Red palm oil authenticity and fraud detection: Awareness, perceptions, and knowledge of producers, sellers and consumers in Cameroon

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ABSTRACT
Introduction: Nowadays, the notion of food authenticity is of utmost importance to consumers considering the devastating food fraud-related incidents both from economic and health perspectives. For example, there is a rising concern over red palm oil (RPO) adulteration in West Africa where RPO has been revealed to be adulterated with Sudan IV dyes. In Cameroon, there is little or no information on RPO adulteration. **Objective:** This study aimed to assess the awareness, perceptions, and knowledge of producers, sellers, and consumers of RPO in Cameroon (Douala and or Yaounde) concerning RPO authenticity, adulteration, and fraud detection. **Methodology:** Data was collected using three different semi-structured questionnaires issued to producers, sellers, and consumers. **Results:** 38% of producers, 26% of sellers, and 47,3% of consumers were aware of adulteration in RPO. 23%, 22%, and 31,5% of producers, sellers, and consumers respectively confirmed that water is commonly used to adulterate RPO. Sellers (44%) and consumers (27%) revealed that colourants or dyes are common adulterants in RPO. Appearance (37% sellers and 56% consumers) and colour (37% sellers and 64% consumers) were identified as the main criteria used by the various studied stakeholders to discriminate authentic RPO from adulterated RPO. **Conclusion:** Among the large variety of foodstuffs falling prey to adulteration palm oil was revealed to be one of the main victims in Africa, Cameroon. Upon realizing this study, the following substances were reported as adulterants: water (POME/ process residual wastewater), paint, dyes from the Sudan family, and low-quality RPO; furthermore, almost all means of detection reported in this study irrespective of the respondent group (producers, sellers, and consumers) were either based on taste, smell, and aspect and may not have any scientific validity but are used till date by consumers to choose a quality RPO

Keywords: Artisanal red palm oil, Consumers, Fraud, Awareness, Perception

I.   INTRODUCTION

The notion of food authenticity and food fraud, maybe old age, but is technically new in Cameroon and has been highlighted by **Abia (2023)**. Food authenticity refers to the original state of food which should be genuine and undisputed in its nature, origin, identity, and claims and meet expected properties (**FAO and WHO, 2018**). In other words, a food is authentic when it or its content corresponds to the original condition and the information on the label (**Abia,2023; Elliott, 2014, 2018**). Food Fraud is the deliberate substitution, addition, adulteration, or misrepresentation of food or food ingredients for economic gain (**Abia, 2023; Elliott, 2014, 2018; FAO, 2017**). As a common food fraud type, Adulteration can occur either by substitution, dilution, unapproved enhancement, or concealment (**Erverstine et al., 2013**). Taking into consideration, some socio-economic factors such as the length and complexity of supply chains, the weakness of control systems and detection tools, the rising gap between supply and demand

concerning many foodstuffs, the smallholder economic system, and the lack of consumers' awareness of which contribute to the amplification of this problem of food fraud in Africa (**Onyeka et al., 2022**). Adulteration of red palm oil (RPO)has been reported in Nigeria (**Nwachoko and Fortune, 2019; Ibukun et al., 2021; Eteng et al., 2022**) and Ghana (**Amoako-Mensah, 2016; Teye et al., 2019; Andohetal., 2020**). The majority of these incidents were linked to health consequences therefore increasing the public's attention to food authenticity and help raising awareness on food fraud.

This background also applies to Cameroon where a variety of products are affected among which RPO suspicion of adulteration is mostly reported in social media. In Cameroon, RPO famous for its deep red colour is an essential ingredient in most traditional delicacies and an important pillar of Cameroon's economic growth (**Nchandji et al., 2013; Dongho et al., 2016**). Furthermore, RPO production in Cameroon is mainly assured by industrials and smallholders (local producers). However, only 1% of the industrial production is found on local markets (**Mbila et al., 2020**), the rest being from artisanal production which research has mainly focused on the quality aspects of the RPO in Cameroon (**Ngando et al., 2011; Ngando et al., 2013; Dongho et al., 2016**), with inadequate or no study on its authenticity or fraud detection.

