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SUSTAINABLE FOOD SYSTEMS FOR FOOD SECURITY

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Chapter 9

Artisanal palm oils: from quality design in southern Cameroon to consumption in Yaoundé

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African countries are facing high population growth, rural exodus and heterogeneous economic growth. These changes are reflected in different ways: rising demand for food, which is supplied by local production and imports; more sedentary lifestyles; and dietary changes, with people eating more out-of-home meals and fried foods, and consuming a higher proportion of fats in their total calorie intake, more processed foods, and less fruits and vegetables. As a result, undernutrition has decreased but still persists, while rates of overweight and metabolic diseases are rising and protein, vitamin A and micronutrient deficiencies remain a main concern (Nansseu et al., 2019; National Institute of Statistics [Cameroon] and ICF, 2020).

African countries around the Gulf of Guinea are traditional producers and eaters of red palm oil (RPO). In these countries, oil and fat consumption is continuously rising as a result of economic development (Ambagna and Dury, 2016), but the younger generations show a tendency to abandon RPO for sociocultural reasons (Lamine, 2006). Meanwhile, the increasing use of palm stearin from refined palm oil by food industries has led to a growing controversy at the international level due to both the environmental impact of industrial oil palm plantations and the health consequences of frequent consumption and high levels of dietary saturated fatty acids. This controversy should be carefully weighed with regard to Africa where RPO consumption could solve health problems related to vitamin A deficiency (Engle-Stone et al., 2017).

In the southern regions of Cameroon where oil palm (*Elaeis guineensis*) is endemic, the production of artisanal RPO is rising due to the development of artisanal mills (Ndjogui et al., 2014; Rafflegeau et al., 2018). Used as an ingredient in various local dishes, the artisanal and industrial RPOs are sold on the markets to local consumers without any quality control for the artisanal RPO. However, a decrease of its consumption per capita has been observed in the urban area of Yaoundé. In 2001, RPO was reported to be the most-consumed oil by the population of Yaoundé,

totalling 60% of oil consumption, 5% of household budgets and 10% of calorie intake for residents. In 2016, RPO accounted for 25% of the oil consumption and only about 20% of the edible oil market due to its lower price than refined palm, soya and cottonseed oils (Rébéna et al. 2019).

This chapter highlights the links between extraction conditions of artisanal RPOs in southern Cameroun and their physicochemical and nutritional characteristics. It also aims to identify the determining factors of consumer choice for specific RPO culinary applications in Yaoundé. The potential contribution (negative or positive) of RPO to nutritional intakes with regard to health issues and dietary trends is also underlined.

⏩ Characteristics of processed fruits, artisanal mills and production factors in the surveyed area

Over time, southern Cameroon farmers developed a deep understanding of how to manage the local wild *dura* palm. From the late 1970s, the African oil palm development plan named 'plan palmier' introduced farmers located near industrial mills to a new high-yield selected palms. This selected *tenera* palm, which produces 100% *tenera type fruits*, is obtained from selected *dura* × *pisifera* palms of different origins (Ndjogui et al., 2014). Farmers rapidly adopted this new selected palm, but they lacked information on its propagation: where to buy selected *tenera* seedlings or seeds and the reasons why they should buy them systematically. Curry et al. (2021) explain why without this propagation knowledge, farmers planted mainly open pollinated progenies, a mix of 50% *tenera* palms, 25% *dura* palms and 25% abortive *pisifera* palms instead of 100% selected *tenera* palms. Farmers located farther away from agro-industries adoped the selected tenera palms more slowly without any support from development projects. Meanwhile, non-governmental organizations promoted the artisanal extraction of RPO by training blacksmiths to replicate different models of small-scale presses (Poku, 2002). Nowadays in the whole palm oil production area, the outcome of these development efforts is a diversity of fruit types processed by artisanal millers, where every possible mixture of fruit types can be seen: 1) wild *dura* fruits with a very thin pulp layer and thick stone shell, 2) *tenera* fruits with thick pulp layer and thin stone shell, and 3) *dura* fruits with intermediate characteristics. Since palm oil is extracted from the pulp, the type of processed palm fruits is the main factor explaining the rate of oil extraction for a given extraction tool and process (Rafflegeau et al., 2018).

In 2015, we interviewed 32 artisanal millers from four production regions and described, for each artisanal mill, the processed fruits, the equipment and the processing conditions. The main technical factors differentiating these artisanal mills were the type of processed palm fruits, the production conditions from harvest to extraction and the type of extraction press, with characteristics varying from one region to another (Figure 9.1).

