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ORIGINAL ARTICLE

Sale conditions, Use and Consumption of Provitamin A Rich-Foods in Douala-Cameroon: Case of Crude Palm Oil

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Abstract

In order to contribute in fighting against vitamin A deficiency (VAD) in Cameroon through carefully use of crude palm oil (CPO), three surveys were carried out in Douala town and some of its surrounding rural areas.

The first consisted of information collection from 55 sellers on the CPO's sales conditions (containers, exhibition conditions and liquefaction method). The second and the last was to collect information respectively on the use and the consumption of dishes prepared with unbleached CPO respectively from 199 housewives and 309 individuals. The results reveal that 87% of sellers exposed CPO in the open air during commercialization although 44% of them knew that sunlight could have a negative impact on its quality. Heating and/or sun exposure were the technics used to liquefy oil. On the 98% of households that prepared with CPO, 93% of them often bleached it, although 64% were aware of the detrimental effect of this process. The social status of housewives significantly influenced this result. Unbleached CPO was used to prepare many dishes which were frequently consumed by 87% of people with a significant influence of lifestyle and region of origin. The results of this study showed that CPO could be used for fight against VAD in Cameroon if it is carefully commercialized and used in households and if people frequently consume dishes prepared with unbleached CPO.

Practical application

The knowledge of information on selling conditions, use and consumption of CPO will contribute to fight against VAD. In fact, it will guide policies for the development of strategies to improve in its commercialization conditions; to propagate the CPO and its consumption throughout the country and to improve nutritional education.

Keywords: Cameroon; vitamin A deficiency; carotenoids degradation; crude palm oil; selling and cooking conditions; consumption.

1. Introduction

Vitamin A deficiency (VAD) remains a major worldwide nutritional problem, despite substantial progresses in recent decades (Kollo *et al.*, 2001; Strobel *et al.*, 2007; Gouado *et al.*, 2008; WHO 2009; Ministry of public health in Cameroon, 2011). It is estimated that more than 500,000 preschool children become blind each year because of VAD, among which 250,000 die

because of resulting immune dysfunction (Edem, 2009). The distribution of vitamin A (VA) capsules permits good coverage of child populations at relatively low cost. However, it is widely recognized that food approaches should be part of the means to tackle VAD sustainably, taking into account nutrition education, production, marketing, processing and consumption (Delisle *et al.*, 2003). In developing countries, dietary approaches are very encouraging in the case of VA. However, fruits and vegetables rich in provitamin A are not always available and accessible in these countries like crude palm oil (CPO) which is generally available and cheap (Zeb & Mehmood, 2004; Edem, 2009). This oil is extracted from the pulp of palm fruits (*Elaeis guineensis*) and contains provitamin A (500-900 ppm), mainly β-carotene (Zeb & Mehmood, 2004; Mukherjee & Mitra, 2009). Its importance in the reduction of VAD is obvious, especially in developing countries (Mahapatra *et al.*, 1997; Mahapatra & Manorama, 1997; Zagré *et al.*, 2002; Solomons & Orozco, 2003; Sundram *et al.*, 2003; Spinnler 2003; Wattanapenpaiboon & Wahlqvist, 2003; Zagré *et al.*, 2003; Mukherjee & Mitra, 2009). This oil has a special place among vegetable sources of VA, because of the absence of plant matrix and the presence of lipid, which increase absorption of carotenoids. Moreover, Dongho *et al.* (2017a) showed that consumption of some Cameroonian local dishes cooked with CPO leads to significant increase of plasma carotenoids content mainly provitamins A. Crude Palm Oil also provides energy, essential fatty acids, phytosterols, phosphatides and vitamin E (Mukherjee & Mitra, 2009).

The presence of unsaturated fatty acids exposes palm oil (PO) to lipid oxidation reactions. These reactions result in qualitative and nutritional alterations (rancidity, losses of essential fatty acids and vitamins) and even toxicity caused by oxidative products (peroxide, aldehydes). They are influenced by extrinsic (temperature, light) and intrinsic factors (fatty acid composition, presence of pro- or antioxidants). A food will be more resistant to oxidation if its natural antioxidants content is high as in CPO, which is very rich in carotenoids and vitamin E (Cillard & Cillard, 2006). On the other hand, development of oxidative reactions may be enhanced by storage, cooking and refining (Gary *et al.*, 2005). In fact, some authors have shown the negative effects of refining (Verhé *et al.*, 2006), heating (Ahmed *et al.*, 2006a; Zeb *et al.*, 2008; Combe & Rossignol-Castera, 2010) and light (Zeb *et al.*, 2008; Fekarurhobo *et al.*, 2009) on the nutritional, sensory and/or physicochemical properties of vegetable oils including carotenoid degradation. Also, Dongho *et al.* (2014) have noted that bleaching of CPO leads to a significant decrease in carotenoid content and to development of peroxides proportionally to exposure time and temperature. Likewise, they showed that during cooking of maize cake, the carotenoids contents significantly decrease with the cooking time. It has proven that even if short exposure (14 hours) to sunlight doesn't significantly affect the stability and the carotenoids content of CPO (Dongho *et al.*, 2014), oil samples exposed to open air are more prone to contamination by microorganisms and particles (Dongho *et al.*, 2017b).