In recent years, some potential RPO adulterants have been revealed to include Sudan dyes in Ghana (**Teye et al., 2019**), and sorghum bicolour leaves extract in Nigeria (**Okogeri et al., 2016**). Several laboratory / analytical techniques are known to be used in oil authentication worldwide: prominent in these methods are high-performance liquid chromatography (HPLC), liquid chromatography-tandem mass spectrometry (LC-MS/MS), near-infrared spectroscopy (NIR), and Fourier transform infrared spectroscopy (FTIR) (**Andoh et al., 2019**). These techniques are however either time-consuming, expensive, laboratory-based, or unpracticable for consumers' personal use; therefore, there is a need to look for simple methods that may be used locally by the different stakeholders to assess RPO authenticity and detect fraud. To achieve this goal, a descriptive study was conducted among producers, sellers, and consumers of artisanal RPO to investigate their awareness, perception, and knowledge about RPO authenticity and fraud detection.

II. METHODOLOGY

This survey conducted between August and December 2022 was carried out in the two largest cities of Cameroon: Douala (being the economic capital; estimated at 210 Km^2 with 4.063 million inhabitants Latitude: 4°03' North; Longitude: 9°42'East) and Yaounde (the administrative capital; approximately 180 Km^2 with about 4.5 million inhabitants; Latitude: 3°50' North; longitude: 11°29' East). Of interest in this study were those who produce, sell/retail, and or consume artisanal red palm oil (RPO) sold in local markets in Douala and or Yaounde.

For data collection purposes, three different sets of semi-structured questionnaires were developed and pretested accordingly before administration. The questionnaire for producers was focused on artisanal RPO processing; as well as on their awareness, perception, and knowledge of RPO authenticity and fraud detection; and how they can detect their product in the market. Sellers/retailers' questionnaires dwelled on their understanding of the RPO market system, RPO commercialization (sale, opportunities, and motives for adulteration), as well as their awareness of any potential adulterants and how to differentiate adulterated from authentic RPO. In addition to the above, consumers' questionnaires capitalized on how they feel if they have been/are been sold adulterated RPO, and whether they are willing to fight against RPO fraud.

Producers and retailers were met at their production and or retailing sides where each of them was administered a semi-structured questionnaire. Whilst the consumer populations survey was done online whereby a semi-structured questionnaire was processed into Google Form, a link was generated and sent out to potential participants via a variety of social networks such as meeting groups, market people / "buyam-sellam" platforms, and youth groups amongst others.

Data was then extracted from the questionnaires and analyzed using basic descriptive statistics of mean and presented in the form of tables, or figures.

III. RESULTS AND DISCUSSION

In total, 13 out of 18 producers and 27 out of 75 retailers of artisanal red palm oil (RPO) that were visited responded to the semi-structured questionnaire. Results and discussion are presented below according to studied sub-population groups, and in the end, a comprehensive discussion is presented.

3.1 Producers

The studied artisanal RPO producers had varied experiences including >20 years (23%), 6-20 years (39%), and less than 5 years (38%). 23 (3/13) percent of the producers manually press out the artisanal RPO, whilst 76 (10/13) percent use a machine (motorized press). The majority (62%) of producers were aware of food fraud in general and 38% were aware of RPO adulteration. 23 % of producers revealed that wastewater (i.e., RPO mill effluent, POME; locally known as "mbouki") is the main adulterant used by producers. POME is a brown slurry of organic solids (4-5%), residual oil (0.5-1.0%), and water (95%) which is generated by the RPO mill during the multiple processing steps of crude oil production (**Tan et al.,2015**). Because of the residual oil contained in this oil, POME will blend with RPO creating a homogenous paste-like mix.

Furthermore, all producers indicated that the major motive for adulteration is to increase the quantity to meet customers' demand and more importantly to make more profit. Generally, all studied producers revealed that originality/authenticity can be assessed basically through colour, taste, smell, and viscosity.

