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ORIGINAL ARTICLE

Contribution to the investigation of the artisanal fish oil (*Sardine pilchardus*. Walb.) Sector in the Far-North Region-Cameroon

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Abstract

Sardina pilchardus commonly known as sardine is a fish species abundantly fished for in the Far-North Region of Cameroon mostly from September to November each year. In this Region, the main fishing points are the Logone and Chari rivers and the Maga Lake. This study was initiated with the aim to analyze the fishing sector and the different oil production steps from sardine and its co-products. A survey involving 295 persons was carried-out between the months of September and November 2021 at several production points. During the survey, samples of *S. pilchardus* oil were collected from producers in order to evaluate the impact of processing methods on oil quality. The results of the survey revealed that oil extraction from co-products (viscera) is a traditional activity which has long been practiced by women in the localities of Pouss, Mourla, Tekele, Gazama and Areinaba. Fishers are men (50%) and women involved in oil production (90%). The extraction by cooking after fermentation, the extraction by cooking without fermentation and the extraction after direct drying without fermentation were the three production methods identified. More than 80% of the viscera oil was found to be used for culinary purposes. In the traditional pharmacopoeia, these oils are employed at 61.9 % in the treatment of stomach pains. The chemical characterization of the produced oils showed a significant difference ($p<0.05$) with respect to the production zones. Irrespective of the localities, the water contents (0.15 to 0.38%), acid values (5 to 6.93 mg KOH/g oil), saponification values (214 to 255 mg KOH/g oil) and iodine values (100 to 115 g I_2/100 g of oils) were not in accordance with the Codex standards. The results obtained indicated that a particular attention should be given to the extraction conditions of fish oil with the aim to improve its quality.

Practical application

Women in the Far- North Region of Cameroon value co-products from fishing to produce oils which is sold. However, the production yield is relatively low and the oils are not always of good quality. Knowing the different production steps will improve the production yield and the quality of the viscera oil. Given the good proportion of omega-3 fatty acids found in fish oil, the improvement of its production and quality could also lead to the creation of small production units, improving family incomes and health in the Far-North and ensuring food security.

Keywords: Fishing sector, viscera, oil, extraction, chemical characterization

1. Introduction

World fish production has increased over the past five years from 154 million tonnes in 2011 to 179 million tonnes in 2018 for an estimated total worldwide value of 410 billion US dollars (FAO, 2020a). According to the Statistica Research Department (2019), Cameroon went from nearly 205,000 tonnes of fish produced in 2013 to about 285,000 produced in 2019. This increase in production is mainly explained by the commitment of the government and the population to the fishing sector and aquaculture.

Fish is eaten fresh, dried, smoked or fermented. During these transformations, more than 50% of co-products (heads, viscera, skins, bones, fin, gills, backbones, belly flaps, liver, roe, and others) are generated (Marti-Quijal *et al.,* 2020), with a huge impact on environmental pollution and disposal problem (Ajay *et al.,* 2022). Only 29-30%

of the global production of co-products is used for the production of fishmeal and fish oil (IFREMER, 2010, Al-Khawli *et al.,* 2019, Krishna Kumar *et al.,* 2022). The use of fishery co-products is not a new idea. In Africa, and mostly in Ghana, Senegal, Mauritania and Morocco, co-products from the fishery processing industries are more and more valorized. Mauritania and Ghana lead the ranking of fish oil production and exportation with 500 and 19,654 tonnes respectively (Mohamed & Mouhamédou, 2012). These co-products are gradually being used in the food industry (Estiasih *et al.*, 2021, Ajay *et al.*, 2022). In Egypt, oil is extracted from co-products for the sustainable production of biofuels (Krishna Kumar *et al.*, 2022). In the Far-North, fish is the second source of lipids after cottonseed. In the fishing communities of the Far-North Regions of Cameroon, the promotion of fishery co-products is multifaceted. Among others are the productions of oil from the viscera. This oil, locally called *emel hagn*, has an excellent aroma in the meals and is also used in traditional pharmacopoeia (Abdoulaye, 2014). Apart from the family use, this oil is a source of income for many households. As far as our knowledge is concerned, very few interest has been given to the production of fish oil in Cameroon. Nowadays the consumption of polyunsaturated oils is encouraged; the investigation of the fish oil sector in the Far North Regions of Cameroon is of great interest. However, this sector is not organized. The present study aimed at defining the physical and economic flow of stakeholders in the fish oil sector; to identify the techniques used for the production of fish oil and to evaluate some quality parameters of oil for comparative purpose.

2. Materials and Methods

The biological material consisted of sardines (*S. pilchardus*) and fish oils from the 5 localities (Mourla, Areinaba, Tékélé, Pouss and Gazama) surveyed and brought back to the bioprocess laboratory for analysis.