In Cameroon, little efforts are made in nutrition education of underprivileged people. Consequently, they do not always have information on the nutritional potential of the food available, their use and how to process them for a better preservation of their quality. This is the case of CPO which is the most

available and accessible oil consumed in Cameroon. Owing to urbanism and modernism over the last few decades, people are increasingly interested in buying refined Palm oil and others oils such as those from soybean, groundnut, cottonseed and olives. Moreover, people using CPO usually bleach it before cooking and few of them know the nutritional potential of CPO, particularly its role in the prevention and reduction of VAD. Consequently, little efforts are made by population to optimize this nutritional potential during production, transformation, marketing, storage and use of CPO.

This study aimed at contributing to the fight against VAD in Cameroon through carefully use of CPO.

2. Material and Methods

2.1. Participants and enrolment

This study was carried out from November 2018 to March 2019 in Douala town and the surrounding rural areas (Bomono, Souza). Douala is a cosmopolitan city with diversified population and is among the most populated of Cameroon with about 2,500,000 inhabitants. Data collection questionnaires were previously established in order to implement the different surveys and the investigators previously trained. In rural areas, data were collected with the assistance of associations of young peoples who facilitated the exchanges between villagers and our team by translating the information from french to local language and vice-versa so that the illiterates can understand. The study was approved by the national committee of ethics of Cameroon.

Written informed consents were obtained from all persons included in the surveys.

A total of three surveys were conducted:

(1) Conditions under which CPO was sold by adults who had been in the business for at least a year. A total of 61 sellers directly contacted in ten markets in Douala (Bepanda Omnisport, Double-Ball Bepanda, Bonamoussadi, Dakar, Deido, Dogpassi, Grand Hangar Bonaberi, Rail Bonaberi, New-Bell, and Missoke) and in two rural markets (Bomono and Souza) were surveyed.

(2) Use of CPO in households assessed by volunteer women. Women were chosen because of their primary role as family caretakers. The main inclusion criterion was to have been cooking in a household for at least one year. This survey was conducted on 208 housewives living in six populous districts (Nyalla, Ndogbong, PK14, Missoke, Bepanda, Oyack) and four residential districts (Bonamoussadi, Logpom, Makepe, Cités des palmiers) of Douala and in rural areas (Bomono and Souza).

(3) Consumption of CPO conducted on adult Cameroonians volunteers of both sexes who had lived in Douala for at least a year. A total of 320 individuals (166 men and 154 women), mainly from the University of Douala were surveyed. Students were chosen because of their great social diversity. They were from all regions of Cameroon and had different lifestyles, i.e. living alone or with a family having a head and a woman dealing with the organization of the household.

2.2. Data collection

For the survey on selling conditions of CPO, information was collected on the amounts and conditions of sale. Thus, we have designated as retailers the sellers who distribute oil to consumers (less than 5 liters) and as wholesalers those who distribute more than 5 liters of oil

generally to retailers. Concerning the sale conditions, data were collected on the nature of the containers used to store oil samples (metal or plastic), exposure during sales (exposure to open air or not, time spent by exposed samples) and method used to liquefy the oil (exposure to sunlight or warming).

Concerning the second survey on the use of CPO in households, socio-demographic parameters were collected (educational level, place of residence), uses of palm oil (refined or crude, bleached or not) and the dishes that are generally prepared with CPO. Subsequently, information was collected on the cooking processes of the dishes with unbleached oil.

For the third survey on the consumption of CPO, information was collected on the dishes based on unbleached CPO generally consumed. Information about the place (e.g. family or public sale points such as restaurants or "tournedos") where these dishes are used to be consumed was also collected.