The survey revealed that the palm oil yield was the lowest in the West region where smallholders often processed wild *dura* palm fruits with water extractors. Using this method, one 200-litre drum of fruits yielded around 25 litres of RPO. In the

other regions, the oil yield ranged from 40 to 60 litres per drum of fruits. These data confirmed the results of a previous survey conducted in 2000 (Rafflegeau and Ndigui, 2001).

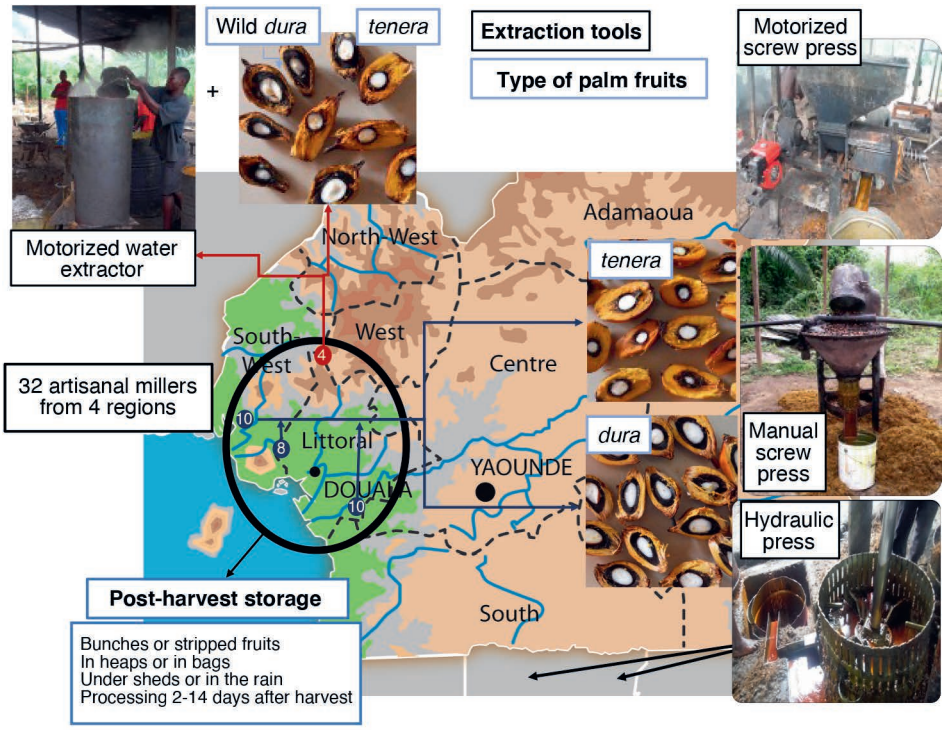

Figure 9.1. Main technical factors differentiating the palm oil artisanal mills in southern Cameroon.

In the Littoral and Centre regions, most of the artisanal millers processed *tenera* or a mix of *tenera* and *dura* fruits, generally harvested from their own plantations, with screw presses or hydraulic presses. In the regions located farther away from oil palm development initiatives, three out of 10 artisanal millers in the South-West region and three out of four in the West region processed wild *dura* fruits. Millers from the West region were the only ones to extract palm oil with motorized water extractors locally designed and machined.

As previously shown, the storage of bunches/fruits before extraction affects the oil extraction yield and the free fatty acid content in the oil. To facilitate stripping and increase RPO extraction yield, the 32 artisanal millers stored the palm fruits prior to extraction as bunches or as stripped fruits in a dry area or under the rain, either in bags or in piles. The time of storage varied between two and 14 days, at a temperature that depended on the season. This contrasts with the way industrial mills operate: they process bunches only from *tenera* palms, selected for their high oil content and harvested at their optimal degree of ripening, within 24 hours of harvesting. Industrial RPO processing meets international export standards.

Another parameter that plays a critical role in oil extraction yield is the temperature of the fruits entering the extraction press. A survey conducted in 2000 (Rafflegeau and Ndigui, 2001) demonstrated that this parameter displayed high variations

depending on the artisanal mills and was a limiting factor. In 2015, all surveyed millers controlled this parameter, often reheating the fruits just before extraction.