2.1 Study area

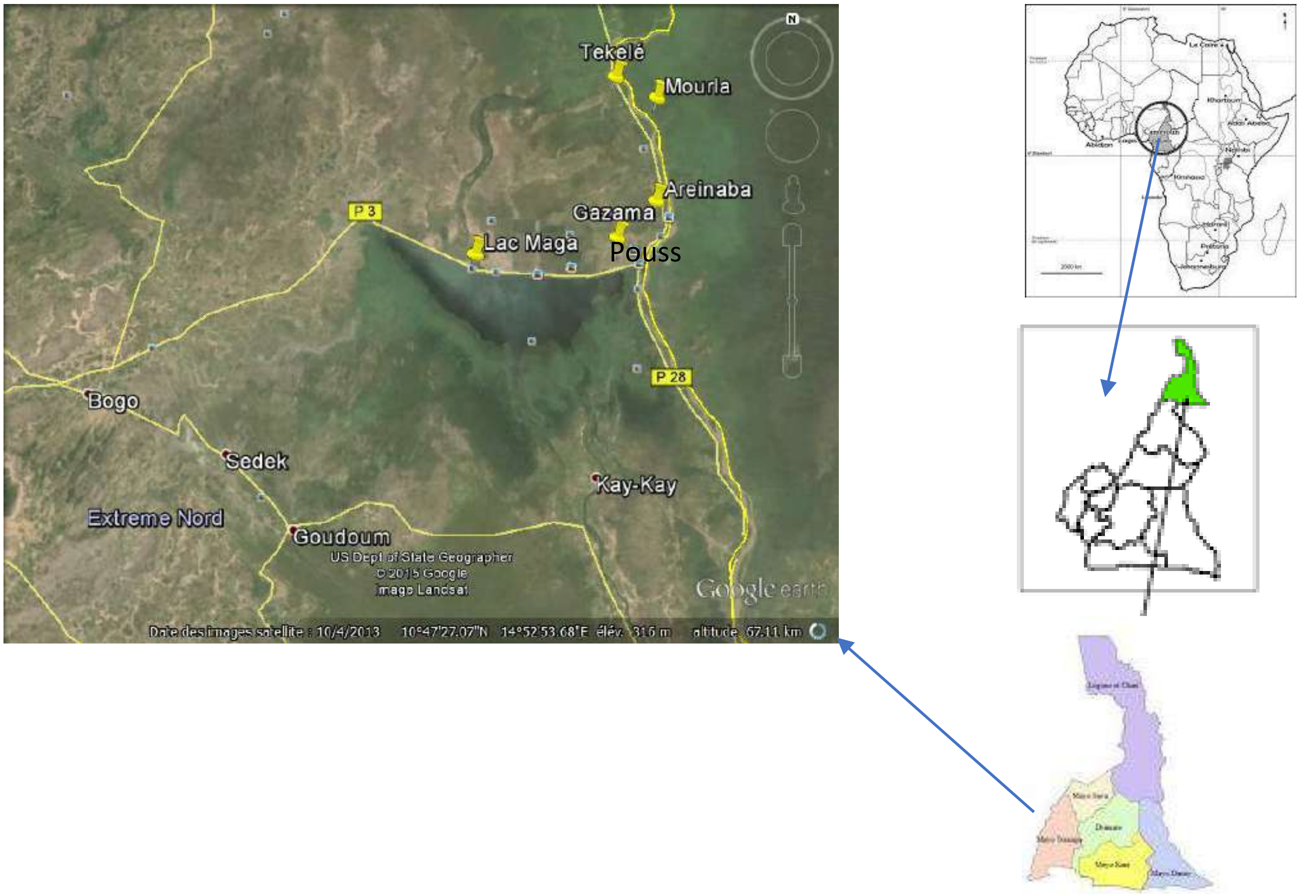
This research was carried out at different localities (Pouss, Mourla, Tekele, Gazama and Areinaba) in the Mayo-Danay Division of the Far-North Region of Cameroon. The selection of a given locality was based on the existence of fish species, fishermen and fish oil producers. The geographical locations of the different Divisions were: Pouss (15°3’44 32 ″ N 10°5052 80 ″ E), Mourla (15°4’44 36 ″ N10°58'5 69 ″ E), Tekelé (15°2’37 93 ″ N10°59’8 74 ″ E), Gazama (15°2’37 93 ″ N10°51’4 00 ″ E) and Areinaba (15°4’37 93 ″ N10°52’54 06 ″ E). Picture 1 presents the map of the localities covered involved in this study.

2.2 Survey

A survey involving 295 people was carried out with a main goal to acquire general knowledge on: sardine fish, fishing activity and conditions, fish oil extraction, packaging and marketing of fish oil. The survey was conducted as a semi-structured interview as described by Dupriez and Leaner (1987). It was carried-out from September to November 2021. Interviews of 20 to 30 minutes were done either in French, English or *Musgum* dialect depending on the participant’s preferred language. A facilitator and other interpreters were hired in each locality.

