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Cottonseeds and Crude Peanuts Oils Production Technology and the Edible Oils Sale Conditions in Ouagadougou and Bobo Dioulasso Markets

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ABSTRACT

Background: This study evaluated production technologies of the refined cottonseed oils and crude peanut oils and investigated the edible oils' sales condition in markets of Ouagadougou and Bobo Dioulasso, Africa. **Methods:** The study was carried out by administering a questionnaire to 316 edible oil sellers in markets, 25 cottonseed oil producers, and 18 crude peanut oil producers. The production technologies and sale conditions such as brands, origins, storage, and packaging were evaluated on the basis of observations and surveys. The edible oils' sale conditions, production conditions of the peanut and cottonseed oils, as well as the means used for production of the aforesaid oils were investigated. **Results:** The results showed that the crude peanut oils were produced in two ways by only women (100%) using rudimentary means. However, cottonseed oils' production was of three types and mostly dominated by men (96%). The sodium hydroxide (100%), phosphoric acid (36.4%), citric acid (63.6%), filters (100%), and tonsil (80%) were used during refining cottonseed oils. In markets and other places, imported edible oils (94%) were mainly sold and 34.2% of the sellers exposed oils to the sun. Imported edible oils generally came from Ivory Coast, Malaysia, and Indonesia. So, local edible oils were faced with a great competition against the imported oils. These imported oils are from various origins and are mainly consumed with deplorable sale conditions. **Conclusion:** This study highlighted the production technologies and edible oils' sale conditions. The results of this study can provide the necessary information for the authorities to take measures to ensure the quality of edible oils.

Keywords: *Edible oil; Crude oil; Peanut oil; Cottonseed oil*

Introduction

The seeds and oleaginous nuts produced and processed by the agro-alimentary industry in Burkina Faso are resulted from cottonseeds, shea tree, peanut, and sesame (Traore, 2005). These

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seeds are transformed into vegetable oils. Although the oilseeds' system is mainly dominated by the production of cottonseed oil in Burkina Faso, other oleaginous plants like peanut are exploited for the possible production of edible oil. These food vegetables oils are frequently consumed in this country (Guissou and Ilboudo, 2013). The peanut oil is mainly produced using the traditional methods.

Due to growing population in the area of West African Economic and Monetary Union (WAEMU) and specifically in the countries of the Economic Community of West African States (ECOWAS), the demand for vegetable oils are experiencing a significant increase. In Burkina Faso, the requirement for vegetable oils was estimated at 99,668 tons in 2020 (Hirch, 2002). The local vegetable oils consumed extensively by the populations include cottonseeds oil and peanut oil. Several production units operate in Ouagadougou and Bobo Dioulasso for producing vegetable oils and triturating cottonseeds. Furthermore, peanut oils are produced and sold in different markets. Refined oils are also produced from different oilseeds such as palm oil (palm olein), olive oil, peanut oil, and sunflower oil.

Oil production is still at the traditional scale in Africa. It is considered as a source of income for the local population. So, different oil products have variable qualities and applied in in food, medicine, and cosmetics (Kapseu, 2009). According to Koudougou and Dicko (Koudougou and Dicko, 2008), clandestinely oils produced in Burkina Faso do not have the essential criteria of quality according to the *Codex alimentarius* and are available on the markets. Similarly, previous studies indicated that edible oils, specifically artisanal cottonseeds and peanut oils, do not comply with the required health indices (Zio *et al.*, 2016). Indeed, some components of the oil products can be improved by undergoing more or less important modifications in terms of manufacturing processes and maintenance conditions (Kandji, 2001). Clearly, during the refining and hydrogenation processes, the formation of fatty acids in trans configuration should be considered. For example, application of plastic containers to transport oil products may affect the product since certain liposoluble monomers or residual solvents can migrate into the product. During the storage, the oils may be subject to damage under some parameters such as light, oxygen, or temperature (Lacoste *et al.*, 2005). Furthermore, the conditions can deteriorate the edible oils. For instance, in countries such as Benin, the refined cottonseeds oil products are distributed in transparent bottles that are often exposed to sunlight and air (Adjadji *et al.*, 2009). Therefore, the aim of this study was to evaluate the production technology of cottonseeds oils and crude peanut oils and sale conditions of edible oils in Ouagadougou and Bobo Dioulasso markets.