Additionally, producers indicated that adulteration may also be aimed at enhancing the appearance and colour of RPO considering that many factors along the processing stages can negatively impact those parameters. For example, the maturity (ripeness) of palm nuts, the type/species of nuts, the freshness of the nuts upon processing (delay between harvest and processing), fermentation time to allow for easy detachment of the fruits from the bunch/truck (generally, 5-7 days - again depending of stage of harvesting, and at which time any wounded / brushed fruit would likely accumulate triacylglycerol molecules (**Ngando et al.,2013**) leading to oil acidity that may affect appearance of the finished product and the cooking time and storage conditions.

3.2 Sellers/retailers in local markets

All studied artisanal RPO sellers in local markets in Douala and Yaounde revealed that they bought the artisanal RPO they are selling from different large-scale retailers/distributors who are generally unidentified as some are uncontrolled traders as the supply chain is mostly informal as highlighted by **Onyeka et al 2022** as a factor for food fraud in Africa. This speculates the lack of traceability of RPO sold in the market to the original producers, hence, its authenticity remains questionable. Therefore, this inability to track RPO on the market back to its origin gave opportunities to fraudsters to conduct adulteration.67% of the studied artisanal RPO retailers were aware of food fraud in general and 26% were aware of RPO adulteration specifically. The studied sellers generally detect RPO fraud based on the appearance (37%), colour (37%), and experience of the seller (26%) (Figure 1A). Sellers generally revealed that they are aware that some sellers or large-scale retailers/distributors sometimes adulterate RPO with water (22%), red dyes (44%), cassava flour (26%), and or other low-quality, less expensive oils (7%) (Figure 1B).
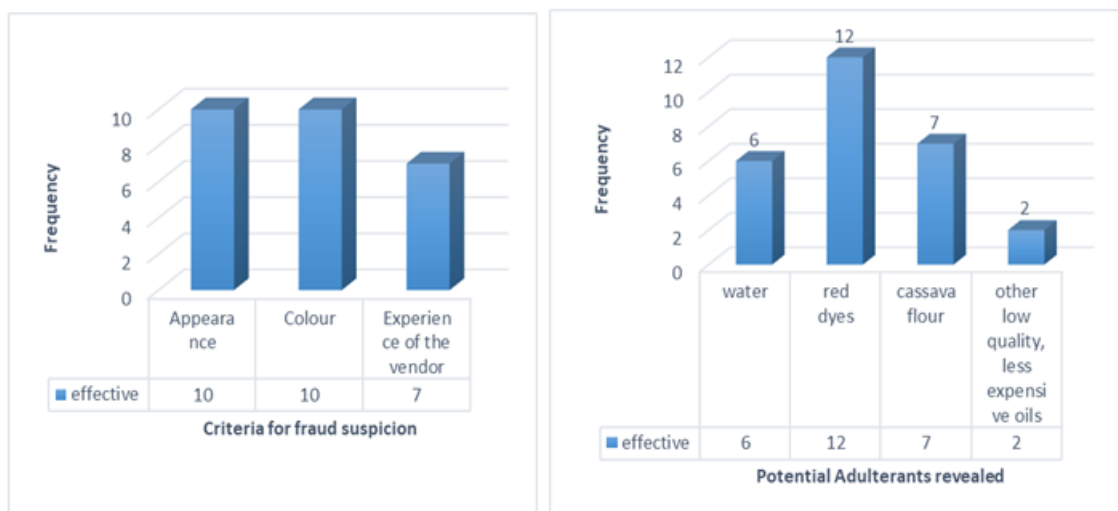
Figure 1: Criteria for fraud suspicion in RPO (A) and potential adulterants (B)

