

EVALUATION OF THE QUALITY OF OCTOPUSES MARKETED IN CÔTE D'IVOIRE

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Abstract. This study was carried out during the year 2019 to 2021. It aims to situate the quality of frozen octopuses, intended for local and international markets in a processing company of fishery products in Côte d'Ivoire. The biochemical (self-check) analyzes (Total Volatile Basic Nitrogen (TVB)) focused on the method of distillation of an extract deproteinized by perchloric acid (HClO₄). The microbiological (self-check) analyzes (Flora total mesophilic aerobic bacteria (FAMT), staphylococci, sulphite-reducing anaerobic bacteria (ASR), faecal coliforms and salmonella) focused on isolation and identification techniques. The various analyzes carried out by the National Laboratory for Agricultural Development Support (LANADA) made it possible to assess the satisfaction rates and the average biochemical and microbiological levels. All the averages (biochemical, microbiological) obtained are lower than the standards indicated. Salmonella are absent in all the products analyzed. faecal coliforms are present at a non-satisfaction rate of 7.48%. However, an improvement in manufacturing practices and preservation methods is in progress dispensable, in order to avoid poisoning the population.

Keywords: *microbiological contamination, biochemical alteration, processed octopuses, Côte d'Ivoire*

Introduction

In 2014, world catches of cephalopods reached new records at 4.8 million tons (FAO 2016). According to the FAO, global octopus catches reached 405,773 tons in 2017 (EUMOFA, 2020). In the EU, the estimated apparent consumption of octopus in 2017 was highest in Italy, Spain, Portugal, Greece and France (EUMOFA, 2020). Fresh octopus represents a limited share of octopus consumption, and it depends mainly on national catches. However, there are large volumes of imported frozen octopus, which can be retailed thawed (EUMOFA, 2020). In Côte d'Ivoire, fishing occupies an important place in the country's economy. It provides a large number of advantages: it notably fuels economic growth, constitutes a sustainable means of existence for a large part of the population and provides, for the majority, one of the main sources of dietary protein (Shep et al., 2016). The production of cephalopods is the result of an industrial and artisanal unit. Cephalopods such as the octopus are almost non-existent in the diet of the Ivorian population apart from the people of the coastal zone. These seafood products represent an economic source worthy of attention and are capable of compensating for the overfishing of certain species of fish (Akesse, 2013). But these organisms rich in protein and so prized by certain countries, especially in the European Union, are the subject of national and international trade. The export of these products meets a number of criteria. This is why companies are subject to self-monitoring in order to keep products safe for human consumption.

The cold, which is the source of preservation in the context of our study, slows down or stops the development of microorganisms such as bacteria, hence its interest in food preservation. However, even when frozen, they do not die. This is why the cold chain

must never be broken (UNEP, 2008). This process makes it possible to preserve the qualities of the products (hygienic, nutritional and organoleptic). Only to be effective, the rules of hygiene must be respected (Thiam, 1983). These octopuses undergo processing before any export. Contamination of these organisms can take place in their living environment (water) or after capture, requiring numerous manipulations (Abotchi, 2010). However, with respect for the cold chain in companies exporting fish products, we believe we have control over contamination. However, some authors have isolated bacterial loads in modern companies (Kaire, 2013; Doua, 2012; Tsamba, 2010; Niyonzima, 2009) on products that have undergone the cold chain. Similarly, these cephalopods, living in the seabed rocky sand and muddy sand can be a source of important microorganisms.

It is to locate the level of microbiological contamination and the level of alteration in ABVT of octopuses, in the case of a company in Côte d'Ivoire that this study was carried out. But this objective is achieved only by basing itself on the analysis of the various self-checks carried out by the National Laboratory for Support to Agricultural Development (LANADA) with within it the Central Laboratory for Food Hygiene and Agro-Industry (LCHAI). During this study, the level of bacterial contamination and the content of Total Volatile Basic Nitrogen (TVBIN) of frozen octopuses will be evaluated.