Materials and Methods

Study area: The research was conducted in Ouagadougou and Bobo Dioulasso, two big cities of Burkina Faso in terms of the population density (**Figure 1**) and high number of cottonseed oils' production units.

Data Collection: The information about oil production technology and sale conditions in Ouagadougou and Bobo Dioulasso was collected from the local producers of the cottonseeds and peanut oils. Moreover, sales conditions of various oils in high-traffic markets were evaluated. In order to conduct the study, two questionnaires were designed specifically for monitoring the production conditions of peanut and cottonseed oil and one questionnaire was used for monitoring the sales' conditions of oils in markets. The researcher referred to the markets and administered the questionnaires among the producers and sellers using the face-to-face interview method. The producers of cottonseed oils were interviewed in the production units and producers of the peanut oils were interviewed at their production site or in the markets. In terms of the cottonseeds and peanut oils' production technologies, the questionnaires included items about the applied production and storage equipment, the chemicals used for refining, the producers' gender and education level, the producers' solutions provided to improve the

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quality of edible oils, the seed origin, the energy sources, and the quality control parameters. With regard to the edible oils' sale conditions, the following criteria were studied: the producers' gender and educational level, the exposure of sale places to the sunlight and outside temperature, the containers used for the sale, the oils' countries of origin, the oils' brands, the oil containers' labelling, and the oils' types sold. The questionnaires were administered according to the interviewee's spoken language in either French or the local language (Mooré or Dioula).

Data analysis: After the data collection, the different questionnaires were manually analyzed. Later, data analysis was done by Sphinx Plus V5 software using variables defined in the questionnaire. The data collection cities were mapped by QGIS 2.18 software. The graphics were made using the Excel 2013 software.

Results

The production of peanut oil: a total of 18 peanut oil producers were interviewed in Ouagadougou and Bobo Dioulasso. The production technology of peanut oil is not the same for all producers. These products were in two types (type A and type B). The second type (type B) of production is minority used and intended only for crude peanut oils production. The first type (type A) is mainly produced by old (100%) illiterate (77.8%) women, who produce peanut oil with rudimentary tools using particular pots/frying pans or roasters (**Figure 2** and **Table1**). In this type, the milling is carried out at the mill entirely. Firewood is used for seeds' roasting, *koura-koura* frying, and oil drying (100%). These oils are mainly used for human consumption (**Figure 3**).

Not all women used the same steps for producing oils. However, the majority of producers used the same step (Type A) in peanut oil production including sorting, hulling, toasting, grinding, mixing, drying, decantation, cooling, and filtering. **Figure 4** and **Figure 5** show the production diagrams of unrefined peanut oils.

The production of cottonseeds oil: The cottonseed oils' producers (N = 25) were interviewed in Ouagadougou and Bobo Dioulasso (32% for Ouagadougou and 68% for Bobo Dioulasso). Cottonseed oil producers were mostly men (96%) and oil production was their main activity (88%). Considering the participants' educational level, most of them had secondary (48%) degree, 24% had academic degree, 12% had the primary school degree, and 16% were illiterate. The seeds came from several cities in Burkina Faso and countries including Togo (12%) and Benin (12%). In Burkina Faso, most seeds came from Bobo Dioulasso. Considering the seeds' origin, 76% came from Burkinabè company textiles fibers (SOFITEX), a cottonseed grading company. With regard to the production of cottonseed oils, the production diagrams are different. All producers used the electric press (100%), where electricity was the source of energy and tanks were used for refining. The firewood was applied to fuel the boilers. Most producers considered that Electricity was very expensive (96%). For some producers (24%), the high cost of electricity was a drag on edible oil production in Burkina Faso. Given the conservation of cottonseeds, the storage period was less than one month before crushing (92%). Most units produced crude refined oils and majority of them used chemical refining. All producers used sodium hydroxide for neutralization, phosphoric acid (36.4%) and citric acid (63.6%) in the refining process, as well as tonsil for fading (80%) (**Figure 6**).

