

Evaluation of Contamination Risks Due to the Sale and Storage Conditions of Smoked, Dried and Fresh Fishes in Ouagadougou

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Authors' contributions

This work was carried out in collaboration among all authors. Author AO designed the study, wrote the protocol, collected data, performed the statistical analysis, managed the literature searches and wrote the first draft of the manuscript. Author CZ managed the field investigation. Author FT and Author HC read, corrected and approved the final manuscript. Authors AS and YT supported financially this study. All authors read and approved the final manuscript.

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ABSTRACT

Aims: Fish is a product more and more consumed in Burkina Faso, especially in Ouagadougou. Poor sale and storage conditions can impact on the hygienic quality of fish. The objective of this study was to identify the contamination risks due to the sale and storage conditions of smoked, dried and fresh fishes.

Study Design: A descriptive design was used to identify the different types and origins of fish on the markets in Ouagadougou and the practices and conditions of sale that could be sources of chemical and microbiological contamination.

Place and Duration of Study: Relevant data was collated in Ouagadougou (Burkina Faso) from February 2019 to July 2019.

Methodology: A survey was conducted among traders of dried and smoked fish from 50 markets and major sales sites in Ouagadougou. Data collection was done using a questionnaire developed with Sphinx Plus2 software.

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Results: The results indicated a higher proportion of men (75%) than women (25%) with an age between 21 and 45 years old were participated in fish trade. The fish encountered in the markets of Ouagadougou come from Sourou, Kompienga and Bagré, as well as from external suppliers such as Côte d'Ivoire, Mali and Senegal. The different types of fish sold were dried or smoked carp (36.67%), smoked catfish (23.33%), dried Nanani or Djêdjê wala (concorde) (13.33%), smoked Macharon (10%), smoked Racok (10%) and smoked eels or Roolgo in mooré (local language) (6.67%). The types of fish most purchased by consumers, in order, were: Carp, Catfish, Macharon, Nanani. In addition, the study detected risks of contamination of the fish, namely: exposure material consisting of tables and baskets, conservation at room temperature, storage period of 10 to 30 days, no training in hygiene, fish served with bare hands, exposed to dust and stray animals.

Conclusion: In sum, the study revealed some characteristics of the fish industry in Ouagadougou and also risks of contamination of fish sold on the markets.

Keywords: Fish; origin; sale and storage conditions; contamination risk; Ouagadougou.

1. INTRODUCTION

Burkina Faso is a Sahelian country, without a seafront. However, the country has an estimated surface water potential of more than 200,000 ha divided among rivers, streams, ponds, lakes, dams and reservoirs that can be used for fishing [1]. Two systems of fish production are encountered, namely capture fisheries (natural fish production) and aquaculture, notably fish farming in ponds, pens, cages and restocking (rearing) [2]. The fisheries sector in Burkina Faso is less developed with a low contribution to GDP (Gross Domestic Product) 0.41% according to data from the General Census of Agriculture [1]. To strengthen domestic production and reduce fish imports, the Burkina Faso government is trying to revitalize this sector through the promotion of aquaculture. Fish farming was introduced to Burkina Faso in 1956, with the support of the Tropical Forestry Technical Centre (CTFT) [3]. Numerous projects have thus been set up successively with the support of several structures in order to popularize fish farming. However, most of the experimental and production stations were abandoned because of topographical, hydrological and socio-economic constraints [3].

As a result, the main supports for fish production today are: dams (Bagré, Kompienga, Sourou, Dourou/Toécé and Ziga) and rivers (Mouhoun, Nakambé, Nazinon, Pendjari, Comoé, Léraba, Béli, Faga, Goroual, Sirba and Tapoa) [2]. National production is limited to fish, which is estimated at 13,000 tons in 2012 [1]. This production reached 27,902 tons in 2019 as a result of efforts invested in aquaculture and promoters who are increasingly involved in fish farming. As for imports, they have fluctuated in recent years between 40,000 and 60,000 tons in

order to make up the deficit. Nevertheless, fishing in Burkina Faso contributes to the fight against poverty through its creation of rural income and its contribution to the improvement of the nutritional level of the population in protein-rich products [4]. On the markets, there are sea fish (smoked or dried, fresh), especially imported and freshwater fish from the interior of the country. The main commercial species found in Burkina Faso are: *Tilapia* sp (carp), *Clarias* sp (catfish), *Lates niloticus* (captain), *Heterotis* sp, *Mormyrus* sp, *Alestes* sp, *Chrysictis* sp and *Synodontis* sp [3].