Study area

This study took place in Ivory Coast, in the city of Abidjan precisely in the commune of Treichville coordinates (5°18'20.887"N; 3°59'58.193"W) (*Figure 1*). It was carried out on the one hand, largely in the company and on the other hand, at LANADA in the Central Laboratory for Food Hygiene and Agro-Industry (LCHAI) for carrying out the analyses. This company is a private establishment in charge of exporting fishery products (fish, crustaceans and cephalopods). It is located in the port area of Abidjan (Côte d'Ivoire). This company is an establishment for the processing and sale of seafood products on the European Union market and on the national market.

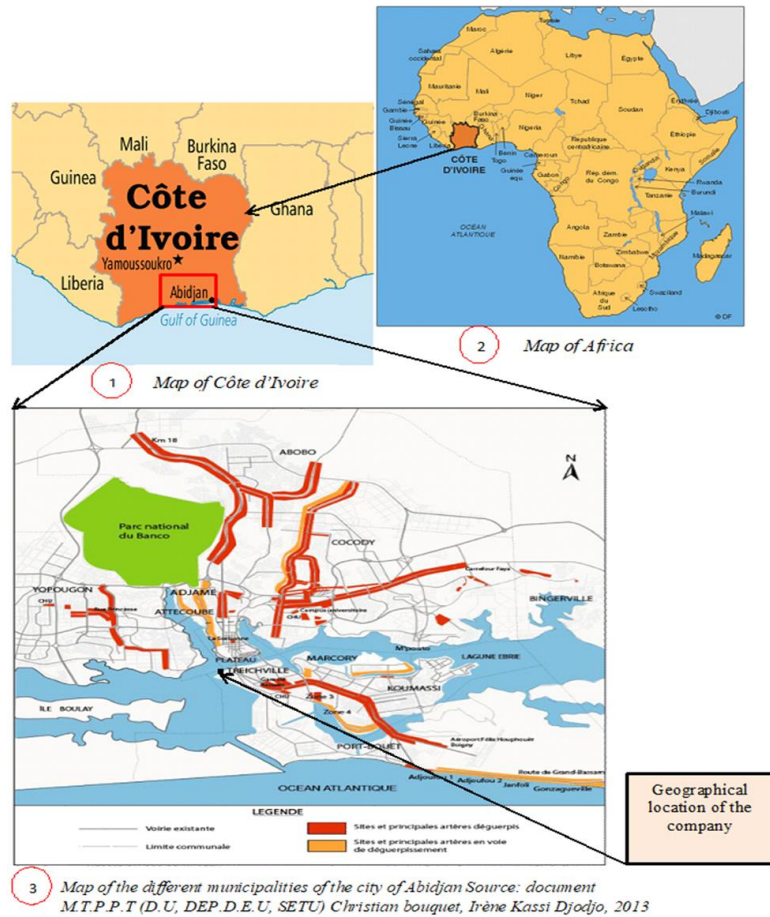


Figure 1. Map of Cote d'Ivoire (1) from Africa; (2) and Abidjan, (3) to locate the company in Treichville.

General information on octopus

Octopuses or octopuses are characterized by their eight arms and their body completely devoid of fin and skeleton, whether internal or external. As in other cephalopods, the arms of octopuses overcome the head. The latter are equipped with suction cups and hooks, the arrangement of which differs according to the species. The head has large eyes covered by a membrane. Unlike squids and cuttlefish, the mantle of octopuses is rounded in shape (Roper et al., 1984). The Order Octopods are described as eight-armed dibranchials, shell rudimentary or absent, funnel without snap, sessile suckers. Species of this order are generally sedentary (Gonçalves, 1991). The example of the species *Octopus vulgaris* is presented by (Figure 2).