Packaging was carried out in hermetically sealed 20 liter cans (100%), on which labels were affixed (100%). These were sometimes the old cans that were reused (96%). The labels included information such as date of production, expiry date, brand (100%), contact (88%) and instructions (76%). The studied producer units claimed to have laboratories for basic parameter analysis (96%). Majority of these units (95.8%) also claimed to have their oils analyzed by National Public Health Laboratory (LNSP). The quality control parameters mentioned by most producers were acidity (95.8%), color (54.2%), odor (70.8%), taste (37.5%), peroxide value (87.5%), moisture (66.7%), saponification value (75%), soap trace (58.3%), iodine value

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(29.2%), insoluble impurities (41.7%), flavor (12.5%), materials volatile (37.5%), and appearance (37.5%). The cottonseed oils produced were used for human consumption. The producers' investigations resulted in three types (Type I, Type II and Type III) of production diagrams (**Figure 7**) in both cities.

In general, the chronological cottonseed oil production steps are: pressing, neutralizing, washing, drying, discoloring, deodorizing, filtering, storing, and packaging. Most production units had the device for fortifying oils with vitamin A, but the enrichment was not realized by all the producers. Filters were used by all producers and inertage was not practiced (100%). To obtain high quality oils, producers needed adequate means. According to the cottonseed oil producers, high quality seeds, adequate production and refining equipment, adequate packaging, and qualified staff could reduce the cost of electricity and production (**Figure 8**).

Oils sale conditions in markets: The data were collected from 316 oil sellers in Ouagadougou and Bobo Dioulasso markets. The markets were flooded by imported oils (94%), while local oils were very few (6%). Local cottonseed oils of semi-industrial production were produced and sold in various markets. All the time, the contents and the quality of oils were doubtful. Sellers were mostly retailers (87.3%). Most salespersons were male (71.2%), while some were females (28.8%). Most respondents had 46 years of age (45.6%) and mean age of participants ranged from 31 to 45 years. The oils sold were mainly from oilseeds; 81% of the products were from refined palm oil (palm olein) supplemented with cotton oil refined (24.4%) produced in oil and soap factories. Local artisanal peanut oils production represented about 1.9% of the oils sold. Other oil products were sold including red palm oil, sunflower oil, sesame oil, maize oil, and various types of olive oils. Sellers used primary packaging (all types) sources (95.6%). These packages included cans (all types) with lids (95.6%), plastic sachet (40.8%), amber bottles with lids (18.7%), non-amber bottles with lids (17.1%), non-amber transparent cans (16.8%), non-amber bottles with lids (7.6%), amber cans transparent (9.5%), cans without lid (3.8%), amber bottles without lids (2.8%), non-amber bottles with lids in sachets (1.6%) , amber bottles with lids in sachets (0.6%), iron Basin with lids (0.6%), rubber basin with lids (0.3%) and rubber basin without lid (0.3%), respectively. Most packages of edible oils sold outside of crude peanut oils were labeled (97%) (**Figure 9**).

The oil containers were labeled and the labels included the following information: the manufacturer's name and address, quantity or volume, batch indication, expiration date, ingredients such as vitamin A, vitamin E, and free cholesterol (**Figure 10**)**.** In the markets, some sellers stored the oils in dark places (15.2%), under shady warehouses (57.9%), and others exposed them to the sun (34.2%) (**Figure 11**). A large number of refined cottonseed oils are produced in Ouagadougou and Bobo Dioulasso, but they do not have any specific brand or information. So, the products' ingredients and constitutes cannot be determined.

The imported oils were mainly from countries such as Ivory Coast, Malaysia, Indonesia, Burkina Faso, Ghana, Senegal, France, Italy, Morocco, Tunisia, Spain, Germany, United Arab Emirates states, Lebanon, and the United States America (USA) (**Figure 12**).

The oil products consumed mainly in Burkina Faso included cottonseeds refined oil, while crude peanut oil products were used less. The most available brands in Ouagadougou and Bobo Dioulasso markets were Dinor (24.8%), Aya (15.5%), Savor (9.0%), Tradekey (7.2%), Viking (4.2%), Palme d'Or (3.6%), Super Delicieux (3.5%), Jadu (2.8%), Family (2.4%), OkI (2.2%), and Chef Aïda (1.9%) (**Figure 13**).

Unbranded oils were crude peanut oils produced in Burkina Faso and unrefined red palm oils. Oils were sold in shops (53.8%), on stands or sheds (40.5%), on surfaces (3.8%), and at roadside (1.9%). Sellers supplied their products mainly from wholesalers or resellers (80.7%) and semi-wholesalers (18.7%). Most oil containers were labeled.