2.3. Data analysis

Data were processed using Microsoft Excel version 2016 spreadsheet. The results were expressed as frequency. For the survey conducted on the selling conditions of CPO, the sellers were grouped based on the nature of the containers they use, the exposure conditions of oil during sale and the method used for its liquefaction. The impact of the amount of oil sold (retailers or wholesalers) on these parameters was determined.

Concerning the second survey, housewives were grouped according to the type of cooking oils generally used, the kind of PO and the form of CPO. Thereafter, the impact of some socio-demographic parameters on these factors particularly the level of studies; the areas of residence and the district of dwelling for those living in urban areas were evaluated.

For the third survey, the participants were grouped according to whether or not they consume unbleached CPO and according to the meals they usually consume. The effects of participants' lifestyle were evaluated and dishes prepared with unbleached CPO were classified according to their area of consumption. Concerning the effect of region of origin, Cameroon was divided into four zones according to geographical position, culture and/or food habit. These include "North regions" consisting of the regions of Adamawa, North and Far-North; West and North-West regions; Littoral and South-West regions; and Centre, South and East regions.

Statistical analyses were performed with Graph Pad Prism package version 5.00 (San Diego California USA) and Chi Square test was used to compare the distribution of different groups. P-values were used as measure of significance with $p<0.05$ being considered significantly different.

3. Results and Discussion

3.1. Selling conditions of crude palm oil

Among the 61 CPO sellers contacted, 6 were excluded owing to incomplete information. The remaining 55 sellers consisted of 38 retailers and 17 wholesalers. All sellers (55) used plastic containers (barrels, cans and basins) and some (14) additionally used metal containers, particularly iron barrels, to keep oil (Table 1). Retailers use only plastic containers whereas wholesalers use those in plastic or metal. This could be explained by the fact that retailers store only small quantities of oil.

Table 1: Distribution of crude palm oil sellers according to selling conditions and influence of activities Size

PARAMETERS				n (%)
Nature of containers				
Total (n=55)				
		Always in plastic		**41 (75%)**
		Plastic and metal		**14 (25%)**
Distribution according to the size of activities				***
Retailers (n=38)		Always in plastic		37 (97%)
		Plastic and metal		1 (3%)
Wholesalers (n=17)		Always in plastic		4 (24%)
		Plastic and metal		13 (76%)
Exposition of oil during the selling				
Exposition to open air				
Total (n=55)				**48 (87%)**
Distribution according to the size of activities				ns
Retailers (n=38)				33 (87%)
Wholesalers (n=17)				15 (88%)
Necessary time to sell an oil sample exposed to open air				
Total (n=48)				
		Maximum days	1	**43 (90%)**
			2	**5 (10%)**
			] 1-3]	**6 (13%)**
			] 3-6]	**40 (83%)**
		Maximum time per day of exposure (hours)	>6	**2 (4%)**
Distribution according to the size of activities				ns
		Maximum days	1	31 (94%)
			2	2 (6%)
Retailers (n=33)			] 1-3]	5 (15%)
		Maximum time per day of exposure (hours)	] 3-6]	27 (82%)
			>6	1 (3%)
		Maximum days	1	12 (80%)
Wholesalers (n=15)			2	3 (20%)
			] 1-3]	1 (7%)
		Maximum time per day of exposure (hours)	] 3-6]	13 (86%)
			>6	1 (7%)
Methods used to liquefy oil				
Total (n=48)				
		Always by exposure to sunlight		**2 (4%)**
		Always by slight heating		**2 (4%)**
		By slight heating or by exposure to sunlight		**51 (92%)**
Distribution according to the size of activities				ns
		Always by exposure to sunlight		1 (3%)
Retailers (n=38)		Always by slight heating		1 (3%)
		By slight heating or by exposure to sunlight		36 (94%)
		Always by exposure to sunlight		1 (6%)
Wholesalers (n=17)		Always by slight heating		1 (6%)
		By slight heating or by exposure to sunlight		15 (88%)
Knowledge of possible negative impact of sunlight on oil quality				
Total (n=55)				**24 (44%)**

ns: not significant influence of *size* of activities at 5%
*** Chi2 p<0.001 across size of activities

Hence, they need for small containers (cans and basins) which are generally in plastics. Contrarily, wholesalers store important quantities of oil hence the need for large containers such as iron or plastic barrels. More often, for financial reasons or in order to ease oil liquefaction, iron barrels are chosen since they are cheap and resistant to heat than plastic containers.