⏩ Influence of processed fruit types and process parameters on the composition and quality of artisanal red palm oil

In the investigated area, the palm fruits processed by the artisanal mills were characterized by a considerable heterogeneity. This heterogeneity arises first from the types of planting material planted in oil palm smallholdings, second from cultivation conditions, and finally from harvest and post-harvest practices. The fruit ripening state when the bunches are harvested; their degree of damage (bruising) during harvesting, handling and transportation; and the storage conditions before extraction affect the activity of endogenous and microbial lipolytic enzymes (Nanda et al., 2020). During storage of the bunches and/or the stripped palm fruits, the activated lipases liberate free fatty acids from the oil triacylglycerols.

In line with the literature on the topic, after extraction at laboratory scale using a small manual screw press, selected *tenera* palm fruits yielded more oil (10 g to 16 g palmitic acid [C16]/100 g fruit) than *dura* fruits (about 8 g/100 g). The resulting palm oil was more fluid and less saturated (57 g/100 g fluid fraction versus 44 g/100 g for RPO from *dura* fruits), due to lower proportions of saturated fatty acids (about 51% total fatty acids versus 56% for *dura*), which included palmitic acid (45% versus 50%). RPO from *tenera* fruits also contained higher amounts of unsaturated fatty acids, mainly oleic acid (35% to 39% versus 33% for wild *dura* fruits) and linoleic acid (9% to 13% versus 9%). Interestingly, the RPO extracted from *dura* fruits contained more linolenic acid (1.5% versus 0.3% to 0.4% for *tenera*) and exhibited a nutritionally favourable omega-6/omega-3 ratio (5.7 versus about 32). The contents in lipophilic antioxidant vitamins, namely carotenoids (provitamin A: 690 mg/g to 730 mg/g) and tocopherols plus tocotrienols (vitamin E: 710 mg/g to 750 mg/g) was roughly similar for the tested fruit types.

The effect of the duration of post-harvest storage on oil extraction yield and their free fatty acid content is also well documented (Ngando Ebonge et al., 2011). We measured an increase in the oil extraction yield at lab scale (*tenera* fruits harvested in selected palms at La Dibamba research station), from 15 g/100 g fruit at day 1 to 29 g/100 g at day 9 (19 at day 5). Meanwhile, free fatty acid content (expressed as grams of palmitic acid/100 g oil) increased from 0.5 g/100 g to 9 g/100 g; this level is acceptable according to the current standards for commercial oils (<5%) until day five (2.5 g/100 g). We also observed a small decrease in carotenoid content (Nanda et al., 2020). Based on these results, we concluded that palm fruits can be stored at room temperature for three to five days post-harvest to facilitate fruit stripping, optimize oil yield during small-scale oil extraction, and preserve the oil quality. For storage times over five days, the risk of declining oil quality increases considerably. Storage in a dry place will also prevent mould growth.

We assumed that these palm fruit characteristics (i.e., fruit types plus storage time and conditions) directly influenced the composition and quality of the resulting crude palm oils. However, we were unable to correlate the fatty acid composition of the RPO sampled at the 32 artisanal mills to the fruit types sampled in the same artisanal mills. This is probably due to the heterogeneity of the processed fruit types.

Artisanal RPO contained roughly half unsaturated and half saturated fatty acids, regardless of the processing conditions or fruit types. In the unsaturated fatty acids (48.0% [g /100 g total identified fatty acids] to 57.3%, mean value: 51.8% ± 1.9), oleic acid content ranged from 36.5% to 46.6% (mean value: 48.2% ± 1.9) and linoleic acid from 8.5% to 11.1% (mean value: 9.8 % ± 2.7). Saturated fatty acids ranged from 44.9% to 51.9% (48.2% ± 1.9), including palmitic acid from 38.5% to 44.7% (41.4% ± 1.7). This composition gives RPO a semi-fluid texture, which is important in achieving the desired characteristics in local dishes. From a nutritional point of view, due to the molecular structure of the palm oil triacylglycerols, the saturated fatty acids (mainly found in external positions of triacylglycerols), are preferentially oxidized, which provides energy without being (or only weakly) atherogenic (Hayes and Khosla, 2007; May and Nesaretnam, 2014). Unsaturated fatty acids, among them the essential linolenic acid, are mainly found in the triacylglycerols' internal position and are thus fully bioavailable. Regarding micronutrients, RPO contained relatively high amounts of carotenoids (390–980 μg/g oil), which are absent from most commercially refined oils. Interestingly, the highest carotenoid content was observed for oils sampled in the West region, where motorized water extractors are used and mainly wild *dura* palms are grown. Carotenoids are what give RPO its orange colour. They display provitamin A activity, which is very important for the population in Cameroon, which suffers from vitamin A deficiency (Dong et al., 2017; Engle-Stone et al., 2017; Oguntibeju et al., 2009). The oils also contained vitamin E isomers (180–790 mg/g), mainly in the form of tocotrienols that, in addition to their antioxidant activities, exhibit anticancer and cardioprotective properties (Agostini-Costa, 2018). Importantly, all the RPOs exhibited peroxide value < 10 mEq active oxygen/kg (mean value = 2.8) corresponding to low oxidation levels and compliance with *Codex alimentarius* specifications (WHO, 2019).