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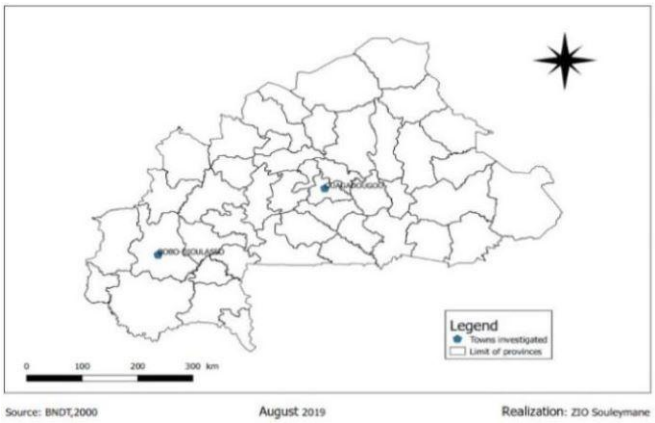


Figure 1. Geographical location of the study area. Ouagadougou and Bobo Dioulasso are the two study sites.



Figure 2. Materials used for producing and refining of the cottonseeds and crude peanut oils (A: Electric press for obtaining crude cottonseeds oil, B: tanks for refining the cottonseed oils, C: refining and frying of Koura-Koura by crude peanut oil).

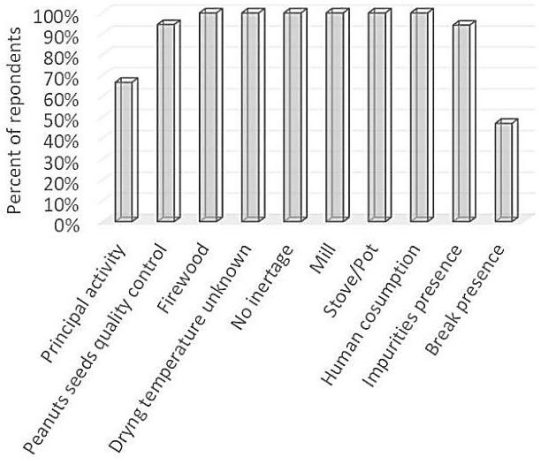


Figure 3. Some peanut oil production parameters. The peanut seeds contain impurities and cracks. Oil is produced as the principal activity of women using rudimentary means.

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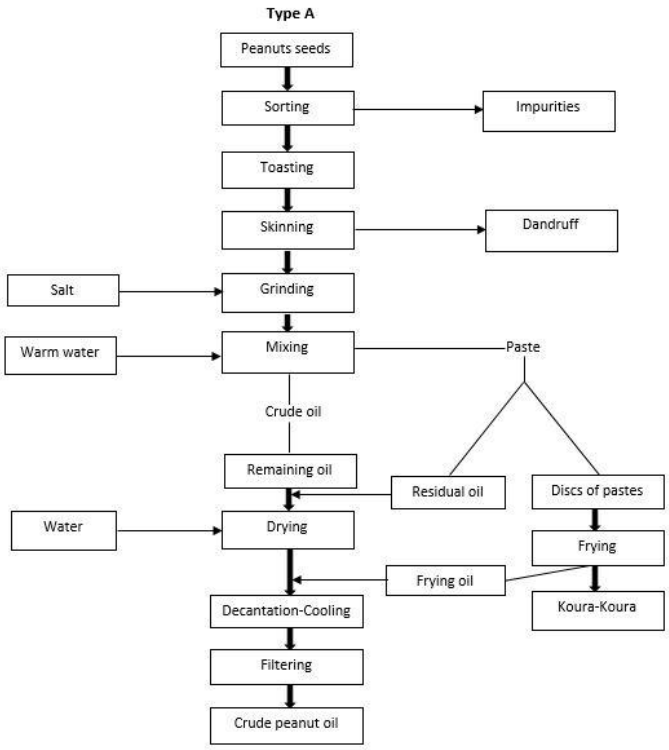


Figure 4. Technology of artisanal peanuts oils production. This production diagram uses stages of baking a cake called koura-koura sold in the studied cities. Salt is added to give taste to the cake. Moreover, this process leads to a crude peanut oil.