2.3 Fish oil characterization

Fish oil samples were collected in brown bottles from the producers during the survey. They were sealed and carefully stored away from light.



Picture 1: Map of the study area

The effect of production processes on the oil qualities was evaluated by determining the moisture content, iodine, saponification and acid values (AFNOR, 1981).

The tocopherol content of oil samples was also determined using the method described by Kivçak & Mert (2001). 10-40 mg of fat was dissolved in 10 ml of chloroform. 1 ml of the product obtained was mixed with 1 ml of 2,2-dipyridyl, and then 1 ml of ferric chloride reagent and stirred for 10 s. The absorbance of the mixture was read at 522 nm in 50 s after addition of ferric chloride.

The α-tocopherol content was calculated using α-tocopherol as a standard curve.

2.4 Statistical Analysis of data

Sphinx software was used to conceive the survey questionnaire and analyze data. Experimentations were done at least in triplicate and results were presented as means ± SD. One way analysis of variance ANOVA was performed using Stagraphic Centurion version XVI.I software, to evaluate the statistical difference between the means of the data obtained. The difference between the values was considered to be statistically significant when the probability was less than 0.05 ($p<0.05$).

3. Results and Discussion

3.1 Fishing points

In the Far North Region of Cameroon, there are several fishing points visited by fishermen at different frequencies. The main fishing points as well as their visiting frequencies were enumerated and the results are presented in table 1. The most visited points for fishing activity are the Lake Maga (36.7%), the Chari River, its tributary (31.41%) and the Logone river (31.01%). These percentages could be explained by the fact that they are the main lake and rivers of the locality.

3.2 Fishing

Fishing is an activity involving 50% of men. Children participation varies from 12.0 to 28.2% depending on the localities. The activity involves a group of at least 10 people since it requires energy and courage due to the high level of water, especially during flood-periods. When there is no fishing, about 80% of fishermen are occupied in their farm activities.

3.3 Fishing methods

Table 2 provides information on the methods used by inhabitants of the Far-North Region of Cameroon to carry out fishing. Seven methods of fishing were identified. Depending on the localities, traps, nets and spears fishing methods were used at the following frequencies: 19.3-33.3; 38.5-27.4 and 19.3-33.4% respectively. The fishing rod method was found only in Pouss with 1.8% of respondents. The hook line method as well as the fishing rod introduced by the ancestors was found to be disappearing due to its poor yield (0.3%).

The traps, net and spear methods were the more solicited in all localities. According to fishermen, these methods permit a capture of good number of fish compared to other fishing methods.

Table 1: Fishing points and visiting frequencies (% of responders)

Sites	Localities					
	Gazama	Mourla	Pouss	Areinaba	Tékélé	Average
Maga	41	37	33.3	33.4	39.2	36.78
Logone	27.5	31.5	33.3	33.3	29.42	31.01
Chari	27.5	31.5	33.4	33.3	31.38	31.41
Blangoua	4	0.0	0.0	0.0	0.0	0.8
Total	**100**	**100**	**100**	**100**	**100**	**100**

In Egypt, for the capture of fish (Sardines (*Sardina pilchardus*, and *Sardinella aurita*)) in the Red Sea, fishermen use purse seine fishery, which is locally called *chancholla*. The hooks and lines constitute about 36% of the total methods, while the different types of nets represent 18% of the whole fleet (Mehanna, 2022).

3.4 Species of fishes caught

The different species of fishes caught by fishermen in the five localities in the Far-Nord region were identified and presented in table 3. Six of them were found in all localities according to the respondents: Captains, Tilapia, Cat Fish, Jaws, Sardines, Carp. Among all these species, Sardine is the only one used for fish oil production.

Table 2: Fishing methods in five localities in the Far North Region, Cameroon (% of responders)

Fishing methods	Localities					
	Gazama	Mourla	Pouss	Areinaba	Tékélé	Average
Traps	24.7	28.3	19.3	33.3	30.8	27.28
Nets	27.4	37.7	35.1	33.3	38.5	34.4
Spears	24.7	28.3	19.3	33.4	30.7	27.28
Fishing rod	0.0	0.0	1.8	0.0	0.0	0.36
4 strings line net	9.5	0.0	5.3	0.0	0.0	2.98
Hook line	1.4	0.0	5.2	0.0	0.0	1.34
Baskets	12.3	5.7	14.0	0.0	0.0	6.4
Total	**100**	**100**	**100**	**100**	**100**	**100**

3.5 Conditioning of fishes

Many methods are used to condition fish after fishing with the principal ones being plastic bags (22.4%), basins (20%), canoes (18.7%) and coolers (18.5%). The absence of freezers was noted in all these localities which could lead to the rapid deterioration of the fish. This could impair on the quality of the oil produced. Among the materials, plastic bags and basins are the most used; these are followed by coolers, canoes and cars.