In Ouagadougou, fish has increasingly become a consumer product. Purchases are generally made at the fish shops, the dam fish market, the sector markets, the large market, food stores, and small dried/smoked fish markets along certain avenues [5]. The popularity is mainly seen through restaurants and the maquis. These fish are consumed in dried, smoked, braised, or fried form. Food safety is currently a national concern. Indeed, fishery resources are increasingly threatened due to certain practices such as overexploitation [6], pollution by pesticides [7] and heavy metals [8]. This could lead to the bioaccumulation of certain pollutants in aquatic ecosystem species, particularly fish [9,10]. In addition, the conditions of sale (environment, equipment, labor, storage and conservation product) of fish are a source of introduction of various contaminants into fish [11–13]. It is therefore necessary to have an overview of the fish sector in Burkina Faso in order to contribute to the improvement of the fish available quality for consumers. The objective of this study was to contribute to the sanitary safety of fish consumed in Burkina Faso. A survey was carried out among traders of fresh or smoked/dried fish and consisted in highlighting

the evolution of the smoked/dried fish sector in Burkina Faso. The aim was to identify: (i) the different types and origins of fish on the markets in Ouagadougou and (ii) the practices and conditions of sale that could be sources of chemical and microbiological contamination of the fish.

2. MATERIALS AND METHODS

2.1 Description of Study Sites

The Study was carried out in Ouagadougou (Burkina Faso). A total of 50 markets and sales sites where dried and smoked fish are sold (Fig. 1) were surveyed. The geographic coordinates of the markets and sites surveyed, were collected during the investigation and the map was drawn up by the Geographic Institute of Burkina.

2.2 Survey Data Collection

For data collection in the field, a survey form was developed using Sphinx Plus² software. The questionnaire covered the main following points: (1) the socio-demographic characteristics of the actors involved in the fish industry; (2) the types (species) of fish encountered in Ouagadougou, their place of origin and the conservation technique used; (3) the selling prices of the fish and the types of fish most purchased; (4) the difficulties and expectations of the actors in their activities; (5) evaluation of the environmental health of the activity, equipment and labor. This evaluation was accompanied by a sampling for microbiological and physicochemical analysis of fish samples in the laboratory.

2.3 Processing of Survey Data

The data obtained was analyzed using three (3) software programs: IBM SPSS Statistics 20.0.0 was used to calculate the percentages and draw graphs of the types of fish and where they came from; Excel 2016 was used to draw the graph of fish prices. The other data were processed with Sphinx Plus² software.

3. RESULTS AND DISCUSSION

3.1 Socio-demographic Characteristics of the Actors Involved in Commerce

It emerges from the survey that among the individuals surveyed, 75% are male and 25%

female aged between 21 and 45 years old. The Mossi ethnic group was the most frequently cited, i.e. 95%, followed by Malian nationality (5%). In view of the results, we can say that there is a predominance of men over women in this study. Compared to some previous studies [12], the results of the study showed that the fish trade activity is predominantly practiced by men. Women are most often involved in fish processing (smoking/drying) [14–16]. In this study, the respondents were large traders who had important fish stocks and whose daily sales can reach 25 Kg per day (Fig. 11). This is of interest because they would have good experience in the field and could provide us with reliable information on the fish sector in Burkina Faso.

Furthermore, micro-detail sales are particularly reserved for women and wholesale sales are specific to men and some women with significant financial means [17].

The high percentage of mossi in this study is due to the fact that Ouagadougou is a city population mainly by mossi who live mainly in central Burkina Faso.