Nearly half of the sellers (24) knew that light could have a negative impact on oil quality yet 48 (87%) of them expose oil to open air during commercial operations (Table 1). The exposure time required to sell completely an exposed CPO sample is 3 to 6 hours but most of them, 90% of sellers liquidated theirs in maximum of 1 day and 83% expose it for 3 to 6 hours per day before liquidation. This can be explained by several reasons. Firstly, the sellers don't have adequate spaces to better exhibit their goods given the lack of organization that exists in some Cameroonian markets. Also, traders expose oil in open air in order to be as close as possible to customers because of the competition. Furthermore, they could do it by ignorance because in this study, only few of them knew that sunlight could have negative effect on oil quality.

This work also revealed that 92% of sellers liquefy CPO (which coagulates at low temperatures) by slight heating with fire or short exposure to sunlight. Elsewhere, 4% of them liquefy it only by slight heating with fire and 4% only by exposure to sunlight.

These results show that in Cameroonian markets, sunlight and heating could be considered as important risks factors of carotenoids losses in CPO since carotenoids are thermo and photosensitive compounds. Besides, some studies showed that light (sun, UV, white) have not only an effect on the carotenoid content, but also on the organoleptic and physicochemical qualities of olive oil (Zeb *et al.*, 2008), soybean and groundnut oils (Fekarurhobo *et al.*, 2009). Fortunately, due to its high content of saturated fatty acids and natural antioxidants (vitamin E and carotenoids), CPO is more resistant to light than these oils (Zeb *et al.*, 2008; Fekarurhobo *et al.*, 2009). Moreover, Dongho *al.* (2014), Oyem (2011) and Fekarurhobo *et al.* (2009) showed that short exposure to sunlight (1-14 hours) didn't significantly affect the stability and carotenoids content of CPO. It is demonstrated that the main risk when CPO is exposed in open air is its contamination by microorganisms and particles as shown by Dongho *et al.* (2017b).

3.2. Uses of palm oil in households

Among the 208 housewives surveyed, 09 were excluded for not having properly filled the questionnaire. The 199 housewives among whose 66 lived in rural area (53% have been attended primary studies, 41% secondary studies and 6% higher studies) and 133 in urban areas. Among the latter, 83 resided in a populous district (18% have been attended primary studies, 60% secondary studies and 22% higher studies) and 50 in a residential district (4% have been attended primary studies, 62% secondary studies and 34% higher studies).

3.2.1. Use of palm oil

Table 2 shows that all the housewives (100%) evaluated use PO. This is explained by the fact that CPO is the most accessible oil in Cameroon. Among them, 74% use PO as only cooking oil while 26% associate other oils to it (soybean, cottonseed, peanut, olive or sunflower oil).

Table 2: Distribution of housewives according to use of palm oil and influence of studies level, residence area and dwelling district

PARAMETERS		n (%)
Cooking oils used		
Use of PO		
Total (n=199)		**199 (100%)**
Use of PO as only cooking oil		
Total (n=199)		**148 (74%)**
Distribution according to studies level		***
≤ Primary studies (n=52)		49 (94%)
Secondary studies (n=108)		75 (69%)
Higher studies (n=39)		24 (62%)
Distribution according to residence areas		***
Rural area (n=66)		59 (89%)
Urban area (n=133)		89 (67%)
Distribution according to dwelling district		**
Populous district (n=83)		60 (72%)
Residential district (n=50)		29 (58%)
Kind of PO used		
Use of CPO		
Total (n=199)		**194 (98%)**
Distribution according to studies level		ns
≤ Primary studies (n=52)		52 (100%)
Secondary studies (n=108)		105 (97%)
Higher studies (n=39)		37 (95%)
Distribution according to residence areas		ns
Rural area (n=66)		66 (100%)
Urban area (n=133)		128 (96%)
Distribution according to dwelling district		*
Populous district (n=83)		82 (99%)
Residential district (n=50)		46 (92%)
Use of PO always crude		
Total (n=194)		**48 (25%)**
Distribution according to studies level		***
≤ Primary studies (n=52)		26 (50%)
Secondary studies (n=105)		18 (17%)
Higher studies (n=37)		4 (11%)
Distribution according to residence areas		***
Rural area (n=66)		32(49%)
Urban area (n=128)		16 (13%)
Distribution according to dwelling district		*
Populous district (n=82)		14 (17%)
Residential district (n=46)		2 (4%)
Form of use of CPO		
Total (n=194)	Sometimes bleached	**180 (93%)**
	Never bleached	**14 (7%)**
Distribution according to studies level		*
≤ Primary studies (n=52)	Sometimes bleached	52 (100%)
	Never bleached	-
Secondary studies (n=105)	Sometimes bleached	96 (91%)
	Never bleached	9 (9%)
Higher studies (n=37)	Sometimes bleached	32 (87%)
	Never bleached	5 (13%)
Distribution according to residence areas		ns
Rural area (n=66)	Sometimes bleached	59 (89%)
	Never bleached	7 (11%)
Urban area (n=128	Sometimes bleached	121 (95%)
	Never bleached	7 (5%)
Distribution according to dwelling district		ns
Populous district (n=82)	Sometimes bleached	77 (94%)
	Never bleached	5 (6%)
Residential district (n=46)	Sometimes bleached	42 (91%)
	Never bleached	4 (9%)
Knowledge of the possible negative impact of bleaching on oil quality		
Total (n=199)		**127 (64%)**