3.3 Consumers

Studied consumers revealed that artisanal RPO is the most highly consumed vegetable oil used widely in cooking and is also generally used in preparing traditional medicine. 80% of the studied consumers generally use RPO daily, whilst 20% scarcely use it. The majority (60%) of consumers did not know the origin of the RPO they buy and consume. 96% of the participants buy their RPO from the local markets, typically from petit sellers/retailers (78%).68,7% indicated they can identify good quality and authentic RPO (Table 10). 74,7% of the participants had heard about food fraud, with 47,3% of the respondents being aware of RPO fraud. In line with **Abayase et al. (2022)** findings, the majority of consumers are aware of food adulteration practices on the market but find fraud detection challenging. Therefore, they mostly rely on some organoleptic parameters to choose a good quality palm oil on the market: as such, according to the participants interviewed in Douala and Yaounde, the major criteria to assess the quality and choose RPO is the colour and taste (64%) (Figure 2). 30,7% of participants claim to be able to identify adulterated RPO (Table 1). According to the respondents, the adulterants mostly used in RPO adulteration in Douala and Yaounde are in order of frequency of use, water, followed by red coloured dyes like Sudan dye IV as identified by **Essuman et al. (2022)**, low-quality RPO, chemicals, and both paints and cassava flour (Figure 3). According to consumers, the main motive for adulteration is the economic game.

Despite the growing concern of media outlets and the research community (**Teye et al.,2019; Andoh et al.,2020**) towards RPO adulteration, more than half of the consumers surveyed in this study were unaware of Red Palm Oil adulteration which is in accord with the findings from **Essuman et al. (2022)** which explains consumers lack information concerning common food adulterants and its effect on human health. Moreover, very few though aware of the existence of adulteration knew of ways to distinguish between adulterated goods from authentic ones; these results are in line with **Abayase et al. (2022)** findings, which explains that consumers who are aware of food adulteration practices are less likely to know of how to detect its use at the household level.
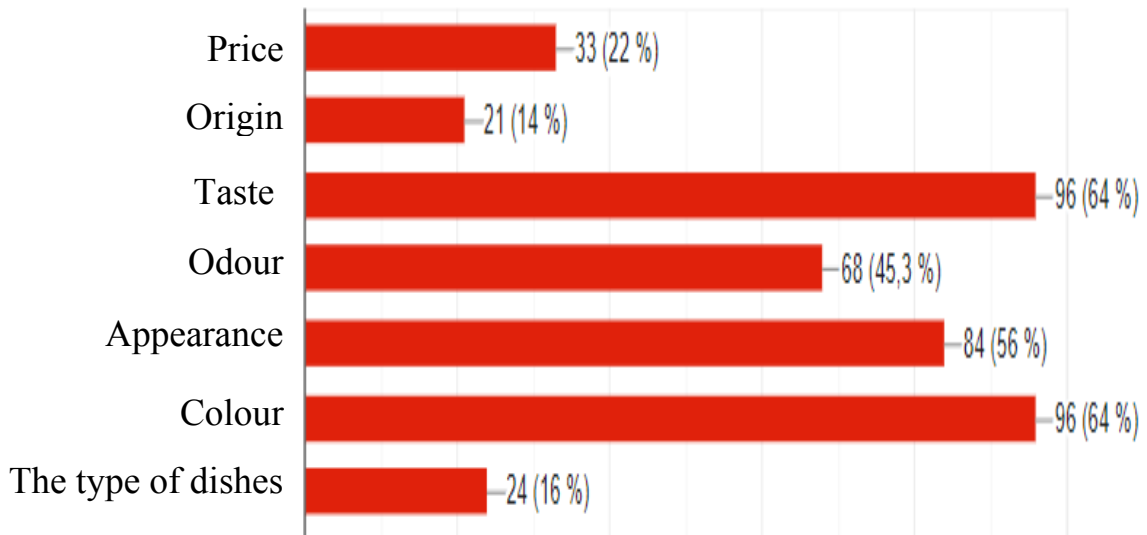
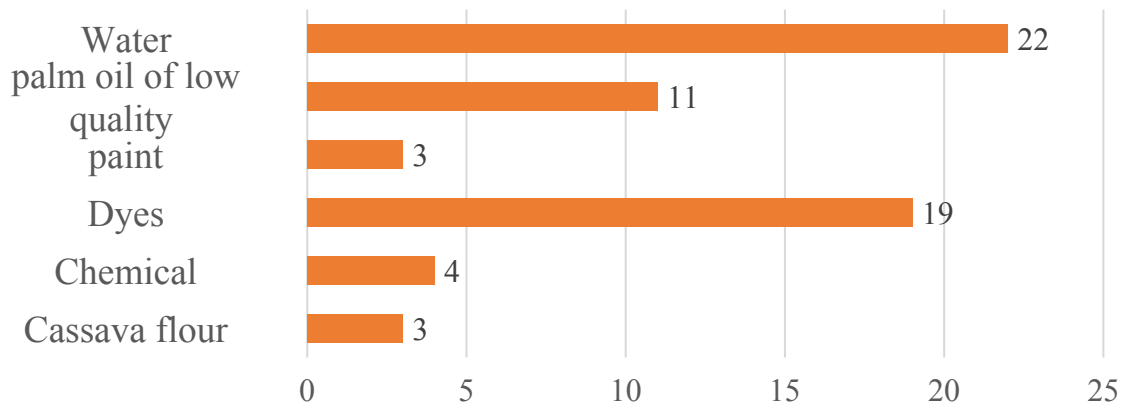Figure 2. What are the determining factors in choosing quality RPO?