The free fatty acid levels of the 32 RPOs ranged from 4.0 g palmitic acid/100 g to 35.1 g palmitic acid/100 g (9.0 g/100 g ± 7.3). Among the RPO samples, only 10 had a free fatty acid content of < 5 g/100 g; the majority (16 samples) had free fatty acid contents of between 5 and 10 g/100 g, and six samples had free fatty acid contents of more than 10 g/100 g, generally around 20 g/100 g. Only one sample reached 35.1 g/100 g. These samples corresponded to over-ripe fruits stored for 14 days, to loose fruits stored in bags for six days, or to fruits stored (three to six days) in bags under the rain. Free fatty acid content over 5 g/100 g is generally considered as detrimental for commercial oil quality and corresponds to the maximum level recommended by international organizations (WHO, 2019). However, it should be noted that free fatty acids do not present any identified adverse toxicological effects. From a nutritional point of view, it would be relevant to address the effects on postprandial lipemia and the metabolic consequences of the presence of high amount of free fatty acids in the bolus before any action of digestive lipase.

⏩ Supply and market practices for artisanal and industrial RPOs in Yaoundé

The RPO issued from industrial and artisanal mills reaches the final consumers in Yaoundé through a supply chain that includes transportation, packaging and possible blending of the oils in containers varying by volumes and material. This supply chain concerns the oil producers who sell directly to mills or in neighbouring markets (only for artisanal millers), and to wholesalers, semi-wholesalers and retailers located in Yaoundé's small shops and marketplaces (Figure 9.2).

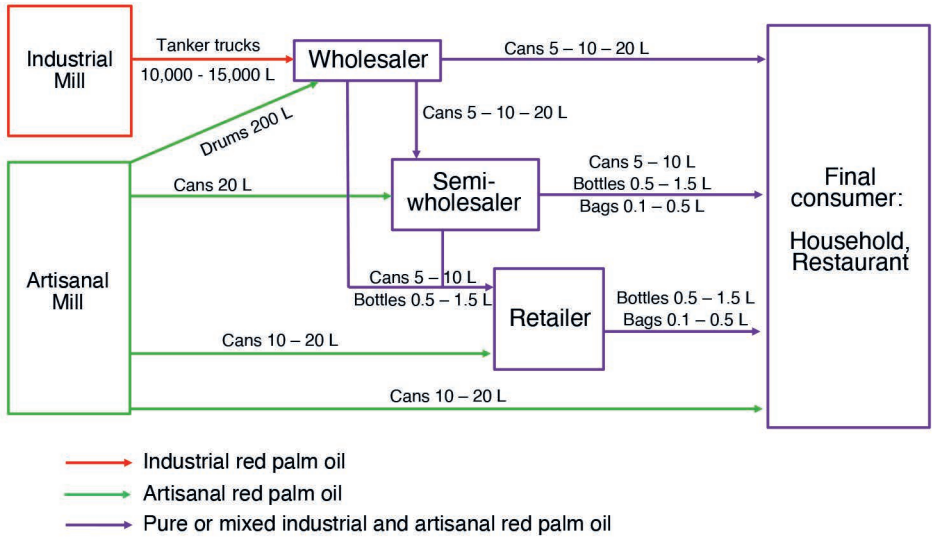

Figure 9.2. Red palm oil supply chain from industrial and artisanal mills to final consumers in Yaoundé (from Rébéna, 2016).

Sometimes wholesalers, semi-wholesalers and retailers mix artisanal and industrial red palm oils, so consumers are used to buying pure or mixed industrial and artisanal red palm oil .

The governement sets the wholesale price for industrial RPO (all taxes included XAF536 per litre in 2016), adding a 20% value added tax, while the price of artisanal RPO fluctuates with the season around an average price of XAF500 per litre without tax. Wholesalers appreciate the stable quality and price of industrial RPO, while they criticize the unpredictable quality of artisanal RPO.