The proportion of those enrolled in school represents 35% with a primary school level and that of those not enrolled is 65%. The percentage of those enrolled in school is therefore low with a low level of schooling for those who have had the chance to go to school. This could constitute an alternative because this trade activity would contribute to the fight against unemployment and a source of income for them.

The experience in the trade activity varies from 2 to 20 years. The distribution of the activity experience is shown in Fig. 2. Many of traders had experience of activity between 5 and 12 years. This means that they are specialized and experienced actors in this field.

3.2 The Types (species) of Fish Encountered on the Market in Ouagadougou

Fig. 3 shows the distribution of the types of dried/smoked fish under their commercial names available in Ouagadougou.

are species generally found in water bodies in Burkina Faso [18,19]. These species would be better adapted to harsh environmental conditions and are easy to produce in aquaculture [20–23]. Moreover, they are among the most imported fish and the most purchased by consumers. This explains their availability on the market.

3.3 Places of Origin of Fish Encountered in Ouagadougou

Table 1 shows the distribution of fish types according to their nature (smoked/dried) and according to their origin. The smoked Racok comes from Ivory Coast and Sourou (Burkina Faso), the Macharon comes from Senegal and Sourou (Burkina Faso), the Nanani or Djédjé wala (Concorde) mainly dried comes from Mali, the smoked carp comes from Mali, Bagré (Burkina Faso) and Kompienga (Burkina Faso), the dried carp only from Mali and Kompienga. Smoked Eels comes Sourou and smoked catfish comes from Sourou (Burkina Faso), Bagré (Burkina Faso) and Mali. Based on this information, we can say that Nanani comes specifically from Mali and Eels from Sourou. However, it should be noted that this could depend on several factors: the types of fish available at the time of our study, the size of our sample, and the choice of the types of fish to be marketed by the sellers or importers based on consumer preferences or ease of sale on the market.

3.4 Selling Prices of Smoked and Dried Fish and the Types of Fish Most Purchased

As presented in Fig. 10, the price of one (1) kilogram of smoked or dried fish was 6.84 USD. In particular, the Macharon from Senegal cost 8.55 USD/Kg. The prices of dried or smoked fish are almost identical. There is therefore an evolution from the prices of previous years, which were between 1.28 USD and 5.13 USD per kg [6]. In addition, these prices are twice as high compared to the international prices related to processing costs. The slightly high cost of Macharon from Sénégal could be due to its specificity and its better quality (rich in pulp, quality of smoking).

Fig. 11 shows the distribution of the fish most purchased by consumers. Four types of fish are generally mentioned: Carp with 47.4%, Catfish, 44.7%, Macharon, 5.3% and Nanani,

2.6%. The uniformity of price shows that the different types of fish are equally accessible. Thus, consumer preferences could be justified by the availability of these types of fish, their organoleptic quality or their nutritional quality [24].

Fig. 12 shows the quantity of fish sold. The individuals surveyed reported selling a quantity of dried/smoked fish between 8 Kg and 25 Kg per day for all types of fish and most of the quantities sold were between 14 and 16 Kg per day. If we consider the selling price, these quantities sold yield about 95.8 USD to 109.48 USD per day. These results indicate a high consumption of fish in Ouagadougou. We can also say that the trade of dried and smoked fish is a resource-providing activity. The most consumed fish are Carp, Catfish, Macharon and Nanani. In particular, according to some respondents, the *Nanani* or *Djédjé wala* coming from Mali is still called fish of the sick because it is used to make soup for the sick person. Also, Eels would have a traditional importance because they would heal individuals who frequently suck their tongue after sucking the tail of this fish.

3.5 Environmental Hygiene of the Activity, Equipment and Workforce

The results of the survey showed that the fish are kept at room temperature with a storage time ranging from 10 to 30 days. The display material consists mainly of tables used by all the respondents (100%) and baskets found in 25% of the traders.

None of the respondents had received any training in hygiene and none of them wore gloves or washed their hands when serving fish. In general, the conditions under which fish is sold do not guarantee good hygienic quality of these products. Even if they are dry fish, storage at room temperature is still risky as it may encourage the growth of mold [25–28] because the fish may become wet over time or if it is not well dried. In addition, fish are most often exposed to dust on tables and in baskets as well as to stray animals. In addition, there is a lack of training in hygiene and serving fish with bare hands. This could be a source of staphylococcus and coliform contamination [29–31].