Figure 3. Substances used in RPO adulteration.

Table 1. Awareness of red palm oil fraud

	Yes %	No %	Maybe %
Can you identify a good quality Red Palm Oil?	68.7	31.3	0
Have you ever heard of Food Fraud?	74.7	22	3.3
Are you aware of food fraud on Red Palm Oil?	47.3	52.7	0
Can you identify Adulterated Red Palm Oil?	30.7	69.3	0

IV.

V. CONCLUSION

Red palm oil (RPO)is a very popular commodity consumed in Cameroon for various purposes (cooking, food industry, chemical industry, biodiesel, etc). RPO is generally produced by smallholders (or local producers and is known as artisanal RPO – mainly for cooking) and RPO industries (less often for cooking). RPO distribution from the production site to the market where its consumers get access is a long and complex supply chain/network with many

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intermediaries (wholesalers, retailers, etc) along which adulteration is likely to occur. Several consumers are aware of RPO adulteration, specifically with water (POME/ process residual wastewater); red-coloured chemicals such as paint, dyes e.g. Sudan dye; and low-quality RPO. Consumers suspect adulterated RPO are based on taste and smell, which may not always be clear. There is a need for RPO fraud detection studies in Cameroon, as well as an enhanced food safety framework to protect consumers' health.

REFERENCES:

[1]. Abia, W.A. (2023) Food fraud-detection: The role of spectroscopy coupled with chemometrics. J.Nutr. Diet Management,1, 103 [DOI: 10.59462/JNDM.1.1.103].

[2]. Amoako-Mensah, J. (2016) Assessment of the prevalence of Palm Oil adulteration with Sudan IV dye in the Greater Accra Region. Department of Food Science and Technology. Kwame Nkrumah University of Science and Technology College of Science.

[3]. Andoh, S.S., Nuutinen, T., Mingle, C. & Roussey, M. (2019) Qualitative analysis of Sudan IV in edible palm oil. Journal of the European Optical Society-Rapid Publications,15, 21[DOI: 10.1186/s41476-019-0117-0].

[4]. Andoh, S.S., Nyave, K., Asamoah, B., Kanyathare, B., Nuutinen, T., Mingle, C., Peiponen, K.E. &Roussey, M. (2020) Optical screening for the presence of banned Sudan III and Sudan IV dyes in edible palm oils. Food Additives and Contaminants. Part A, Chemistry, Analysis, Control, Exposure and Risk Assessment,37, 1049–1060[DOI: 10.1080/19440049.2020.1726500][PubMed: 32077804].

[5]. Deudjui, G., Chongwang, J.&Nakweya, G. (2020) Poisons used to beautify food in Africa. Available from: https://www.scidev.net/sub-saharan-africa/features/poisons-used-to-beautify-food-in-africa/Accessed18.12.2021.

[6]. Dongho, F.F.D., Gouado, I., Sameza, L.M., Mouokeu, R.S., Demasse, A.M., Schweigert, F.J. & Ngono, A.R.N. (2016) Some factors affecting the quality of crude palm oil sold in Douala, Cameroon.