Even if industrial and artisanal RPOs and their mixes have a similar appearance, the quality may vary widely. Wholesalers, retailers, sellers in small neighbourhood shops and the marketplaces, and buyers all use many different names to describe RPO: *huile rouge* [red oil], *huile artisanale* [artisanal oil], *huile industrielle* [industrial oil], and *huile de palme rouge* [red palm oil] are all generic names, but they offer little information about the characteristics of a given oil. Other common names include *huile Bassa* [Bassa oil, which refers to the Bassa people area], *huile Dizangué* [Dizangué oil, after the name of the town], *huile du village* [village oil], *huile Socapalm* [Socapalm oil, after the name of an agro-industry] and *huile Mulapalm* [Mula palm

oil, also after Socapalm, which was selling under this trade name one litre bottled fractioned fluid RPO]. These names are mostly based on the origin of the oil, which is considered to be a quality criterion, but the definition and actual meanings implied by these names fluctuated significantly. Sellers have also their own specific vocabulary such as: *huile de premier choix* ['first-choice' oil], *huile de taro* [taro oil, because the oil is used in a typical dish made with taro] and *tête d'huile* [top oil]. Women and restaurateurs also use their own vocabulary: *huile brute* [raw oil], *huile traditionnelle* [traditional oil], *huile lourde* [heavy oil], *huile fluide* [fluid oil] and *huile pour la sauce jaune* [oil for yellow soup]. Despite this profusion of names, buyers and sellers agree on three main types of RPO based on their colour and texture (Figure 9.3).

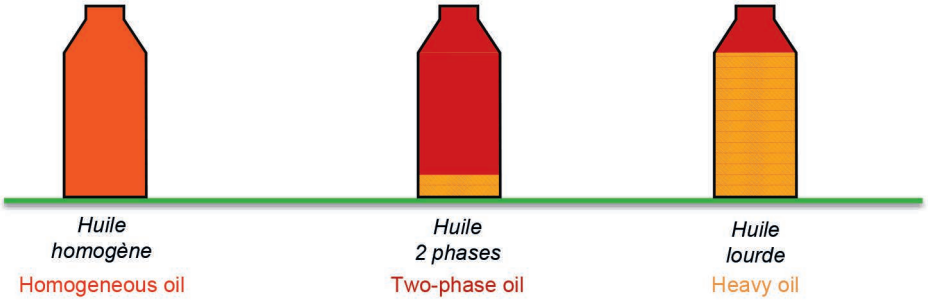

Figure 9.3. Three types of red palm oil are sold in markets and small shops in Yaoundé (from Rébéna 2016).

The homogenous oil is orange-red, slightly opaque and has a thick texture. The two-phase oil has a predominantly translucide, very red and liquid top phase and a small, opaque pale orange and semi-solid bottom phase. The heavy oil contains the same phases as the two-phase oil in reversed proportions .

The oil known as *huile homogène* [homogenous oil] is regularly shaken or stirred by the sellers in 200-litre metal drums to keep it from separating. Each buyer thus purchases a homogeneous portion of the RPO, rather than the top fluid phase of the container for the first buyers or the semi-solid bottom phase for the last buyers. Sellers may also divide the RPO into a mainly fluid RPO sold at a slightly higher price than the homogenous oil, and a mainly semi-solid RPO sold at a lower price. In absolute value, according to buyers, the price for homogenous oil and the two-phase oil varies by up to 100% according to the number of re-sellers and the oil quality.

⏩ Red palm oil: choice criteria, purchase strategy and consumption in Yaoundé

Consumers from Yaoundé buy artisanal palm oil in 20-litre cans directly from millers while travelling to the production area. They also buy RPO from wholesalers, semi-wholesalers and retailers in five to 10-litre cans, 0.5 to 1-litre plastic bottles or individual plastic bags in amounts depending primarily on their storage and cooking strategy, as well as their region of origin and standard of living.

Based on surveys conducted in 2016 of 124 households and 29 small restaurants in Yaoundé (Rébéna et al., 2019), our main findings show that:
– Consumers buy both artisanal and industrial RPOs (pure or mixed).
– They sometimes separate the oil at home into a more semi-solid form to keep part of it for certain dishes (for example, yellow soup) and the other, more fluid part for other uses.
– RPO consumption was found to decrease compared to previous surveys, but it always represented a significant part of the total consumption of edible oils (average consumption = 0.48 L/month/capita, representing about 34% of total consumption of edible oils).
– RPO consumption (from 0 to 3 L/month/capita) and uses vary considerably according to the socioeconomic profile and ethnogeographic origin of the surveyed women.