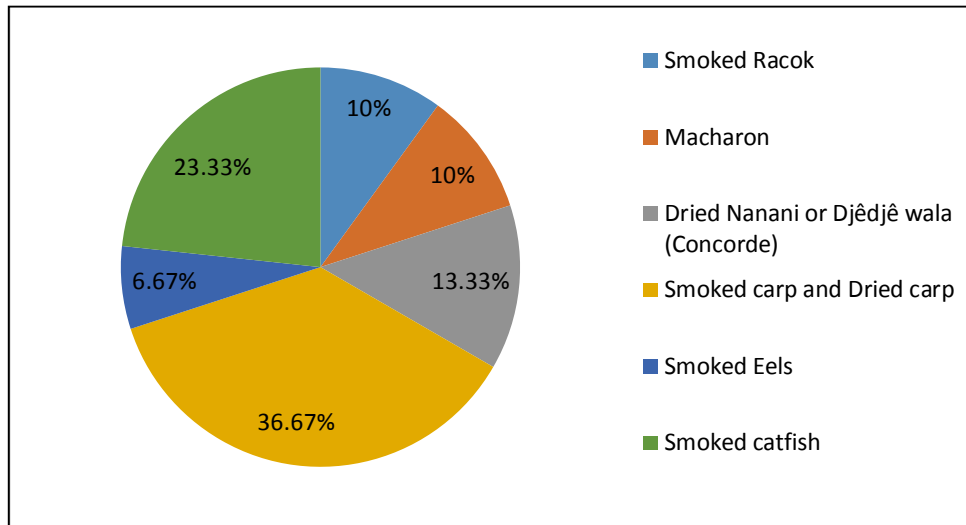


Fig. 3. Types of dried/smoked fish encountered at markets and sales sites in Ouagadougou



Fig. 4. Smoked carp in a basket (*Oreochromis niloticus*)



Fig. 5. Smoked catfish on a table (*Clarias gariepinus*)



Fig. 6. Dried nanani or djêdjê wala (Concorde) in a basket (*Mormyrus rume*)



Fig. 7. Smoked macharon (*Chrysichthys nigrodigitatus*)



Fig. 8. Smoked racok (*Heterotis niloticus*)



Fig. 9. Smoked eels in a basket (*Anguilla bengalensis labiata*)