3.6 Different uses of caught fishes

Irrespective of the locality, fishes are consumed in the dried, smoked or fresh state, depending on the fishing period. During floods periods, caught fishes are mostly smoked or dried due to the highest yield of fishing. However, during the low water periods, fishing activity is hard and the yield is very low. Therefore, the smallest quantities that are caught are consumed directly. More than, 24% of fishermen sell their product directly after fishing, 24.3% use to dry it and only 3.8% of respondents keep the fishes cold before selling or processing. This could be justified by the fact that, dried fishes have a longer shelf-life and are therefore available during off seasons. Additionally, the benefits are significantly higher when fishermen sell their production out of the production season. Samy-kamal (2021) studied the prices of seafood in Egypt and found that in general prices are stable in several months but increase in April, August, October, and November, with the maximal in December. It is well know that price fluctuations for all products and mostly for fish and fish product depend on the supply and demand variations (FAO, 2020b).

3.7 Extraction of fish oil

Extraction by cooking after fermentation, extraction by cooking without fermentation and the extraction after direct drying without fermentation were the three fish oil extraction methods practiced by producers in different localities. The steps involved in the extraction process are summarized on figure 1.

Table 3: Fish species caught in the five localities in the Far North Region of Cameroon (% of responders)

Species	Localities					
	Gazama	Mourla	Pouss	Areinaba	Tekele	Average
Captains	16.5	16.3	16.3	16.5	16.7	16.5
Tilapia	16.5	16.3	16.3	16.5	16.7	16.5
Cat Fish	16.5	16.3	16.3	16.5	16.7	16.5
Jaws	16.5	16.3	15.5	16.5	16.7	16.3
Sardines	16.5	16.3	16.3	16.5	16.7	16.5
Carp	16.5	16.3	16.3	16.5	16.7	16.5
Herring	0.0	1.6	0.0	0.8	0.0	0.5
Tetrodon	0.8	0.0	2.4	0.0	0.0	0.7
Eels	0.0	0.0	0.8	0.0	0.0	0.2
Pikes	0.0	0.8	0.0	0.0	0.0	0.2
Total	**100**	**100**	**100**	**100**	**100**	**100**

The main steps are: reception of fresh fish, fermentation or not, evisceration, mixing, settling, cooking with water or direct drying, settling, drying and cooling. This oil production is tedious due to traditional processes (evisceration with fingers, uncontrolled fermentation) and it takes longer time. 90% of the people involved in oil extraction were women. The extraction was done in groups or individually. This may justify the great variability in the process and even on the oil quality. The extraction knowledge is ancestral and it is transferred from mothers to daughters. These skills differ from one locality to another and sometimes from a family to another.

The extraction method by cooking after fermentation was the most practiced in the Areinaba and Tekele localities, while the extraction method by cooking without fermentation was found mostly in the Pouss and Gazama localities. However, in the Mourla locality, the extraction after direct drying without fermentation was the most common.

After fishing, fishes are grouped according to their sizes and then cleaned with fresh water and treated based on the methods illustrated on figure 2. Fishes other than sardines (used for oil extraction) are sold directly on the site. Selected fishes are spontaneously fermented in anaerobic conditions for 2-5 h, at room temperature (27°C to 42°C). The fermented and non-fermented fishes are eviscerated.

For approximately 30 kg of fish, 10 kg of co-products (viscera) was obtained.

For this, the lateral slit of the fish body, from the anal end to the gills was made using fingers.

The evisceration process took place in a bucket or in a local canary filled- up at 2/3 of its volume with clean water.

Evisceration is a difficult, long and tedious step due to tough work and higher risk of injury. The evisceration process depend on the amount of fish, and last approximately 8 hours for 50 kg of fish. The fish fillets obtained from the gutting was fermented and dried for further use. The heads are not used for oil production because; according to the producers they affect the oil quality and extraction-yield.

The producers knead water-viscera mixture with their fingers in order to reduce the viscera into fine particles. The mixing movement contribute to the destruction of fish cell walls which have already been weakened by the fermentation process this lead to an increase in the extraction yield of the oil. Porridge with a milky appearance is obtained. This mixture is stirred manually and left to stand to facilitate decantation. This resulted in two phases: the white fat that rose to the surface and the impurities that precipitate.