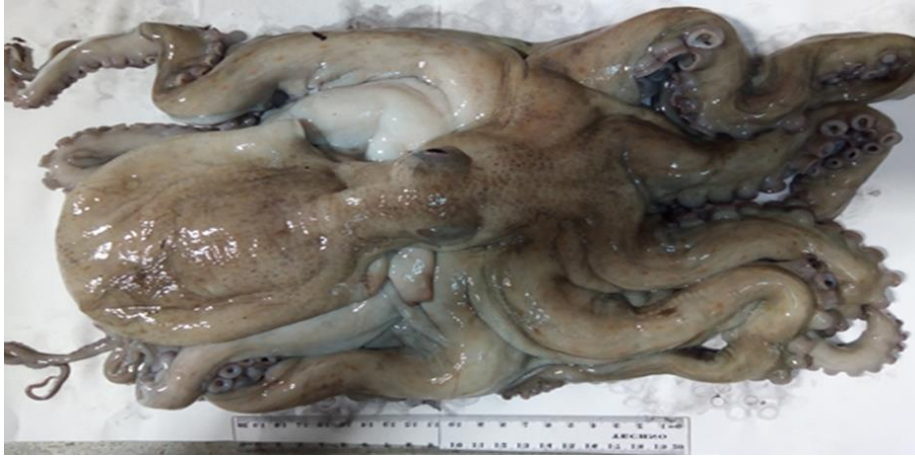


Figure 2. Octopus vulgaris.

Materials and Methods

The material consists of frozen octopus samples (*Figure 3* and *Figure 4*) taken from the warehouse of a company in Côte d'Ivoire. Samples are collected and packaged in sterile pouches under aseptic conditions. They are then weighed with a GRAM S5i electronic scale and packaged in a portable polystyrene cooler with the addition of frozen ice cream. Each batch sampled consists of 5 to 10 individuals of octopus sampled from 2019 to 2021, between 500 g and 800 g each on a ton of goods for self-checking analyses. A total of 535 microbiological analyzes and 85 biochemical analyzes were carried out. The microbiological analyzes (107 samples) focused on 5 germs including Total Mesophilic Aerobic Flora, faecal coliforms, presumed pathogenic Staphylococci, sulphite-reducing anaerobic bacteria and salmonella. A stock solution consisting of ten (10) grams of octopus flesh and 90 ml of a buffered peptone water (EPT) solution are taken and then followed by decimal dilutions according to the NF ISO 6887-3 standard of January 2004 where one milliliter of the stock solution is taken and introduced into a test tube containing 9 ml of tryptone salt (TS). Microbiological analyzes make use of isolation and identification techniques and counting techniques. The biochemical analyzes focused on the determination of total Volatile Basic Nitrogen (ABVT) (85 samples). For total Volatile Basic Nitrogen, the method of distillation of a deproteinized extract with perchloric acid (HClO₄) then steam distillation, followed by its neutralization with hydrochloric acid (HCl) was used.



Figure 3. Frozen octopus on trays.



Figure 4. Frozen octopuses in plastic molds.

Microbiological and biochemical criteria

The microbiological and biochemical criteria used are those established by Regulation (EC) No. 1441/2007 of December 5, 2007 amending Regulation (EC) No. 2073/2005 concerning microbiological criteria applicable to foodstuffs (EU, 2007). As well as those established by the Central Laboratory for Food Hygiene and Agro-Industry (LCHAI) within the National Laboratory for Agricultural Development Support (LANADA). *Table 1* and *Table 2* respectively show the microbiological (m) and biochemical criteria used to interpret the results.

Table 1. Microbiological criteria (m) sought per gram of bacteria.