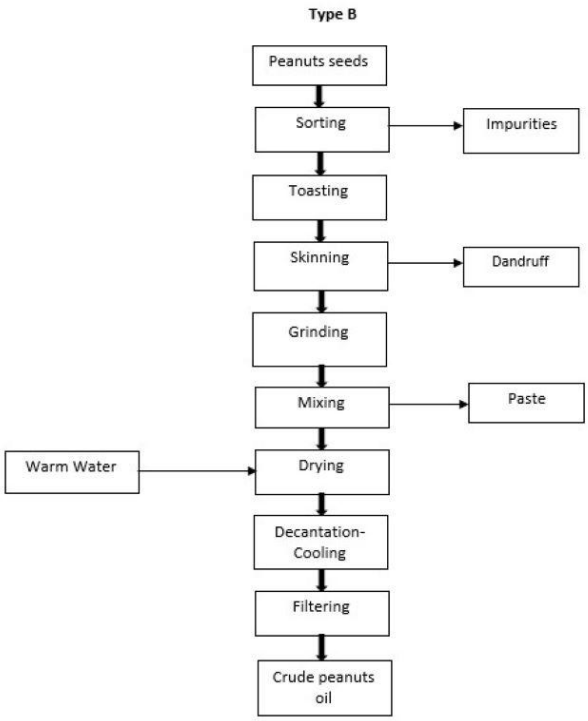


Figure 5. Technology of artisanal peanuts oil production. This type of diagram aims to illustrate single production of peanut oil. No salt is added during the oil production.

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Table 1. Characteristics of the cottonseeds, peanut oils' producers, and edible oil sellers in Ouagadougou and Bobo Dioulasso.

Variables	Proportion by production and seller (%)		
	Crude peanut oils production	Cottonseeds oils production	Sale of oils in markets
Sex			
Male	0	96.0	71.2
Female	100	4.0	28.8
Level of education			
Primary	16.6	12.0	33.5
Secondary	5.6	48.0	16.5
University	0.0	24.0	1.6
Illiterate	77.8	16.0	48.4

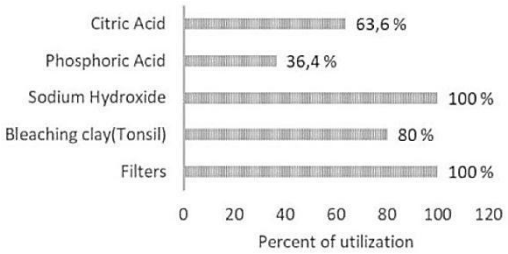


Figure 6. The inputs of the refining cottonseed oils' process. The cottonseed oils' producers usually used acid phosphoric and acid citric for refining, sodium hydroxide for the neutralization step, and tonsil for discoloration. The filters are used to eliminate the impurities.

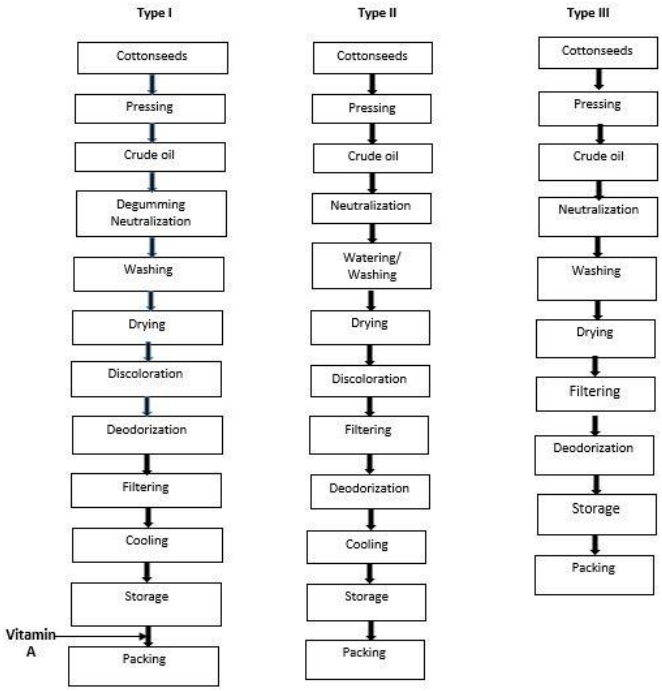


Figure 7. Production diagrams of the refined cottonseed oils. Three production diagrams were identified for the cottonseed oils. The difference is in the lack of degumming step for type II and discoloration for type III. All producers used filters to eliminate impurities. The fortification device of the vitamin A exists in the production units. However, the oils' fortification in vitamin A remained doubtful.