The fat is collected most often with the hands or with a spoon and then boiled for 2-3 hours at 90°C with water (5:1(V:V)) or dried directly. This operation was ended when the white solution turned to light or golden yellow colour with the disappearance of lumps. After boiling, the pot was allowed to bend for about 30° to ease the decantation and the oil collection process. In fact, this operation improves the separation the two phases. The resulting solution was dried to remove traces of water. The recovered fish oil was transferred to a container and cold at room temperature. Picture 2 shows the sardine fish (*S. pilchardus*) (a) the viscera (b) dumped in nature and the resulting oil (c).

Table 4: Some chemical parameters of fish oils with respect to the production localities

Parameters	Localities					Codex stan dards, (2017)
	Areinaba[1]	Gazama[1]	Mourla[2]	Pouss[3]	Tekele[3]	
Moisture content (%)	0.26 ± 0.01^{c}	0.38 ± 0.01^{a}	0.14 ± 0.01^{d}	0.27 ± 0.02^{bc}	0.31 ± 0.01^{b}	0
Acid value (mg KOH/g oil)	6.03 ± 0.10^{b}	6.93 ± 0.50^{a}	5.83 ± 0.10^{d}	5.33 ± 0.10^{c}	5.97 ± 0.50^{b}	≤ 3
Saponification value (mg KOH/g oil)	255 ± 1^{a}	246 ± 1^{b}	214 ± 2^{d}	233 ± 2^{c}	231 ± 1^{c}	≤ 200
Iodine value (g I_2/100 g of oil)	103 ± 3^{bc}	101 ± 2^{c}	100 ± 3^{c}	107 ± 3^{b}	115 ± 3^{a}	≥ 190
α-tocopherol (mg/g)	30 ± 2^{a}	10 ± 1^{d}	0.2 ± 0.01^{e}	20 ± 1^{c}	25 ± 0.1^{b}	600

[1]*extraction method by cooking after fermentation*
[2] *extraction method after direct drying without fermentation*
[3] *Extraction method by cooking without fermentation*
Value on the same line with the same superscript letter are not significantly different at P < 0.05; n = 3. Values are expressed as means ± standard deviation

