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Characterization of Smoking Activity and Perception of Smoked Fish by Households in the City of Douala (Cameroon)

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Abstract: Smoked fish contributes to the food security of populations through its richness in nutrients and its accessibility to low-income households. This study aimed to characterize the smoking activity and the perception of smoked fish by households in the city of Douala. For this purpose, two surveys were conducted from February to May 2021. The first exhaustive, involving 35 processors identified the actors, the methods used and the most smoked fish species in three smoking centers (Youpwé, Bonassama and Manoka). The second survey, cross-sectional, of 384 households in five subdivisions of the city of Douala focused on the socioeconomic characterization of households and their appreciation of smoked fish. SPHINX software (2018) was used for descriptive data analysis. This study revealed that 85.8% of processors are over 40 years old and 97.1% have a low level of education. The smoking time varies between 8 to 48 hours and the three smoking kilns (Metal-drum, Banda and Altona) commonly used have an impact on health. However, 98% of households, regardless of their social status, consume smoked fish at least once a week, and the most consumed fish species out of more than 17 identified are bunga (27.08%), cod (22.14%), mackerel (14.58%), sole (10.16%) and pike (5.73%). The results of this study provide valuable information and constitute a working basis for improving fish smoking sector in order to guarantee the quality of the smoked fish.

Keywords: Smoking Activity, Perception, Survey, Smoking Kiln, Smoked Fish

1. Introduction

Fish is considered as a valuable source of nutrients and an integral component of a well-balanced diet. It provides a healthy source of energy, high quality proteins, vitamins (D, A, E and B12), essential minerals and particularly n-3 long-chain polyunsaturated fatty acids (LC PUFA). These PUFA are mainly eicosapentanoic acid (20:5 n-3 EPA) and docosahexanoic acid (22:6 n-3 DHA), whose pleiotropic effects on health promotion and disease prevention are well recognized [1-3]. They also play an important role in the prevention and treatment of some non-communicable diseases. Fish oils could be used for nutritional, pharmaceutical and industrial applications [4-6]. Giving its importance, global fish production has grown steadily for decades. From less than 40 million tonnes in the 1960s, thids production rose to 179 million tonnes in 2018 with an estimated annual supply consumption of 20.5 kg per capita and a total first-sale value estimated at USD 401 billion [7]. In Cameroon, global fish production is estimated at 287,461 tonnes with an annual supply consumption of 19.4 kg per capita and represents 40% of animal proteins and 9.5% of total protein requirements [8, 9]. This abundant production

makes fish the most traded foodstuff in the world but also poses a conservation problem mainly in developing countries [7].

Indeed, since fish is a highly perishable commodity, special care must be taken at the time of capture or harvest and throughout the supply chain in order to preserve its quality and nutritional attributes, to avoid the risk of contamination and to limit loss and waste [10, 11]. According to the FAO, it is estimated that 35% of the global harvest is either lost or wasted every year [7]. These losses in quantity and quality are due to the inefficiency of value chains, especially for sub-Saharan countries. To limit these losses, preservation methods exist such as freezing, refrigeration, salting, drying and especially smoking [12]. Smoking/drying is more widespread and more used especially in sub-Saharan Africa countries. According to WorldFish, more than 200 million people consume regularly fresh fish, but more often smoked or dried [13]. In Cameroon, 80% of artisanal maritime fishing and inland fishing production is distributed in the smoked form [14]. The city of Douala, given its geographical position, is a large basin for the production of smoked fish due to its seafront and the presence of numerous surrounding rivers, but also for consumption due to its cosmopolitan population of around 3.795 million inhabitants in 2019 [15]. In addition, farmed fish and imported frozen fish are also purchased and processed [16].

Smoking has several advantages: it prolongs shelf life, provides a good aroma, reduces post-harvest losses and facilitates the transport and sale of fish [17]. In addition, smoked fish remains an accessible commodity for low-income households. Despite the difficult smoking conditions and the various smoking procedures adopted such as diversity of operation units, stoves and fuels used, there is also a diversity of quality smoked fish on the market [18]. An inventory of smoking practices, including the most consumed smoked fish species and their perception among households, seems necessary for a possible improvement of the processes that will guarantee better nutritional, hygienic and organoleptic quality [19, 20]. Besides, there is a paucity of study having adressed this topic in Cameroon especially in the city of Douala.

The aim of this study was to characterize the influence of smoking processes on the quality of smoked fish and the perception of their quality among consumers in the city of Douala. The objectives were to conduct surveys among processors and households respectively in Douala.