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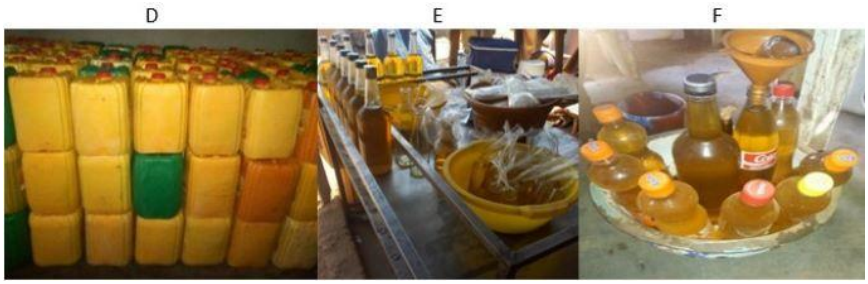


Figure 8. Edibles oil containers (D: Cans of cottonseed oil stored in a shop, E: Edibles oils displayed for sale in a market, F: Peanut oils packed for sale in a market).

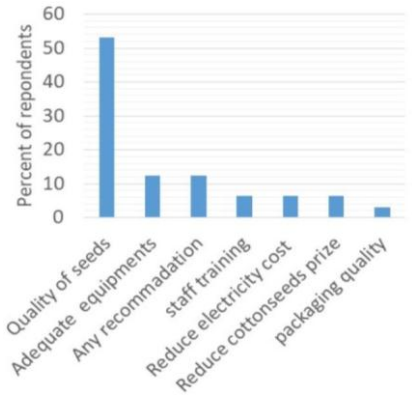


Figure 9. Solutions provided by some interviewees to improve oils' quality. The producers affirm that obtaining edible oils' quality required suitable measurements, good seeds, qualified staff, and optimal production conditions.

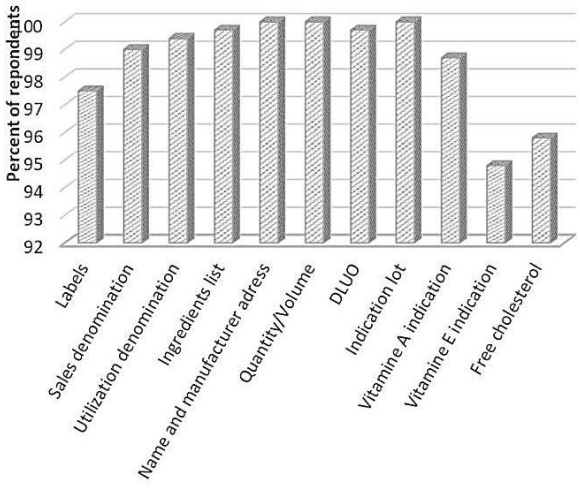


Figure10. Labels of the oil containers sold in the markets. Majority of the edible oils sold in the markets were labeled containing information about the manufacturer's name and address, quantity or volume, batch indication, expiration date, ingredients such as vitamin A, vitamin E, and free cholesterol

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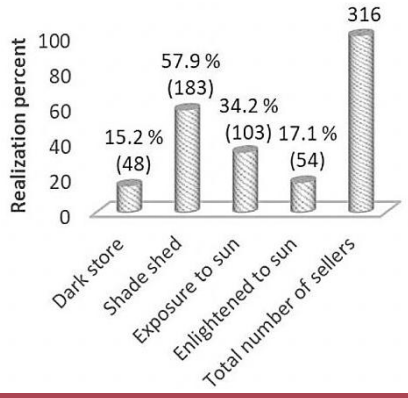


Figure 11. Types of storage of edibles oils in markets. The oils in markets were mainly safe from the light. However, a considerable proportion of the products were exposed to the sun. The bad conditions of conservation can affect the oils' quality.