RPO purchasing criteria by end users are based on 1) the appearance of the oil: colour, texture, odour and taste; 2) the targeted use: consumers choose a more fluid or more semi-solid RPO depending on the dishes they want to prepare; 3) the trust buyers have in known re-sellers and/or in the oil's origin (e.g., the village where the artisanal RPO was extracted); and 4) oil price: for some buyers, a high-quality RPO is always more expensive.

Other criteria such as oil stability at high (frying) temperatures (an RPO that produces smoke upon heating is considered to be of poor quality), the freshness of fruits used for oil extraction and the oil composition are generally not available at small stores and market stalls.

Women and restaurateurs buy in decreasing amounts:
– Homogenous oil, with an average price of XAF690/L (XAF450 to 1000/L), whatever the region of origin;
– Two-phase oil, with an average price of XAF670/L (XAF450 to 1000/L), with a preference for consumers from the three northern regions;
– Heavy oil, with average price of XAF590/L (XAF500 to 750/L); consumers originally from the West, North-West and South-West regions preferentially buy this oil.

By comparison, the average market price for a one-litre bottle of refined palm oil fetches XAF1200/L.

Consumers buy RPO from semi-wholesalers when they want to stock up and from retailers for immediate use when they have run out. The higher the consumers' living standard and RPO consumption, the more they buy oil from wholesalers and artisanal millers in larger containers. People who have moved recently to Yaoundé (within eight years or so) maintain ties with their home village, where they often buy pure artisanal RPO directly from artisanal millers as a guarantee of quality. Large RPO containers may also be offered as a gift by family members still living in the home village. Women of Yaoundé who are originally from the three northern regions of Cameroon use less RPO than others, so they buy RPO for occasional use in small containers from retailers or semi-wholesalers. Consumers regularly purchase RPO from sellers they trust. Otherwise, when they do not trust the seller, they buy RPO in small containers to reduce the risk of buying poor-quality RPO.

The average RPO consumption of 0.48 L/month/capita would supply the provitamin A and vitamin E amounts recommended by international food security and nutrition

or health agencies. However, RPO consumption is very heterogeneous depending on the region of origin of the surveyed women and regional food habits, ranging from 0 to 3.0 L/month/capita. RPO consumption is particularly low among the population originally from the northern regions of Cameroon, and who are the most sensitive to vitamin A deficiency in Yaoundé.

Red palm oil: a main ingredient in local dishes

Our survey provides evidence that women living in Yaoundé know an average of 3.8 cooking recipes (from 0 to 9) with RPO as ingredient (Rébéna et al., 2019). Women cook from 0 to 44 dishes with RPO per month (11 on average). The average number of recipes including RPO known by a given surveyed woman roughly reflects the average RPO consumption per capita for a given region of origin. It is the highest for surveyed women from the regions where oil palm is endemic. It is the lowest, both for the number of known dishes (2) and for dishes prepared with RPO per month (2), for women originally from the northern regions where oil palm does not grow. In contrast, an average of 16 dishes are prepared with RPO per month by the women originally from the Centre and North-West/South-West regions (Figure 9.4). These results illustrate the huge diversity between surveyed women.