2. Material and Methods

2.1. Study Framework

The study was conducted in the city of Douala, economic capital of Cameroon, located on the estuary of the Wouri river and open to the Gulf of Guinea between 3°50'-4°08' North latitude and 9°30'-9°75' East longitude (figure 1).

By virtue of its population, its wealth of waterways and its proximity to the Atlantic Ocean, the city offers good opportunities for fishing, processing and marketing of fishery products. Indeed, some smoking centers have been developed around this fishing activity.
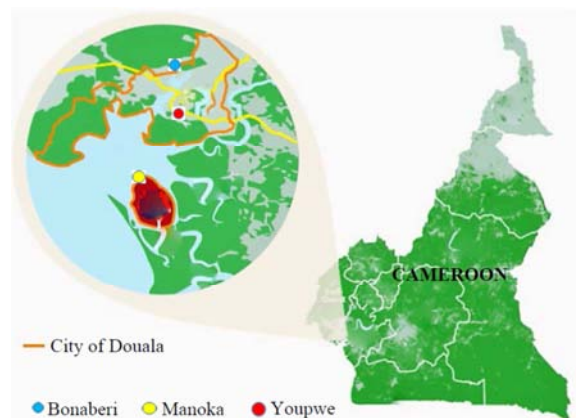

Figure 1. City of Douala with smoking sites.

2.2. Information Gathering Techniques

Two questionnaires were addressed: one to processors and the other to households. The first step consisted of a pre-survey to locate the different processing sites and to have a general idea of the smoking activities. Then it is about the distribution, explanation, filling, collection, verification and finally the analysis of the survey forms. In order to facilitate communications and obtain information, fish names were given in local language.

2.3. Processors Survey Design

This was a comprehensive survey of 35 processors listed in the database of veterinary health inspection services of the Ministry of Livestock, Fisheries and Animal Industries. The survey was carried out during three weeks in February 2021 in the three main smoking centers in the city of Douala namely: Youpwe, Bonabéri and Manoka whose geographical coordinates are (4°00' N - 9°69' E), (4°07' N - 9°68' E) and (3°56' N - 9°72' E) respectively (figure 1). According to the processors, this period corresponds to the main fishing season with a wide variety of smoked fish species. This survey took place for 15-25 minutes for each respondent via the face-to-face interview at the smoking sites in order to minimize any misunderstanding related to the questionnaire.

This questionnaire focused on the socioeconomic characterization of smoking activity as recommended by Gunter et *al.* [21], the determination of the most smoked fish species sold; processing and the impact of smoking on the health of processors. The inclusion criteria were as follows: be a fish processor and active in one of the three major smoking centers; agree to participate in the survey and sell the smoked fish in Douala.

2.4. Household Survey Design

This survey was carried out on a representative sample of the 758,000 households in the city of Douala (world-statistical data, 2021) [15]. The sample size was found

according to the following formula of Lorentz:

$$N = z^2 \times p \,(1 - p) \,/\, m^2$$

N: sample size; z: 95% confidence level; p: estimated proportion of the population; m: Margin of error (5%).

The fieldwork survey took place for 10-20 minutes for each household via the face-to-face interview at home. Thus, 384 households were surveyed over 12 weeks, from March to May 2021 in 5 subdivisions of the city of Douala (Douala 1st, 2nd, 3rd, 4th, 5th). The choice of households was made randomly with the objective of covering the five subdivisions.

The objective of this questionnaire was the socioeconomic characterization of households according to Gunter et al. [21]; identification of the most consumed fish species and valued; the frequency of their consumption and general perception.

The sample was made up of women responsible for their household and taking care of meals.

2.5. Data Analysis

Data collected were keyed, verified and then analyzed statistically. The data, the raw tables and the figures were produced by Sphinx Plus2 software (V. 5.0.0.82, 2018), Word and Excel (Microsoft, Windows 2013). Quantitative variables were expressed in numbers and percentages.

3. Results

3.1. Processors Survey Results

3.1.1. Sociodemographic and Socioeconomic Status

Table 1 summarizes the socio-demographic status of the processors. Analysis of these results shows that smoking activity is carried out only by women, 85.80% of whom are over 40 years old and 88.60% are legally married. In terms of educational attainment, only 2.90% of processors reached high school. It also emerges that 97.20% of them are over 16 years old in this activity.

