dietary fat as part of a healthy, balanced diet would not be associated with a risk of cardiovascular disease. These results were similar to those of other studies which have shown that palm oil consumption has no significant influence on lipid and lipoprotein parameters in populations [13, 16, 22]. Thus, we can postulated that palm oil consumption is not the cause of elevated total cholesterol levels in Ivorian consumer, likewise others consuming population in the world.

5. Conclusions

This study, which was one of the first of its kind in Côte d'Ivoire, assessing the impact of palm oil consumption on cholesterol levels in Ivorian subjects, highlighted the lack of impact of palm oil consumption on the occurrence of hypercholesterolaemia. Thus, palm oil consumption does not significantly influence the occurrence of hypercholesterolaemia in subjects. The findings suggest that other factors, potentially dietary age, sex, BMI, lifestyle or genetic, may play a more prominent role in the development of hypercholesterolemia in the population at large. Further studies with details dietary assessments are needed to better understand the potential impact of palm oil on cholesterol levels and cardiovascular health. Normal consumption of this oil should be encouraged because of its biochemical properties and its numerous virtues.

Abbreviations

BMI	Body Mass Index
TC	Total Cholesterol
LDL	Low Density Lipoprotein
HDL	High Density Lipoprotein
VLDL	Very Low Density Lipoprotein
AI	Atherogenicity Index
FA	Fatty Acids

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Author Contributions

Yapo-Kee Aké Chibrou Bénédicté: Writing – review & editing

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Iklo Coulibaly: Supervision, Validation

Mondé Aké Absalome: Conceptualization, Project administration

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Data Availability Statement

The data supporting the outcome of this research work has been reported in this manuscript.

Conflicts of Interest

The authors declare no conflicts of interest.

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Biography



Yapo-Kee Aké Chibrou Bénédicte has been a Lecturer-Researcher at the Felix houphouet Boigny University (UFHB) in Abidjan since August 2023. A medical doctor by training since July 2019, she is currently a medical biologist in the biochemistry laboratory at Treichville University Hospital (Abidjan). She obtained her Master's degree in Biochemistry and Nutrition in 2021 and her diploma in Endocrinology in 2022 from the same university. After her Master's, she will enrol at the university for her doctoral thesis. Her research focuses on lipids, specifically palm oil. She is currently a doctoral student at the Félix Houphouet Boigny University in Abidjan, working on palm oil and cardio-metabolic risk in collaboration with the biochemistry laboratory at the CHU Lapeyronie and the PhymedExp research unit in Montpellier.



health in relation to palm oil consumption.

Aké Aké Alexandre is member of Biochemistry laboratory of the Medical Sciences Faculty as a research associate at Alassane Ouattara University, basic and bioclinical sciences Department. He completed his PhD degree in biological sciences (Nutrition-Health) from Nangui Abrogoua University, Abidjan (Côte d'Ivoire) in 2018, and his post-graduate diploma in Physiology, Pharmacology and Phytotherapy from the same institution in 2013. As deputy coordinator of the palm oil and population health research team with FIRCA, Dr. Aké Aké has participated in recent years, in two nationwide projects that have demonstrated the lipid and lipoprotein profile of oil-consuming populations in Côte d'Ivoire. He is also the author of several publications and his research focuses on nutrition and



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Lohore Kouzahon Colombe Jeannine has been an intern at the Ivory Coast Hospitals since 2020. A doctor by training, she obtained the State Doctorate in Medicine at the Felix Houphouët and Boigny University (UFHB) in Abidjan in March 2022 and is currently working in the Biochemistry laboratory of the Treichville University Hospital (Abidjan). Dr LOHORE obtained a master's degree in Biochemistry Molecular Biology in January 2024 at the Felix Houphouët Boigny University (UFHB). She is enrolled in the dissertation year of the Specialized Study Diploma in Endocrinology, also enrolled in the Specialized Study Diploma in Biology in 2024 at the same university.



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University, and as such participates in several national and international thesis juries. His team works closely with Professor JP CRISTOL's team at the Biochemistry and Nutrition Laboratory of the University of Montpellier's Medical Faculty.

Research Field

Monde Absalome: Biochemistry & nutrition of lipids, fats, edible oils: palm oil and metabolic and cardiovascular diseases

Aké Aké Alexandre: Biochemistry & nutrition of lipids nutrition and health in relation to palm oil consumption.

Yapo-Kee Aké Chibrou Bénédict: Biochemistry & nutrition of lipids, fats, edible oils: palm oil and metabolic and cardiovascular diseases

Ecrabey Yann Christian: Biochemistry & nutrition of lipids, fats, edible oil, Biochemistry & metabolic and cardiovascular diseases, Biochemistry & cancer.

Lohore Kouzahon Colombe Jeannine: Biochemistry & Nutrition of lipids, fats, edible oils: palm oil and metabolic and cardiovascular diseases. Biochemistry-Molecular Biology: genes, genetic diseases and diabetes, endocrine and metabolic diseases

Bamba Youssouf Ben Soualiho: Biochemistry and nutrition: valorization of cashew fruits (cashew nuts and cashew apples), nutritional characterization and study of the impact of cashew apple juice and cashew nut oil on physiological and biological parameters