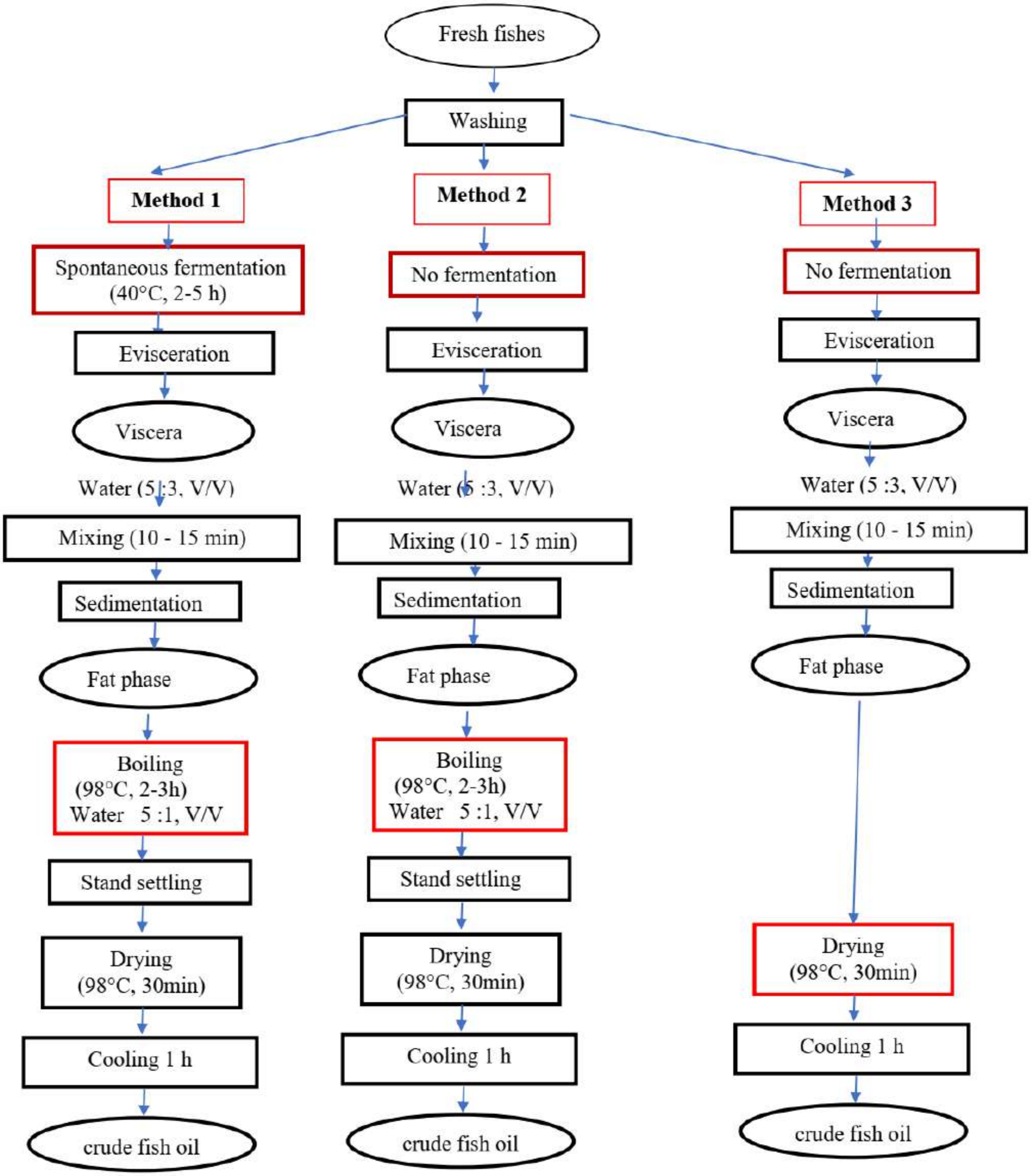


Figure 1: Process diagram of oil extraction from fermented or non-fermented fishes

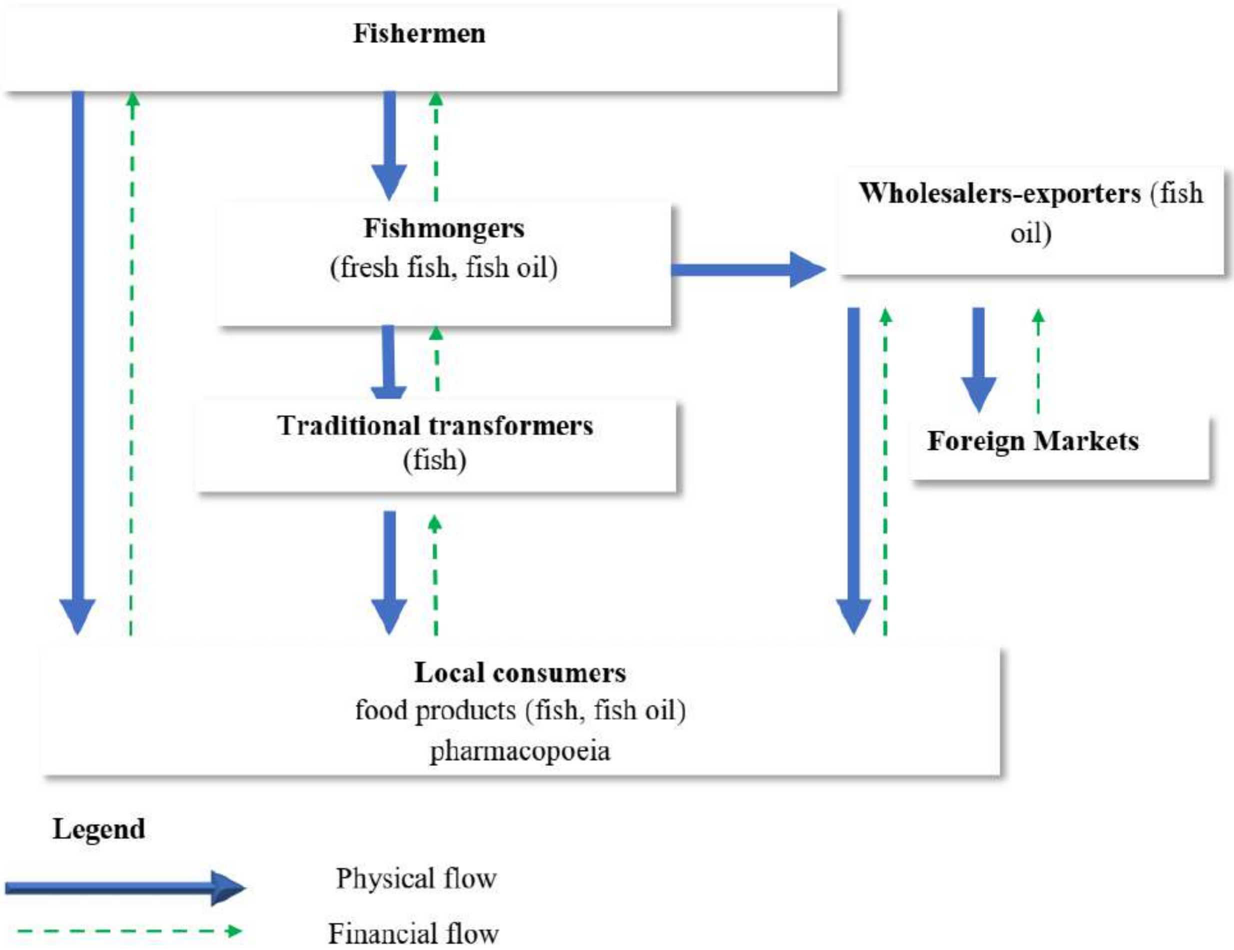


Figure 2: Flow of exchanges between actors in the fish oil sector in the Far North Region of Cameroon

The main utilizations were against stomach aches (61.9 % of responders) followed by dermatosis (10.3%) and joint pains (6.4 %).