Table 1. *Distribution of processors according to their socio-demographic status.*

Variables	Parameters	Numbers (over 35)	Percentages
Age	20-30	1	2.90%
	30-40	4	11.40%
	40-50	15	42.90%
	50-60	12	34.30%
	> 60	3	8.60%
Educational level	None	2	5.70%
	Primary	16	45.70%
	College	16	45.70%
	High school	1	2.90%
	University	0	0.00%
Marital status	Single	1	2.90%
	Married	31	88.60%
	Widow	3	8.60%
Number of years in the trade	12-16	1	2.90%
	16-20	10	28.60%
	> 20	24	68.60%

3.1.2. Types of Smoking Kilns

The kilns generally used in the smoking centers of Youpwe, Bonassama and Manoka are: the Banda kiln, the Half-metal drum kiln and Altona kiln (Figures 2, 3 and 4).

Figure 2. *Banda.*

Figure 3. *Half metal drum.*

Figure 4. *Altona.*
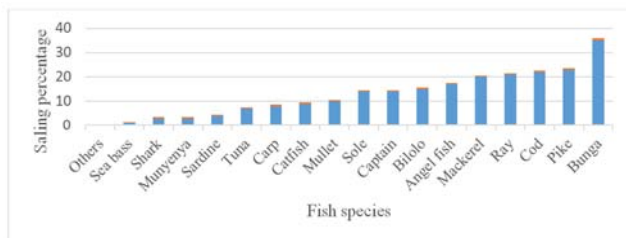
3.1.3. Presentation of the Activity

Table 2 presents some aspects related to the smoking activity. The results of the survey show that 100% of processors received on-the-job smoking training either by other processors (62.90%) or by the family (37.10%). The Banda kiln is the most used (77.10%), followed by the half-metal drum (20%) and Altona (2.90%). The smoking time is 80% between 24 to 48 hours. The smoking frequency at 91.40% varies between 2 and 4 times per week.

Table 2. *Presentation of the smoking activity.*

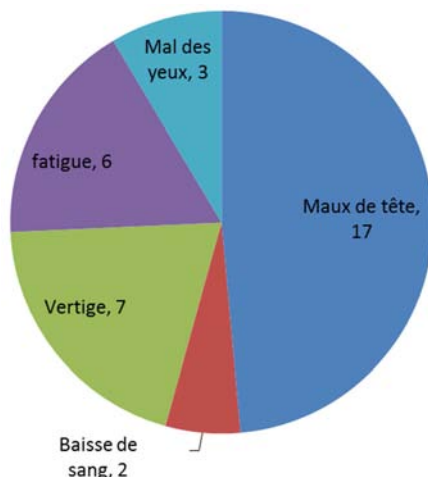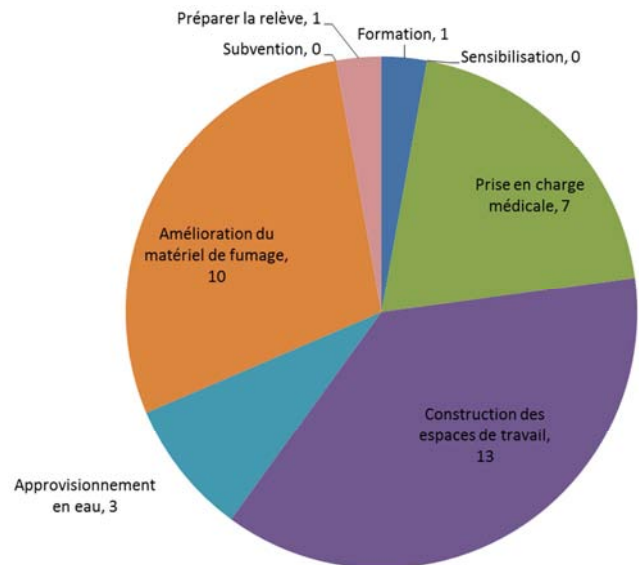| Variables	Parameters	Numbers (over 35 processors)	Percentages
Smoking training	Processors	22	62.90%
	Families	13	37.10%
	State/NGOs	0	0.00%
Smoking frequency	Every day	0	0.00%
	2-4 times/week	32	91.40%
	2-4 times/month	3	8.60%
Type of oven	Half-metal drum	7	20.00%
	Banda	27	77.10%
	Altona	1	2.90%
Smoking time	4-8 hours	2	5.70%
	> 8-24 hours	5	14.30%
	24-48 hours	28	80.00%
	> 48 hours	0	0.00%

3.1.4. Best-selling Fish Species

Figure 5 presents the best-selling fish species. These results show that the 5 best-selling smoked fish are: bunga, pike, cod, ray and mackerel.