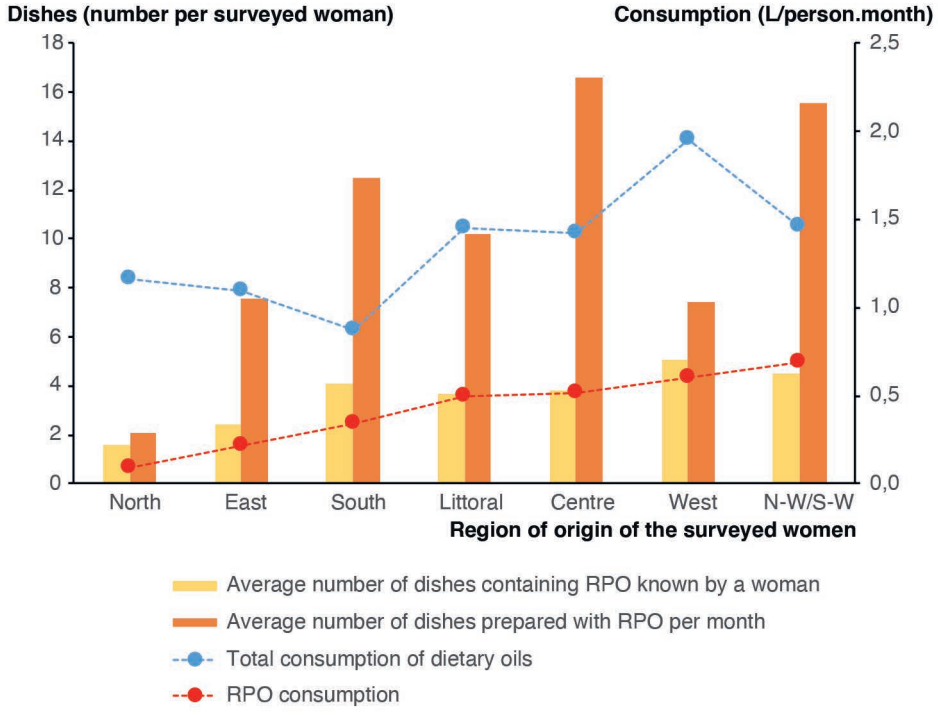

Figure 9.4. The use of red palm oil (RPO) by Yaoundé's women according to their region of origin.

The women surveyed who were over age 46, those born in Yaoundé and/or those belonging to households with 10 to 16 people declare the highest monthly per-capita consumption of RPO. The reason for this use in large households is budget-driven, since RPO is much cheaper than refined palm oil. The youngest women consume less RPO than their mothers and tend to replace RPO with other oils.

Women of Yaoundé are used to cooking with RPO, refined palm oil, or a mix (Figure 9.5). Some of the women heat RPO at a high temperature until its colour becomes lighter. This treatment degrades carotenoids and other antioxidants, causes losses of essential fatty acids and produces toxic neo-formed contaminants. This RPO, called *huile blanchie* (bleached oil) is prepared and used when the heavy colour of RPO is considered to be detrimental to the appearance of the dishes (mostly for frying and in sauces).

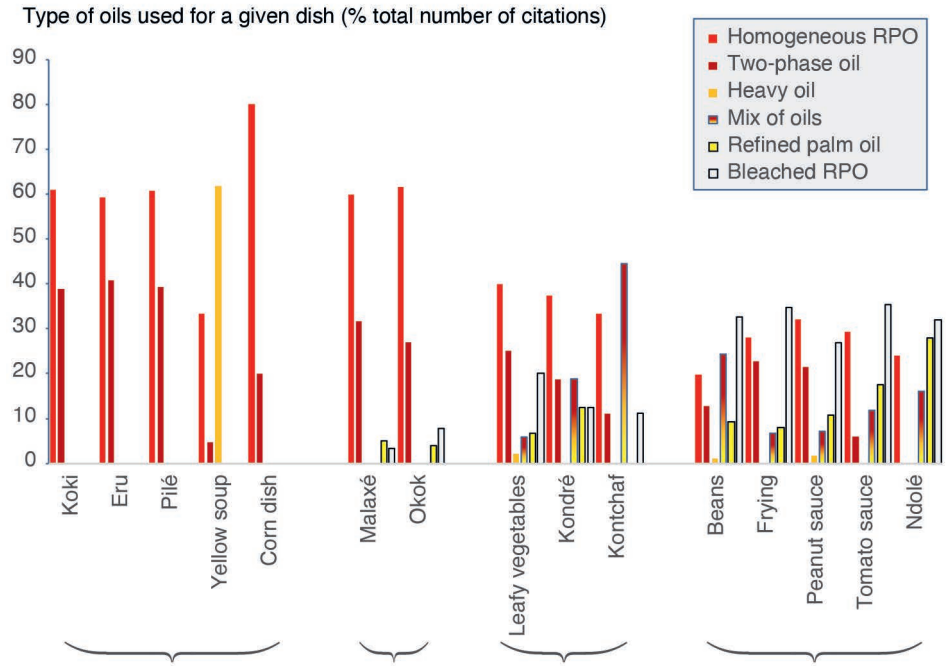

Figure 9.5. Uses of red palm oils (RPO) for cooking and importance of RPO in dishes: percentage of the different oils cited to be used to prepare a given dish (modified from Rébéna, 2016).

RPO has a different status as an ingredient in dishes (from left to right): it may be irreplaceable for some dishes, replaceable if necessary for others, appreciated but replaceable for others, or only as a substitute for another preferred oil.