ns: not significant influence of studies level, residence area or dwelling district at 5%
* Chi2 p<0.05 across studies level, residence area or dwelling district
** Chi2 p<0.01 across studies level, residence area or dwelling district
*** Chi2 p<.0001 across studies level, residence area or dwelling district

It was also noted that 2% of housewives used PO always refined while 98% used it always crude or crude and refined. This result was significant influenced ($p<0.05$) by socio-economic status of housewives. Indeed, although all the housewives used PO, those considered to have weak socio-economic status (with low studies level, living in rural areas or in populous districts) tended to use PO as the only cooking oil and preferentially in crude form.

Besides, 93% of surveyed housewives used CPO sometimes bleached against 7% only who never bleached it, although 64% of them knew that bleaching could negatively affected oil quality. This behavior can be explained partly by ignorance, because in this study, just 44% of them knew that bleaching could have a negative effect on the oil quality. It can also explain by the lack of finances. Indeed, the results showed than bleached CPO is generally used for dishes require less colored oil than CPO like peanut, soybean, olive and cottonseed oils or refined PO which are generally expensive for most Cameroonians. In fact, this study showed that CPO was generally the only cooking oil used by housewives living in rural areas, in populous districts and/or those with low studies level who have limited financial incomes.

This study shows that in Cameroon, heating CPO (either during preliminary bleaching or cooking of dishes) can be regarded as an important factor for reduction of the carotenoids content. Indeed, many studies showed that heating of oil decreases its carotenoids content, and deteriorates its physicochemical, organoleptic and nutritional qualities (Kurt, 2005; Ahmed *et al.*, 2006; Zeb *et al.*, 2008; Combe & Rossignol-Castera; 2010; Dongho *al.*, 2014). Therefore, the practice of bleaching should be avoided because it not only reduces carotenoids content, but also leads to the formation of dangerous compounds (hydroperoxides). It is obvious that these compounds negatively react with cellular components such as proteins, nucleic acids, lipids, carbohydrates and poly-unsaturated acids (Dongho *et al.*, 2014; Combe & Rossignol-Castera, 2010).

3.2.2. Dishes prepared with crude palm oil

Several dishes prepared with CPO (previously bleached or unbleached) were inventoried nearest housewives. For those prepared with bleached CPO, it was observed that for their preparation, oil is previously heated till discoloration. This practice is done for dishes requiring fewer colored oils (refined PO, soybean oil, cottonseed oil, groundnut oil, olive oil…). The most concerned dishes are "corn shaft", various fries (fishes, meets, potatoes, sweet potatoes, plantain, donuts…), stew vegetables, jallof rice, jallof noodles, stew potatoes, omelets and various sauces (tomato, groundnut, "mbongo", okra, pistachio...). Consumers who practice bleaching justified their behavior by poverty, CPO being cheaper than other oils. Carotenoids present in CPO being totally destroyed during bleaching (Dongho *et al.*, 2014), dishes prepared with bleached CPO could not be considered as solution for fighting VAD.

For dishes prepared with unbleached CPO, several was enumerated: corn maize cake, "eru", grounded cocoyam, "kpwem", "koki", "mintoumba", "okok", pounded beans, stew banana/plantain, stew tubers (cassava, cocoyam, yam…), yellow "gari" and yellow sauce.