Figure 5. *Best-selling species.*

3.1.5. Difficulties and Grievances Expressed

Figure 6 shows the discomforts experienced by the processors. It turns out that the most common ailments are headache (48%), dizziness (20%), fsatigue (17%), eye pain (9%) and drop in blood (6%).

Figure 7 presents some complaints about improving the working conditions of processors. It appears that 66% are campaigning for the construction of convivial spaces and for the improvement of equipment. Others want medical care (20%), the supply of water points (8%), training (3%) but also the preparation of the next generation of processors (3%).

Figure 6. *Discomfort felt by the processors.*

Figure 7. *Grievances expressed.*

3.2. Household Survey Results

3.2.1. Sociodemographic Status

Table 3 summarizes the socio-demographic characteristics of households. It emerges from this table that the age of the respondents is over 20 years old. The most represented age group is that of 50 to 60 years (28.70%) against that of over 60 years (13.10%) which is the least represented. Regarding the level of education, (35.90%) of the respondents reached higher education followed by college and high school with (29.20%) and (23.40%) respectively. The lack of schooling and the primary level represents 10.50%. 57.80% are married. 22.10% live in a common-law union. Single women are 11.70%. divorcees represent 4.40% and widows 3.90%. In addition. 87.50% of the households surveyed have at least 4 people.

Table 3. *Socio-demographic characteristics of households.*

Variables	Parameters	Numbers (over 35 processors)	Percentages
Age	20-30	53	13.80%
	30-40	73	19.10%
	40-50	97	25.30%
	50-60	110	28.70%
	> 60	50	13.10%
Educational level	None	6	1.60%
	Primary	38	9.90%
	College	112	29.20%
	High school	90	23.40%
	University	138	35.90%
Marital status	Single	45	11.70%
	Cohabitation	85	22.10%
	Married	222	57.80%
	Divorced	17	4.40%
	Widow	15	3.90%
Number of people in the household	1-3	48	12.50%
	4-6	233	60.80%
	7-9	91	23.80%
	> 9	11	2.90%

3.2.2. Selection Criteria of Smoked Fish and Frequency of Consumption

Figure 8 presents the household selection criteria for smoked fish. 67% of respondents base themselves on the smoked fish species, 11% for eating habits, 9% for the quality of smoking, 7% for the price, 5% for the availability and 1% for the flavor.

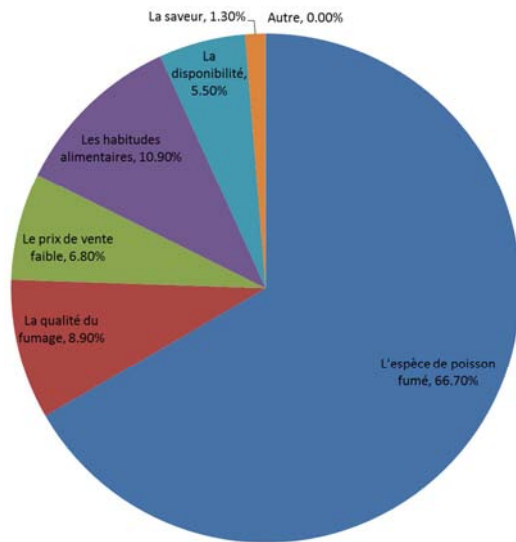Regarding the frequency of consumption (Figure 9), 98% of respondents consume smoked fish at least once a week.
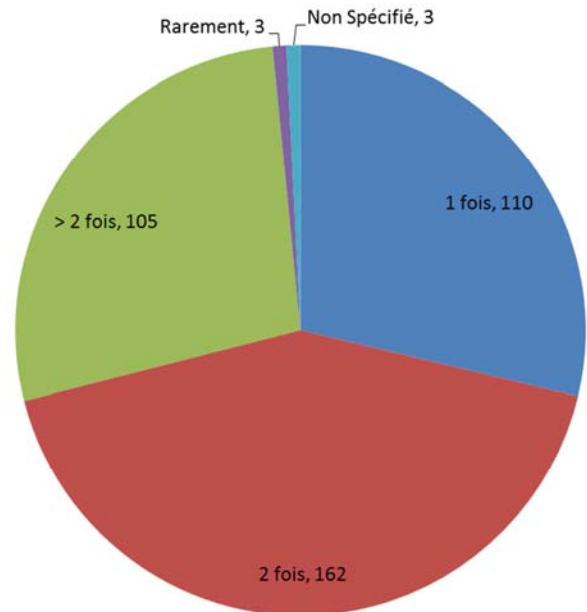
Figure 9. Frequency of consumption.