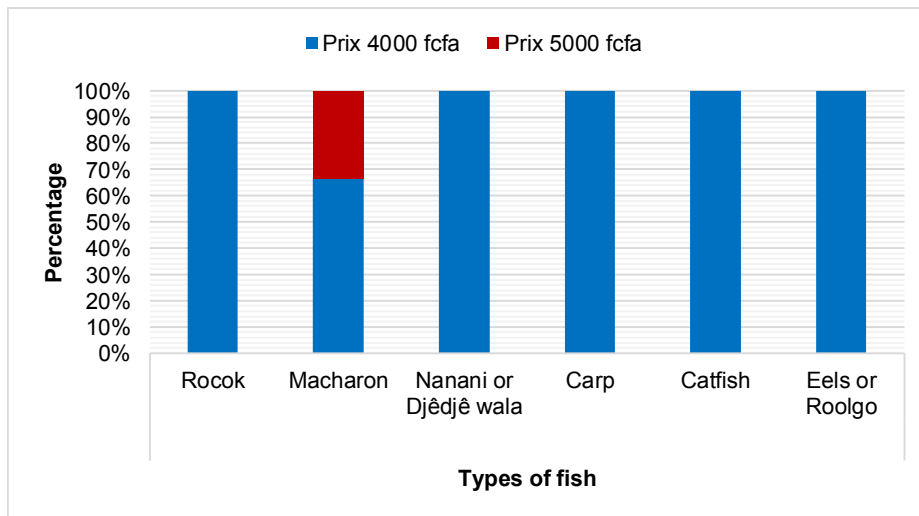


Fig. 10. Prices of different types of smoked/dried fish

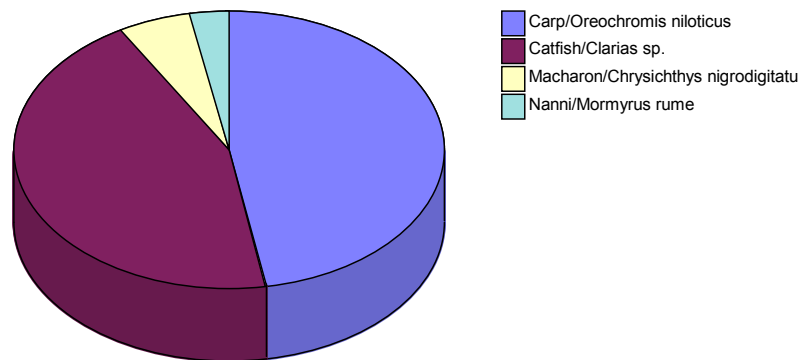


Fig. 11. Distribution of fish most purchased by consumers

Table 1. Origin and proportion of different types of fish encountered in Ouagadougou

Types of fish	Origin	Proportion (%)
Smoked Racok	Ivory Coast	10.00
Macharon	Sourou (Burkina Faso)	10.00
	Senegal	
Dried Nanani or Djêdjê wala (Concorde)	Sourou	13.33
	Mali	
Smoked carp	Mali	36.67
	Bagré (Burkina Faso)	
	Kompienga (Burkina Faso)	
Dried carp	Mali	6.67
	Kompienga	
Smoked Eels	Sourou	6.67
Smoked catfish	Sourou (Burkina Faso)	23.33
	Bagré (Burkina Faso)	
	Mali	

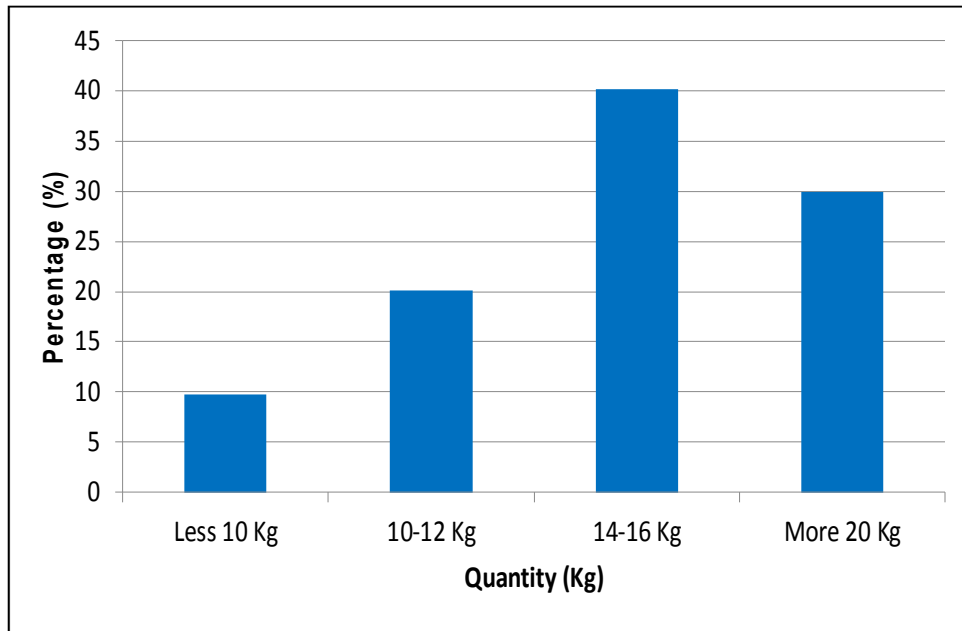


Fig. 12. Percentage of fish sold per day distributed

3.6 Difficulties and Expectations of Actors in their Activities

The difficulties encountered by the actors are:

- The frequent variation in the price of fish. This variation would be due to the fact that there are different suppliers who each set their selling price;
- A smoking defect that causes the fish to deteriorate. In addition, re-smoking causes a loss of weight which reduces the profit;
- A problem of availability of fish;
- Lack of fish preservation equipment.
- The expectations or suggestions of the actors in the majority of cases are:
 - To be able to place large orders with suppliers;
 - The government to make adequate fishing gear available to fishermen in order to allow them to catch more fish because some dams have a high potential of fish but lack appropriate equipment.