3.8 Packaging and marketing

Fish oils are packaged in plastic containers and stored for commercialization or use. During the period of abundance (November to April), one liter of fish oil cost 1500 to 2000 FCFA. However, it increases up to 2500 and 3500 FCFA during the periods of scarcity. Additionally, apart from being sold in the local market, fish oil is also sold out of the production zones especially in Yaoundé or Douala for more incomes generation (4000 or 5000 FCFA per litter).

3.9 General knowledge of Sardina fish

The general knowledge on fish consisted of evaluating the importance of fish in the social life of the population. The *musgum* people are ̏people of the water ˝ and the fishing activities are related to it. The *musgum* population is located near streams and they base their main subsistence on water. The Maga Lake and the Logone river are very important in the cultural life of *Musgum* people. The lake and river are very good tools for agriculture and also working points of income generation for fishermen in the Far North Region as well as for the neighbouring countries (Afti, 2014).

Picture 2: (a) Fishes (S. pilchardus) (b) viscera; (c) oil

In each locality, it was noted that sardine is a myth. This could be the reason why fish farming was not conducive for sardines.

The responses were unanimous that sardine is a very appetizing fish and provides oil which is their main source of income during lean periods as well as during abundance periods.

3.10 Actors of the fish oil sector

The flow diagram between the main actors of the fish oils sector in the fives localities is presented in figure 2. The various stakeholders involved in the fish oil activities alongside with their percentage include fishermen (31%), wholesalers (5%), traditional processors (62%) and sellers (2%) with significant flows between them. Fishing provides to producers incomes permitting them to meet their personal and / or family needs, through the direct sale and marketing of the extracted oil. Fishmongers are the operators who travel throughout the villages to buy the fish and particularly their oil. They usually work for the more affluent traders who put their money for this purpose. They either buy directly from the markets, or by giving loans to the peasants in charge to storing. It should be noted that some producers of fish oil are also wholesalers. During the period of abundance, women from Pouss locality buy fish oil in other localities such as Zina and Gazama to resell in the village because in Zina and Gazama the number of buyers is significantly lower.

Traditional transformers are exclusively women who were trained by their mothers. These skills differed from one locality to another and sometimes from one family to another. Producers were very familiar with the transformation processes at all levels from the pre-treatment to the end product. The extracted fish oil currently represents a potential income-generating activity, which might improve the economy producers.

The handicraft and rural nature of its mode of production could provide a new impetus to the development of a locality. The fact that all production and basic marketing are dedicated to women presents a positive aspect for the fish oil sector. However, the economic value of fish oil in Cameroon remains very low compared to certain African countries such as Mauritania, Ghana where fish oil has a high economic value. These two countries respectively export 500 and 19,654 tons of fish oil (Mohamed and Mouhamédou, 2012).

3.11 Some constraints related to the development of the fish oil sector

Constraints related to the development of fish oil sector were of several types:

-Lack of equipment, poor hygiene and sanitation, lack of development of the sites in accordance with the principles of the Codex Alimentarius Standard.

- Access to raw materials. Availability in quality and quantity are difficult. This major constraint is due to the scarcity of the resource. It is also due to the disorganization of actors, ignorance of all sources of supply and finally the insufficient financial capacity.

- Marketing: women producers face difficulties in marketing their products. They do not control commercial information, prices and distribution pathways. The poor quality of their product, the lack of packaging, limits the access of products to modern markets (supermarkets).

- Law regulations: there exist no legal texts to protect this sector of artisanal processing of fishery products.

3.12. Chemical analysis of fish oils from various localities

In order to evaluate the influence of traditional extraction methods on the quality of fish oils, some physicochemical analysis were carried out and the results are presented in table 4. The results were compared to Codex standards (2017), to have specific ideas on the quality of the final oil. Irrespective of the extraction methods and to emphasize on the necessity to standardize the production process.

3.12.1 Moisture content

The moisture content of oil is a parameter used to evaluate its aptitude for preservation. It can be observed from the data in table 4 that the moisture contents of the different fish oils ranged from 0.14 % (extraction after direct drying without fermentation) to 0.38 % (extraction method by cooking after fermentation). This can be justified by the fact that during extraction after direct drying without fermentation, there was no additional water added to the product, which was not the case for the cooking extraction. These values were higher than 0.14 % reported by Fatma *et al.* (2018) on the tilapia viscera oil. Codex standards (2017), recommend that fish oil should be free from water (0 %). The presence of water in all these fish oils could initiate hydrolysis and polyunsaturated fatty acids peroxidation.