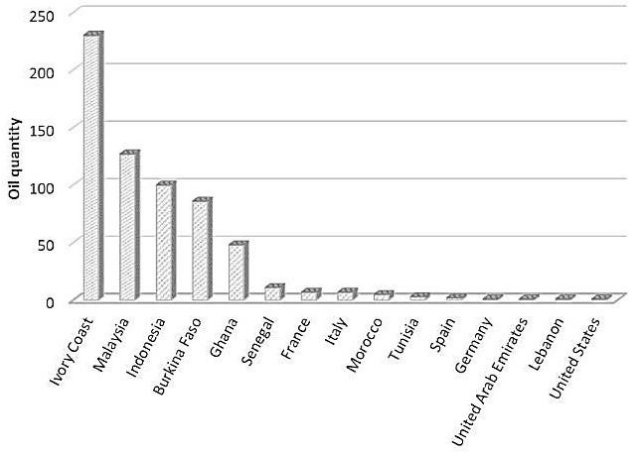


Figure 12. Origin countries of some edible oils sold in the market. The edible oils sold in the markets mainly came from the foreign countries such as the Ivory Coast, Malaysia, Indonesia, and Burkina Faso position.

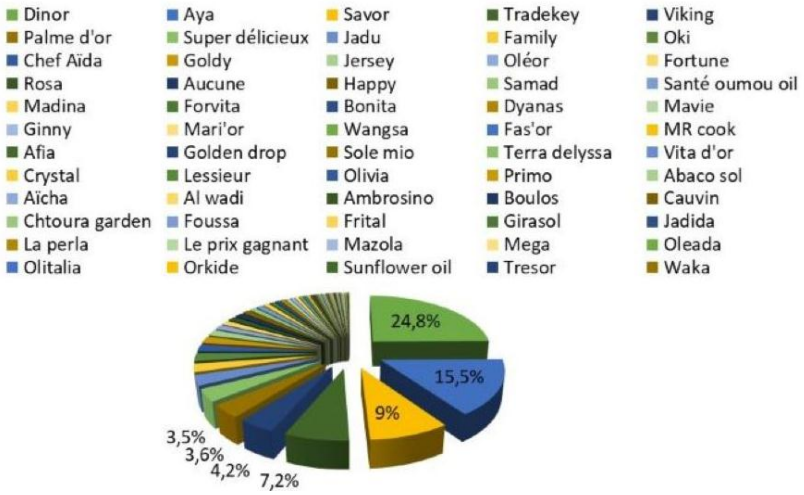


Figure 13. List of edible oils' brands commonly sold in the markets. An impressing number of edible oil flooded the markets. The main brands included Dinor, Aya, Savor, Tradekey, Viking, Palme d'or, Super délicieux, Jadu, Family, and Oki.

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Discussion

The peanut oil produced by women is a crude oil. A sub-product of the peanut oil is *Koura-Koura*, which is a cake sold on the markets. In addition, all women added salt to dehulled seeds before grinding. The aim of adding salt was to give a taste to *koura-koura*. Apart from seed saponins, salt can be responsible for the presence of soap trace in the oils. A previous study confirmed the presence of residual soap in artisanal peanut oils produced in the city of Ouagadougou (Zio *et al.*, 2016). This production process is identical to that proposed by Kapseu (Kapseu, 2009) in terms of frying patties, but does not highlight addition of salt. The results of this study also corroborated with the results reported by food and agriculture organization (FAO) in 1991 on women's in Benin (Food and Agriculture Organization, 1991). Furthermore, the manufacturing processes mentioned by these authors did not show addition of salt. The production equipment was identical to the ones found in our study, namely the pot/frying pan and mill. Adding salt to peanut seeds may result in residual levels of soap in the oils. The second process (Type B) of production aimed only at the production of peanut oil. However, the production chart of type B of our study is same as the one proposed by Rouzière and Ribier (Rouzière and Ribier, 1992), because it does not mention baking cake. Consumption of peanuts and its by-products including oil can cause pathological consequences for humans and livestock due to contaminants such as mycotoxins (aflatoxins) produced by fungi (*Aspergillus flavus* and *Aspergillus parasiticus*), aflatoxin B1 (AFB1), and aflatoxin B2 (AFG2) that cause hepatocellular carcinomas in humans and animals (Nikiéma, 1993). Therefore, these undesirable compounds and potentially contaminants should be eliminated by refining the vegetable oils (Pages *et al.*, 2010). Aflatoxin was reported in home-produced edible oils in Senegalese homemade peanut oils (Martin *et al.*, 1999). As a result, aflatoxin can be expected in Burkinabe peanut oils, which are subjected to high temperature for long time during peanut cake (*Koura-Koura*) frying and drying. This can reduce or eliminate the presence of aflatoxin in the oils. In this regard, it has been proven that below 100 °C the aflatoxins are very stable to heat (Martin *et al.*, 1999). Furthermore, heating at elevated temperatures and for a long time could deteriorate the oils quality.