3.7 Actions Carried Out by the State of Burkina Faso for the Development of the Fish Sector

The support actions of the Burkinabe State are characterized by a willingness to develop fishing

through national fisheries and aquaculture policies as well as strategies for the sustainable development of fishing and aquaculture up to 2025. The objectives are: to increase production by 10%/ year, to strengthen the capacity of the actors, to ensure a sustainable management of the fishing resources, to develop the value of the fishing products.

The fishing sector is frequently unstable due to the fact that it is constantly shifting between several ministries: Agriculture, Animal Resources, Water and Sanitation. This results in the loss of financial and human resources as well as the halt of projects that were in progress.

3.8 The Types (species) of Fresh Fish Found on the Market in Ouagadougou and their Price

A wide variety of fresh fish can be found in Ouagadougou as shown in Fig. 13. Many of the fresh fishes are imported.

The prices of fresh fish vary greatly. Compared to dried/smoked fish, fresh fish is slightly more expensive. Indeed, the majority of fresh fish have prices above 6.84 USD/Kg. Some fish such as fresh salmon can cost up to 34.21 USD/Kg. These fish are therefore not very accessible to the less fortunate.

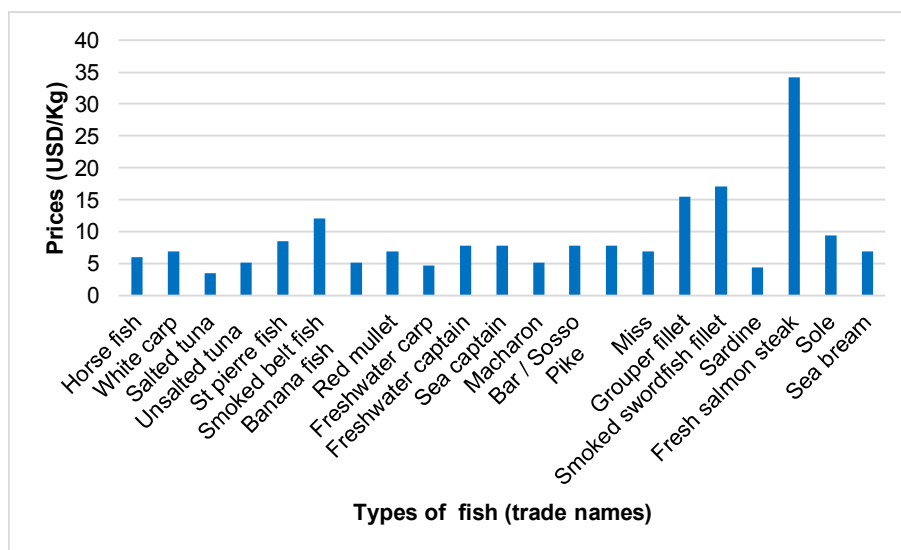


Fig. 13. Prices of different types of fresh fish

4. CONCLUSION

This study provided an overview of the commercial activity and conditions of the sale of fish (fresh, smoked/dried) in Ouagadougou. The survey revealed that there was a predominance of men over women in the fish trade. Several types of fish (smoked/dried) are available on the market but the most purchased fish are Carp, Catfish, Nanani or Match Fish, Macharon, Racock, Eels. The prices of smoked or dried fish are almost uniform unlike those of fresh fish. The fish found on the market in Ouagadougou come from Sourou, Kompiemga and Bagré as well as from external suppliers who are Ivory Coast, Mali, and Senegal. The observation of the conditions of the sale has made it possible to detect practices that could constitute risks of contamination by pathogenic microorganisms and deterioration of the quality of the fish. This preliminary study will guide us in the sampling of fish types to search chemical and microbiological contaminants in the laboratory.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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