3.12.2 Acid value

From table 4, the acid values of different oils samples were 6.93 mg KOH/g oil (extraction method by cooking after fermentation) and 5.33 mg KOH/g oil (extraction method cooking without fermentation) respectively. These results were comparable to 5.8 mg KOH/g oil and 5.93 mg KOH/g oil reported for Tilapia viscera oil respectively by Oliveira *et al.* (2013) and Fatma *et al.* (2018). It should be noted that these authors also performed extraction using cooking method. These values were also in the range of 1.55- 7.43 mg KOH/g oil pointed out by Mwangi *et al.* (2020) on some fish oils in Kenya.

Acid value is one of the important oil parameters influenced by the amount of free fatty acid and other non-lipid acids, such as acetic acid. This indicates that the oil acidity can vary with factors such as oil compounds and extraction methods (AFNOR, 1981; Gbogouri *et al.*, 2006). The acid value also gives an idea on the age and quality of the oil (Abdulkadir *et al.*, 2010).

Whatever the locality, the values are higher than that recommended by the Codex Standard (2017) (≤ 4 mg KOH/g oil). In fact, during fermentation of fish, the action of microbial lipases could explain the origin of free fatty acids. Likewise, the residual moisture of the oil, the high temperatures generated by the cooking and drying processes of oils added to the presence of water could have promoted the lipid oxidation and the production of free fatty acids (Aidos, 2002, Wrolstad *et al.*, 2004; Dave *et al.*, 2014).

3.12.3 Saponification values

The difference of saponification value reflects the type of fatty acids and the length of the carbon chain associated (Bonilla-Méndez and Hoyos-Concha, 2018).

The higher these two elements, the lower the saponification value. The result of the saponification values presented in table 4 vary from 255 (extraction method by cooking after fermentation) to 214 mg KOH g^{-1} (extraction method after direct drying without fermentation). The standard saponification value in fish oil according to the Codex Alimentarius (2017), ranges from 175-201 mg KOH g^{-1}. All values obtained for the different studied fish oils were above the standard. They were also higher than that of the mackery fish oil (197 mg KOH g^{-1}) reported by Bako *et al.* (2017) and lower than that of catfish (318 mg KOH g^{-1}) found by Abdulkadir (2010). The variation in saponification values of the fish oils found in this study could be due to the presence of short-chain fatty acids originated from the hydrolysis of triglycerides and the oxidation of polyunsaturated fatty acids. These two phenomena could have probably taken place during fermentation, drying and/or cooking of the raw materials (viscera).

3.12.4 Iodine value

The iodine value is directly proportional to the degree of unsaturation and inversely proportional to the melting point of the lipids (Thitiphan & Waranya, 2015). The highest iodine value (115.29 g I_2/100 g of oils) was obtained in the fish oil sample from the Gazama's locality. This result indicated that fish oil from the said locality was rich in unsaturated fatty acids such as eicosapentaenoic and docosahexaenoic. The iodine values of the fish oil samples from all localities were less than that of Codex standard (190 g I_2/100 g of oils) (table 4). These values were also lower than that found by Vida *et al* (2020) in oil from sardine co-products which is 167 g I_2/100 g of oils. These low values may be explained by the oxidation of polyunsaturated fatty acids due to high temperature during the fish oil extraction processes and the lipid peroxidases. It may also be due to light effect and the bad storage conditions of the oils (Aboubarkar *et al.*, 2008; Bouazzari, 2014).

3.12.5 α-tocopherol content

α-Tocopherol is a natural antioxidant and it is important for the stability of oils (Maryam, 2011). From table 4, the α-tocopherol content varies from 0.2 to 30 mg/g. Fish oil from the Tékélé locality had the highest value which was 25 mg/g. These α-tocopherol values were lower than 35-40 mg per 100 g of oil found by Njinkoue (1995) for sardine fat. This low α-tocopherol content in fish oils from all these localities was not good information as these may not promote their good preservation.

4. Conclusion

The actors involved in the fish oil sector are 90% women. The packaging and conservation of the oils do not meet the standards, which has an influence on the quality of the oil. Chemical analyzes show that the oils produced by women in different localities are not always of good quality. The economic challenges presented by the fish oil sector require an attention on certain aspects of production, the mastery of which can present factors of valuation, in order to promote fish oil in the most promising markets.bFish oil therefore currently represents a potential income-generating activity, for inhabitant of the rural zones of the Far North Region of Cameroon. The artisanal and rural character of its mode of production could provide new Job opportunities and therefore boost the development of the country.

Acknowledgments

None

Conflict of interest

The authors declare that there are not conflicts of interest.

Ethics

This Study does not involve Human or Animal Testing.

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