3.2.3. The most Consumed Smoked Fish Species

Figure 10 shows the most consumed smoked fish species in households. It emerges from this figure that 95.30% of the most consumed fish belong to five species: bunga (27.08%), cod (22.14%), mackerel (14.58%), sole (10.16%) and pike (5.73%).
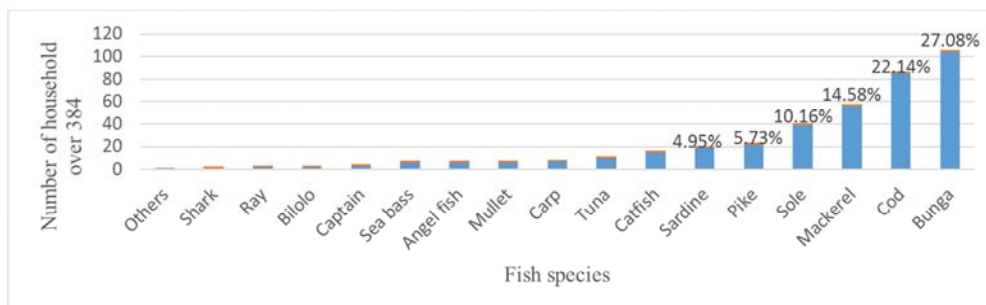
Figure 8. Criteria for choosing smoked fish.

Figure 10. The most consumed smoked fish species.

3.2.4. Perception of Smoked Fish by Household

The sensory perception of smoked fish is presented in figure 11. These results show that overall households find the color (91%), the texture (84.60%), the taste (98.70%) and odor (90.90%) good or very good.
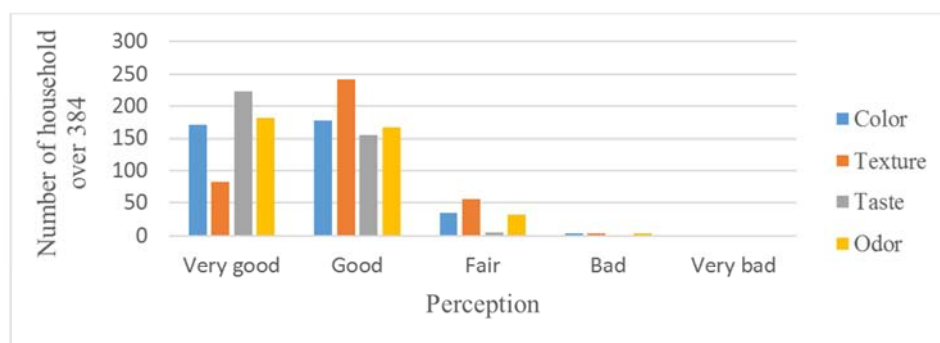
Figure 11. Perception of smoked fish.

4. Discussion

The smoking centers of Youpwe, Bonabéri and Manoka use the Half-metal drum and Banda kilns in 97.10% of cases. These ovens are traditional and semi-closed. They are direct hearth meaning that the product is exposed to direct radiation from the furnace and the combustion fumes are in direct contact with the product. Ekomy et *al.* made the same observation in two large smoking centers in Owendo and Ikendji in Gabon [22]. As a result, the treatment of the product is not homogeneous within the smoker and the product is often calcined rather than smoked. Indeed, Nsoga et *al.* have shown that smoking methods have effects on the sensory and bromatological quality of fish [20]. Likewise, Ekomy et *al* showed a decrease in benzo (a) pyrenes contents from 57μg / kg of finished product for the banda oven to 4μg / kg for the improved oven [22]. In addition, these traditional smokers have low energy efficiency due to heat dispersion wich increased smoking time (between 24 to 48 hours) in 80% of cases. This time is nevertheless less than that obtained by Ekomy et *al.* who found 72 hours [22]. The type of smokehouse and the smoking method could therefore influence the quality of the smoked fish but also have an impact on the health of processors because of the release of heat and fumes. The use of these traditional smoking methods could be influenced by custom. Indeed, 100% of the respondents received their training on the job either by the family (37.10%) or by other processors (62.90%). In addition, age (85.80% are over 40 years), level of education (97.10% have not reached high school) and number of years in the trade (97.20% are over 16 years old in smoking) could explain the attachment to these traditional methods. However, the younger generation does not have the same perception of the smoking activity. Informal discussions with the processors confirm that this younger generation prefers other income-generating activities.