Journal of Food Research,6, 50[DOI: 10.5539/jfr.v6n1p50].

[7]. Enyegue, M.B.&Enyegue, A.B. (2020) Le commerce de l'huile de palme dans les marches Camerounais: Analyse du dynamism des circuits, strategies devente, acteurset des Varietes d'huiles commercialises. Editions Francophones Universitaires d'Afrique.

[8]. Essuman, E.K., Teye, E., Dadzie, R.G.& Sam-Amoah, L.K. (2022) Consumers' knowledge of food adulteration and commonly used methods of detection. Journal of Food Quality, 2022, article ID21050, 10 pages [DOI: 10.1155/2022/2421050].

[9]. Eteng, O.E., Moses, C.A., Ugwor, E.I., Enobong, J.E., Akamo, A.J., Adebekun, Y., Iwara, A. & Ubana, E. (2022) Ingestion of Sudan IV-adulterated palm oil impairs hepato-renal functions and induces the overexpression of pro-inflammatory cytokines: A sub-acute murine model. Egyptian Journal of Basic and Applied Sciences,9, 11–22[DOI: 10.1080/2314808X.2021.2010884].

[10]. Everstine, K., Spink, J. & Kennedy, S. (2013) Economically motivated adulteration (EMA) of food: Common characteristics of EMA incidents. Journal of Food Protection,76, 723–735[DOI: 10.4315/0362-028X.JFP-12-399][PubMed: 23575142].

[11]. FAO/WHOCAC (codex Alimentarius Commission) (2017). Discussion Paper on Food Integrity and Food Authenticity, CX. FICS 17/23/5. Prepared by Iran with Assistance from Canada and the Netherlands, Codex Committee on Food Import and Export Inspection and Certification Systems (CCFICS) (23rd Session). Mexico City, 1-5 May 2017.

[12]. Ibukun, K.-A. (2021). Prevalence of Azo Dye Adulterated Palm Oil in Ondo State (Nigeria) and Toxicological Effects on Liver, Kidney and Testicular Tissues of Albino Rats.

[13]. Igomu, T. (2020) Using chlorine bleach in fufu, gari, way to kill people 'softly'. From https://healthwise.punchng.com/using-chlorine-bleach-in-fufu-gari-way-to-kill-

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people-softly-experts/. Retrieved9September.

[14]. Nchanji, Y.K., Tataw, O. &Nkongho, R. (2013) N. and Levang P. Artisanal Milling of Palm Oil in Cameroon. Working Paper 128. Center for International Forestry Research: Bogor, Indonesia.

[15]. Ngando, E.G.F., Mpondo, M.E.A. & Ewane, M.A. (2013) Some quality parameters of crude palm oil from major markets of Douala, Cameroon. African Journal of Food Science, 7, 473–478[DOI: 10.5897/AJFS2013.1014].

[16]. Nwachoko, N. & Fortune, A.R. (2019) Toxicological effect of Sudan III azo dye in palm oil on kidney parameters of albino rats. World Journal of Pharmaceutical and Medical Research.

[17]. Onyeaka, H., Ukwuru, M., Anumudu, C. & Anyogu, A. (2022) Food fraud in insecure times: Challenges and opportunities for reducing food fraud in Africa. Trends in Food Science and Technology,125, 26–32[DOI: 10.1016/j.tifs.2022.04.017].

[18]. Tan, K.M., Liew, W.L., Muda, K. &Kassim, M.A. (2015). Microbiological Characteristics of Palm Oil Mill Effluent. ICCBES-855, pp. 186–200.

[19]. Teye, E., Elliott, C., Sam-Amoah, L.K. & Mingle, C. (2019) Rapid and non-destructive fraud detection of palm oil adulteration with Sudan dyes using portable NIR spectroscopic techniques. Food Additives and Contaminants. Part A, Chemistry, Analysis, Control, Exposure and Risk Assessment,36, 1589–1596[DOI: 10.1080/19440049.2019.1658905][PubMed: 31535956].