Table 3 summarizes these dishes and briefly presents the main foodstuffs used, the method of preparation and the form of consumption. It was noted that the majority of the dishes and foodstuffs were based on cereals, tubers and/or

leguminous. Furthermore, those based on vegetables and sauces are eaten associated with cereals and/or tubers. Concerning the preparation method, the study showed that cooking time varies according to the dishes. We distinguished those prepared when cold like yellow sauce and those prepared by cooking. The latter was categorized according to cooking time particularly those with small cooking time (<15 min), those with average cooking time (15-60 min) and those with high cooking time (>60 min). Furthermore, the moment of adding of CPO to dish during cooking depended to the dish. We have those for which oil is added at the beginning of the cooking and those for which it is added during or after the cooking. For some dishes as stew tubers, CPO could be added at the beginning or during cooking according to the preferences. For other as corn maize cake, oil could be added at the beginning or after cooking according to the type of cake and/or to the preferences. Only dishes prepared when cold would contain almost the totality of carotenoids initially present in oil. For those prepared by cooking, carotenoids retention depends not only on the quantity of oil added, but mostly on the cooking time and at the time the oil is added. The dishes most at risk of carotenoids losses are those with high cooking time and for which CPO is added at the beginning of cooking. It has showed that after cooking, these dishes still contain considerable amount of carotenoids able to cover 5-52 % of human vitamin A dietary references intake for 100 g of food (Dongho, 2017). Therefore, all the dishes prepared with unbleached CPO could be used to fight against VAD in Cameroon.

3.3. Consumption of food prepared with unbleached crude palm oil

From 320 individuals contacted, 309 were evaluated. Among them, 89 lived alone (38% originating from "North regions", 19% from "West or North-West", 18% from "Littoral or South-West" and 25% from "Centre, South or East") while 220 lived in family (14% originating from "North regions", 30% from " West or North-West ", 33% from " Littoral or South-West" and 23% from " Centre, South or East ").

Results (Table 4) show that 87% of surveyed people consume unbleached CPO. Non-consumers justified their choice by dietary habits and health problems such as stomach ache. This result was significantly influenced by life style ($p<0.01$) and the region of origin ($p<0.05$). In fact, it was observed that, 95% of people living in family consume unbleached CPO against 70% of those living alone. This could be explained by the fact that majority of people living alone generally feed in public sale points where there are not always dishes prepared with unbleached CPO. Furthermore, those who do not feed in public sale points are used to prepare dishes which do not require unbleached CPO (rice, noodles, fries, etc.) because their preparation process is less complex compared to those prepared with unbleached CPO. Likewise, it was observed that 91%, 90% and 89% respectively of people originating from “Littoral and South-West regions”, “West and North-West regions” and “Centre, East and South regions” consume unbleached CPO against 77% of those from "North regions". This would especially be explained by the fact that the majority of people from "Far North" included in this study lived alone. This observation could also be explained by their dietary habit. In fact, in Cameroon CPO is generally produced in the regions of Littoral, South-West, West, North-West, Centre, East and South.

Table 3: Cameroonian dishes prepared with unbleached crude palm oil, main staples, preparation method and form of consumption