According to Song-Naba (Song-Naba, 2016), the SN-Citec is the only major cotton seed processing company in Burkina Faso. Production of cottonseed oil is dominated by a myriad of informal craft enterprises, which can contribute to low quality edible oil (Koudougou and Dicko, 2008). The type I production process of cottonseed oil found in this study is similar to the one proposed by Pages *et al*. (Pages *et al.*, 2010), but does not involve the cooling, inertaging, and dewaxing stages. Producers use tonsil for discoloration, but for type III discoloration is not realize. The discoloration eliminates pigments, soap traces, residual phospholipids, polar oxidation products, and some contaminants. Filters were used by all producers for the removal of impurities, but inertage was not practiced. Based on the literature, reducing the oils' exposure to light and heat or reducing the availability of oxygen by inertaging oils under nitrogen were effective in eliminating oxidation in products (Cuvelier and Maillard, 2012). Producers used various refining technologies, which may have a negative impact on the quality of Burkinabè cottonseed oils. The cottonseed oil producers were numerous but they refused to talk about their occupation. Respondents claimed that they were confronted with difficulties in producing cottonseed oil due to poor quality of seeds, inadequate production equipment, and high cost of electricity. The sale conditions determined in this study included storage, containers used for carrying and selling oils, labelling, oil types, brands, and origins. Containers of the edible oil were different in types such as cans and amber bottles, but very few of them had lids. It has been proved that the opaque cans and polyethylene terephthalate (PET) packages preserve cottonseeds oil and its chemical hydrolysis, thus promoting its stability during storage (Adjadji *et al.*, 2009). Moreover, oil conservation in the dark and at low

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temperature allows good stability of oil. The opaque cans and PET packaging must be used by sellers. The most commonly used oil brand in Ouagadougou and Bobo Dioulasso markets was Dinor. A study carried out in Mali claimed that Dinor was the most commonly used brand of oil in Bamako with a rate of 21.5% (Yattabare, 2012). The edible oils are mostly stored or conserved in shaded warehouses. In Benin, the distribution of oils, especially cottonseed oil, by semi-wholesalers was done in transparent bottles exposed to light and air (Adjadji *et al.*, 2009)). According to Cuvelier and Maillard (Cuvelier and Maillard, 2012), storage conditions such as heat and light increase the rate of auto-oxidation, which can lead to the phenomenon of rancidity and decrease it's the product's marketability. In addition to intrinsic factors (Hsieh and Kinsella, 1989), other environmental factors such as light, sun, and high temperature influence oxidation. These factors can cause oxidation, deterioration (Choe and Min, 2006), and alteration of the lipid constituents such as vitamins and pigments consequently (Roman, 2012).

Conclusion

The present study was conducted to investigate the production processes of edible oils during the production of refined cottonseed oils and crude peanut oils. We also studied sale conditions of the edibles oils in Ouagadougou and Bobo Dioulasso markets. The findings showed that markets were flooded by imported oils coming from various foreign countries, which competed with the local oils. The sale conditions were not appropriate in most cases, so that the oil products were exposed to the sun light, free air, and high temperatures. The products were mainly packaged in inappropriate containers with no lids, which could cause natural oxidation. The peanut oils produced were not refined; therefore, their quality could be questionable. Only one refined Burkinabè cottonseeds oils had the required visual characteristics among the other brands. Consequently, oil producers are recommended to control the production steps, from refining to storage, more carefully. Future researchers are recommended to study the quality of some other edible oils in Burkina Faso.

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Conflict of interest

The authors declare no conflict of interest.

Authors' contributions

Zio S, Somda RS, Hama-Ba F, Sawadogo A, and Tapsoba F contributed in conception, design, collection, and analysis of the data. They also participated in drafting the manuscript. Savadogo A and Traore Y supervised the study. All authors approved the final draft of the manuscript.

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