The smoked fish sold belong to more than 17 species. The species not recorded during this investigation would be due to their seasonality, to the constraints linked to the species such as high lipid content or to their ecology and reproduction cycle. This remark can be confirmed by Mujinga et *al.* on the inventory of fish species available in urban markets and on the categories of fishery products sold in Lubumbashi markets and their nutritional value [23]. Likewise Gsegner et *al.* carrying out a study on the Niomo market in Niger observed a very wide variety of species sold in smoked, fresh, dried and fried form [24]. However, some species were absent especially in the smoked form.

Smoking is not a safe job. The discomforts felt by processors are manifold. These are headache (48%), dizziness (20%), fatigue (17%), eye pain (9%) and drop in blood (6%). Indeed, during their work, the women use firewood. Combustion produces smoke, a mixture of gaseous products and solid particles of varying colors and toxic to the body. Constantly inhaled, these gases negatively affect the health of the actors in the short and long term.

According to Akmel, there may even be a long lag time between nuisances and pathogenic effects [25]. He insists that under the action of fire, women sweat profusely and the skin becomes dehydrated considerably. Weakened by repeated attacks, the skin can no longer protect the body which becomes an open door to dryness of the skin and malaria. It can be noted why 86% of the processors need the improvement of their working conditions. in particular: the construction of modern workspaces (37%), the improvement of smoking equipment (29%) and medical care (20%). On analysis, processors are ignorant of the health risks associated to smoking fish. Many women do not know that they are exposed to more disabling diseases. Faced with the lack of jobs and poverty, they have only one concern: to improve their precarious living conditions. Women therefore do not have time to question the consequences of their activity. This behavior corroborates the thesis of Marx who said: "It is not the consciousness of people that determines their being. On the contrary, it is the social being that determines their conscience" [26].

Regarding the household survey, the results show that smoked fish is generally consumed and appreciated in the city of Douala. This consumption does not depend on age, marital status, education level or number of people in the household. This may be due to its cost. Indeed, according to the FAO, smoked fish constitutes an important source of animal protein accessible to low-income households, especially in developing countries where the price of meat remains beyond the reach of the market of the average consumer [27]. The frequency of consumption of smoked fish varies from household to household. Thus, 69% of households consume smoked fish at least twice a week while 29% consume it once. These results are close to those obtained by Mujinga et *al.* who showed that the frequency of fish consumption in general in Lubumbashi varies between households from once to seven times a week [23]. Certain criteria can explain these choices such as the fish species (67%), eating habits (11%), quality of smoking (9%), price (7%), availability (5%) and flavor (1%). Milong et *al.* corroborate these results by showing that the lack of knowledge or the scarcity of certain species does not encourage consumers to take the risk of buying them [28]. Moreover. according to Cardoso et *al.*, geographic factors affect the preference and consumption of certain products [29].

Regarding the ray fish, it is among the most smoked species but not the most consumed ones in Douala. This could be because it is much more exported compare to other species. However, these results also show that in general the most consumed smoked fish (bunga, cod, mackerel, sole and pike) are among the most sold. This result is in agreement with the work of Mananga et *al.* who have shown that the most sold smoked fish (*Clarias spp., Protopterus dolloï and Distichodus spp.*) are also the most consumed in Brazzaville [30].

5. Conclusion

Smoked fish plays an important economic role for processors and occupies a key place in the diet of the people of Douala. However, smoking methods remain traditional, sometimes with consequences on the quality of the product and on the health of processors. Many smoked fish species remains generally available and appreciated by households in the city of Douala.

These findings provide valuable information's for the smoked fish processing sector especially to plan improving strategies of production for the promotion of quality of smoked fish. The analysis carried out in this study suggest that the public authority should intensify their relationship with the processors and promote the extension of the fish smoking activity by giving a finincial and technical support. In addition, smoking methods has an impact on the quality of fish. Future works should therefore focus on both microbiological, nutritional and toxicological quality assement of smoked fish according to each smoking method in order to promote the best one for human health.

Conflicts of Interest

The authors declare that they have no competing interests related to this article.

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