DISHES	MAIN FOODSTUFFS	PREPARATION		FORM OF CONSUMPTION
		Process	Cooking time / Moment of oil adding	
Corn maize cake	Cereal	Corn maize (*Zea mais*) paste supplemented with CPO, salted, wrapped in banana leaves and steamed. Depending on the nature of the corn and added ingredients, we have: fresh corn cake, corn (dry or fresh) cake with peanut (*Arachis sp.*), corn cake (dry or fresh) with soybeans (*Glycine max*), corn cake (dry or fresh) with cocoyam leaves.	High / At the beginning or at end of cooking	Directly or associated with vegetables
"Eru"	Vegetable	Sauce prepared with *Gnetum africanum* and "water leaf" (*Portulaca grandiflora*) leaves, supplemented with CPO, seasoned and spiced.	High / During cooking	Associated with tuber
Grounded cocoyam	Tuber	Cocoyam (*Colocassia sp*) paste supplemented with CPO, salted, wrapped in banana leaves (or plastic) and steamed.	High / At the beginning of cooking	Associated with sauce
"Koki"	Leguminous	Black eyes peas (*Vigna unguiculata*) paste supplemented with CPO, salted, wrapped in banana leaves (tins or aluminum paper) and steamed.	High / At the beginning of cooking	Associated with tubers
"Kpwem"	Vegetable	Sauce prepared with cassava (*Manihot Esculanta*) leaves and paste of fresh peanut, salted or not, supplemented with CPO (or palm nuts juice), seasoned and spiced.	High / During cooking	Associated with tubers or cereals
"Mintoumba"	Tuber	Fermented cassava paste supplemented with CPO, salted, wrapped in banana leaves and steamed.	High / At the beginning of cooking	Directly or associated with vegetables or sauce
"Okok"	Vegetable	Sauce prepared with the *Gnetum africanum* leaves and paste of fresh peanut, supplemented with CPO (or palm nuts juice), seasoned and spiced.	High / During cooking	Associated with tubers
Pounded beans	Leguminous + tuber / fruit	Pasty dish prepared with black or red beans (*Phaseolus sp.*) and with a thickener, mixed with CPO and salt. Depending on the thickener used, one can have: pounded with ripe plantain-banana, pounded with cocoyam, pounded with potato (*Solanum tuberosum*), pounded with corn cake.	Average / At end of cooking	Directly
"Sanga"	Cereal + vegetable	Meal prepared with fresh corn maize seeds, vegetable leaves (*Amaranthus sp.*), bark of garlic tree (*Scorodophleus zenkeri*), supplemented with CPO (or palm nuts juice), salted (or sweetened).	High / During cooking	Directly
Stew banana/plantain	Fruit	Banana (*Musa sapientum*) or plantain (*Musa paradisiaca*) stewed with peanut paste, supplemented with CPO, seasoned and spiced.	Average / At the beginning or during cooking	Directly
Sweet potato cake	Tuber	Sweet potato (*Ipomoea batatas*) paste supplemented with CPO, salted, wrapped in banana leaves and steamed.	Average / At the beginning of cooking	Directly or associated with vegetables or sauce
Stew tubers	Tuber	Stew tubers supplemented with CPO, seasoned and spiced. The most often encountered are: cocoyam, cocoyam with vegetable leaves (*Vernonia sp*), cassava, white yam (*Dioscorea rotundata*).	Average / At the beginning or during cooking	Directly
Yellow "gari"	Tuber	Flour of fermented cassava supplemented with CPO. Cooking time is short (< 15min) and CPO is added at the beginning of the cooking.	Small / At the beginning of cooking	Associated with sugar, milk and/or groundnut
Yellow sauce	/	Sauce prepared when cold with CPO (or palm nuts juice) and spiced.	/	Associated with tubers or cereals

Table 4: Consumption of dishes prepared with unbleached crude palm oil; influence of life style, origin and distribution of dishes according to the place of consumption

	DISHES n (%)													
	Corn maize cake	"Eru"	Grounded cocoyam	"Koki"	"Kpwem"	" Mintoumba"	"Okok"	Pounded beans	"Sanga"	Stew banana / plantain	Stew tubers	Sweet potato cake	Yellow "gari"	Yellow sauce
Consumption of dishes														
Total (n=270)	**159 (59%)**	**217 (80%)**	**194 (72%)**	**252 (93%)**	**141 (52)**	**158 (58%)**	**145 (54%)**	**166 (62%)**	**135 (50%)**	**221 (81%)**	**174 (64%)**	**58 (22%)**	**164 (61%)**	**132 (49%)**
Influence of the to the life style	*ns*	*ns*	*ns*	*ns*	*	*ns*	*ns*	*	*ns*	*	*ns*	*ns*	***	*ns*
Family life (n=208)	127 (61%)	166 (80%)	156 (75%)	196 (94%)	117 (56%)	123 (59%)	118 (57%)	135 (65%)	108 (52%)	177 (85%)	136 (65%)	47 (23%)	114 (55%)	108 (52%)
Solitary life (n=62)	32 (52%)	51 (82%)	38 (61%)	56 (90%)	24 (39%)	35 (56%)	27 (44%)	31 (50%)	27 (44%)	44 (71%)	38 (61%)	11 (18%)	50 (81%)	24 (39%)
Influence of origin	***	*ns*	**	*	***	***	***	**	***	***	*	*	*ns*	***
"Littoral and South-West" (n=80)	51 (64%)	66 (83%)	64 (80%)	76 (95%)	55 (69%)	51 (64%)	56 (70%)	42 (53%)	40 (50%)	64 (80%)	53 (66%)	19 (24%)	49 (61%)	35 (44%)
"North regions" (=49)	14 (29%)	38 (76%)	27 (55%)	44 (90%)	4 (8%)	22 (45%)	10 (20%)	28 (57%)	19 (39%)	35 (71%)	26 (53%)	6 (12%)	28 (57%)	17 (35%)
"West and North-West" (n=74)	53 (72%)	62 (84%)	60 (81%)	72 (97%)	30 (41%)	32 (43%)	29 (39%)	59 (80%)	22 (30%)	72 (97%)	50 (68%)	13 (19%)	46 (62%)	58 (78%)
"Centre, South and East" (n=67)	41 (61%)	51 (76%)	43 (64%)	60 (90%)	52 (78%)	53 (79%)	50 (75%)	37 (57%)	54 (81%)	50 (75%)	45 (67%)	20 (30%)	41 (61%)	22 (33%)
Distribution according to the place of consumption	***	ns	***	***	***	***	***	***	***	***	***	***	***	***
Family	154 (97%)	78 (36%)	172 (89%)	221 (87%)	134 (95%)	128 (81%)	125 (86%)	156 (94%)	125 (93%)	201 (91%)	162 (93%)	57 (98%)	162 (99%)	126 (95%)
Family and restaurant	1 (1%)	63 (29%)	13 (7%)	27 (11%)	2 (1%)	4 (3%)	7 (5%)	3 (2%)	2 (1%)	13 (6%)	8 (5%)	-	-	1 (1%)
Restaurant	3 (2%)	76 (35%)	9 (4%)	4 (2%)	5 (4%)	26 (16%)	13 (9%)	7 (4%)	8 (6%)	7 (3%)	4 (2%)	1 (2%)	2 (1%)	5 (4%)