Three main drivers explain households' uses of refined palm oil and RPOs. First, households follow traditions by reproducing their family cooking habits. Second, they consider the oil's culinary properties: taste, colour (a red or yellow colour is desired) and texture (a dish cooked with RPO needs to be hot enough to keep the sauce fluid; a good yellow soup depends on the RPO being able to stabilize the foamed emulsion). Third, the choice is economical because RPO costs half as much as refined palm oil,

with the heavy oil type being the cheapest. Price leads consumers to separate and bleach RPO at home to produce bleached oil when the red colour is not desired.

High levels of free fatty acids in RPOs and the presence of the semi-solid phase help the oils form stable emulsions and contribute to the popularity of local dishes such as yellow soup. Free fatty acids contribute to the oral detection and sensory characteristics of fats (Poette et al., 2013) and thus participate in the typical taste of local dishes. A panel has recently evaluated versions of yellow soup prepared with RPOs with different acidity indices. The panel preferred the dishes prepared with the oil presenting the highest acidity index (about 16 mg KOH/g oil), corresponding to free fatty acid content around 7 g palmitic acid/100 g oil). However, a maximum acceptable level was not determined.

⏩ Conclusion

In this chapter, we explored the artisanal palm oil sector in Cameroon and highlighted links between the tools and practices of artisanal millers, the physicochemical and nutritional characteristics of red palm oil (RPO), the RPO distribution chain, and purchase criteria and cooking uses by consumers in Yaoundé. Our work provided evidence of a sector that includes a large variety of actors, processes, marketing conditions, types and usages of RPOs. The development of this artisanal sector could be an opportunity for the local development of small-scale entrepreneurship with economical, nutritional and anthropologic benefits including the preservation of local cultures.

One main conclusion is that, whatever the type of RPO, it is of nutritional interest for all local consumers because of the provitamin A content, a micronutrient for which deficiencies exist in Cameroon. Artisanal RPO is also characterized by a balanced fatty acid composition. RPO consumption should thus be promoted in the whole population, with specific messages targeting those who do not traditionally use this oil, i.e., those originally from the three northern regions of Cameroon and the younger generations who have tended to abandon its consumption. Simple and affordable recipes could be also disseminated among these populations.

RPO is of culinary interest for traditional African dishes in which it is irreplaceable due to its typical taste, colour, flavour and texture (Lamine, 2006). The artisanal RPO often contains levels of free fatty acids that are higher than current international standards, but these high levels likely participate in the characteristic and desirable flavour and texture of typical dishes such as yellow soup. However, to limit free fatty acid content in the oils to acceptable levels, avoid loss of vitamin E and A in RPOs while maximizing oil yield, and making fruit stripping easier, recommendations should be made to artisanal millers to process the fruits within five days of harvest and to store the bunches or fruits in dry conditions, or within three days of harvest to obtain red palm oil with free fatty acid levels that meet international export quality criteria.

The diversity of planting material and resultant types of palm fruits (*tenera* and *dura* from selected seedling to wild *dura* fruits and their mixtures), and of oil extraction conditions leads to production of artisanal RPOs with a large range of sensorial and culinary properties. One major challenge faced by end users of RPO (women and

restaurant owners) is the lack of information about the quality and usages of the different RPOs present on the market.

There is a need to support the operators of the artisanal RPO sector through control of production and marketing circuits in order to promote market segregation of different qualities and labelling of RPO. Segregated quality RPO types could emerge from the clear identification of new oil quality criteria based on objective data, local names and/or commercially recognized labels, and display of recommended uses (for example 'heavy oil' is the recommended RPO for yellow soup). The optimal characteristics (e.g., processed fruit types, free fatty acid content, liquid-to-solid phase ratio) and processing conditions to obtain a RPO suitable for the preparation of specific culinary dishes still need to be defined.

Going forward, some key points should be addressed:
– the environmental impacts specific to artisanal RPO production: deforestation associated with artisanal mill expansion (Ordway et al., 2019), use of agricultural inputs (low), water supply and use of biomass energy (firewood, fibres, nut shells and sometimes kernel nuts), effluent treatment (non-existent in artisanal mills but available in industrial mills)
– productivity: loss of a third of the oil not extracted due to poor oil extraction rate, potentially lost co-products (part of the kernels nuts) and by-products (part of the fibres and nut shells)
– social and working conditions, labour health and safety
– food safety: evaluation of contaminants from the environment or from processing and packaging (neo-formed compounds, compounds from materials in contact with the oil)

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