ns: not significant influence of life style, region of origin on dishes consumption or of place of consumption of dishes at 5%
* Chi2 p<0.05 across lifestyle, region of origin or across the place of consumption
** Chi2 p<0.01 across lifestyle, region of origin or across the place of consumption
*** Chi2 p<0.001 across life style, region of origin or across the place of consumption

Once reached in North regions, because of the transport fees, the cost increases by more than 50% compared to other regions (Ngom *et al.*, 2014; Mbadi, 2017). Therefore, populations of these regions got used to consume soya and cottonseed oils which are more available there. CPO could be consumed by these people if it was available and accessible there. In fact, this study done in Douala where CPO is affordable showed a frequency of consumption very high among originating of North regions and this does not reflect the results found in studies done in North regions which showed that this population do not use to consume CPO (Gouado & Tchouanguep, 2001; Gouado *et al.*, 1998; 2005). Table 4 also gives the frequency of consumption of each meal prepared with unbleached CPO. It shows that the most consumed meals were "koki", stew banana, "eru", grounded cocoyam, stew tubers, pounded beans and yellow "gari" while the less consumed was sweet potato cake. As previously mentioned, the life style and region of origin had a significant influence ($p<0.05$) on the consumption of certain meals. Indeed, except yellow "gari" which was mainly consumed by people living alone, all the other dishes were mainly consumed by people living in family. This could be explained by the fact that yellow "gari" does not require any preparation because it is almost ready for consumption. The consumption of certain meals varied according to the region of origin. In fact, except yellow "gari" which consumption did not significantly vary according to the region of origin, stew tubers were mainly consumed by originating from West, North-West, Littoral, South-West, Centre, South or East. "Koki", grounded cocoyam and "eru" were mainly consumed by those from West, North-West, Littoral and South. "Mintoumba", sweet potato cake, "sanga", "okok" and "kpwem" were mainly consumed by those from South, Centre, South or East while corn maize cake, pounded beans, stew banana and yellow sauce were mainly consumed by those from West and North-West. This study confirms that food habit depends on the origin. In fact, dish originating from a region illustrates the identity of that region. The frequency of consumption of a dish had been highest among people originating of the region of origin of the dish. For example, it is known that "mintoumba" is characteristic of Littoral region; "eru" characteristic of South-West; "sanga" and "kpwem" characteristic of Centre, South and East; yellow sauce characteristic of West and North-West regions (Fokou *et al.*, 2009; Kouebou *et al.*, 2013; Gimou *et al.*, 2014). It was also noted that except "eru" which was consumed as well in families as well as in the public sale points, all the others dishes were consumed especially in family.

4. Conclusion

This study showed that sellers used to expose CPO in open air during commercialization and liquefy it by slight heating and/or by exposition to sunlight. Further, CPO is frequently used in households previously bleached or unbleached. Unbleached, it is used to prepared a wide variety of dishes frequently consumed by the population. These results confirm that CPO could be used to fight against VAD in Cameroon although some efforts have to do to limit carotenoids losses during its selling and use. Therefore adequate sheltered spaces should be developed in the markets for its exhibition. Also, Market policies should develop strategies for better propagation of dishes prepared with unbleached CPO throughout the country. Also, widened nutritional education programs should be developed with focus on carefully use of local foods.

Conflict of interest

The authors declare that there are not conflicts of interest.

Ethics

This Study involves Human Testing and was approved by the national committee of ethics of Cameroon.
Written informed consent was obtained from all persons included in the surveys.

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