**TAMF	**CF	SPP	**ASR	App	Salmonella
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(CFU/g)	(CFU/g)	(CFU/g)	(CFU/g)	(CFU/25g)
$F \leq 5.10^5$	$F \leq 20$	$F \leq 10^2$	$F \leq 2$	Satisfying
$5.10^5 < F \leq 5.10^6$	$20 < F \leq 2.10^2$	$10^2 < F \leq 10^3$	$2 < F \leq 20$	Acceptable
$F > 5.10^6$	$F > 2.10^2$	$F > 10^3$	$F > 20$	Not Satisfying

*Notes: App=Appreciations; ASR=Sulfito-reducing anaerobes; CFU=Colony Forming Units; CF=faecal coliforms; F=Flora; TAMF=Total Aerobic Mesophilic Flora; Ppm=Parts Per Million; SPP=Presumed Pathogenic Staphylococci.
Source: EU (2007)

Table 2. Criteria for TVB-N content at LANADA.

Organization	Octopus	Appreciation
Biochemical qualities	**TVB-N	-
Reference threshold	$\leq 35\text{mg}/100\text{g}$ of flesh	Satisfying
	$> 35\text{mg}/100\text{g}$ of flesh	Not Satisfying

*Notes: TVB-N=Total Volatile Basic Nitrogen.

Results and Discussion

Temperatures taken from octopus

During the period of this study, we monitored the temperature control of the products upon receipt and after processing. The average temperature at the reception of the octopuses is 2.8°C and at the end of their transformations there is an average temperature of 20.7°C. These octopuses are frozen at a temperature of -18°C (Table 3).

Table 3. Average temperatures (T°) of the various fishery products.

Fish product	T° at the reception	T° after conversion	Freezing temperature
Octopus	2.8°C	20.7°C	-18°C

Biochemical quality

Total Volatile Basic Nitrogen (TVB-N) (Table 4) is present in all the samples analyzed (frozen octopuses) with an average level of contamination of 15.43 mg of nitrogen (N) per 100 g of flesh. Of all the frozen octopuses analyzed, 98.82% are satisfactory (TVB-N ≤ 35 mg) and 1.18% are unsatisfactory (TVB-N > 35 mg).

Table 4. Alteration of octopus by the level of Total Volatile Basic Nitrogen.

Alteration level	TVB-N ≤ 35 mg/100g	TVB-N > 35 mg/100g
Appreciation	Satisfying octopuses	Not satisfying octopuses
Samples	84	01
Averages	15.17	37.73
Percentage (%)	98.82	1.18

Microbiological quality

The Total Aerobic Mesophilic Flora (TAMF) (Table 5), Faecal Coliforms (CF) (Table 6), Aerobic Sulphite-Reducing (ASR) (Table 7), Presumed Pathogenic Staphylococci (SPP) (Table 8) are present in all samples analyzed. We have respectively for frozen octopus (TAMF, CF, ASR, SPP), an average level of contamination of $3.8.10^4$ CFU/g with 98.13% of satisfactory results ($F \leq 5.10^5$ CFU/g) and 1.97% are acceptable ($5.10^5 < F \leq 5.10^6$ CFU /g); 63.06 CFU/g with 85.98% satisfactory results ($F \leq 20$ CFU/g), 6.54% acceptable ($20 < F \leq 2.10^2$ CFU/g),

7.48% unsatisfactory ($F > 2.10^2$ CFU/g)); less than 1 CFU/g with 100% satisfactory results ($F \leq 2$ CFU/g), less than 100 CFU/g with 100% satisfactory results. Absence of Salmonella and ASR (contamination rate less than 1 CFU/g in all samples analyzed).

Table 5. Contamination of octopus by Total Mesophilic Aerobic Flora.

Contamination	$F \leq 5.10^5$ CFU/g	$5.10^5 < F \leq 5.10^6$ CFU/g	$F > 5.10^6$ CFU/g
Appreciation	Satisfying octopuses	Acceptable octopuses	Not satisfying octopuses
Samples	105	2	0
Averages	$02.8.10^4$	$05.7.10^5$	0
Percentages (%)	98.13	1.97	0

Table 6. Contamination of octopus by faecal coliforms.

Contamination	$F \leq 20$ CFU/g	$20 < F \leq 2.10^2$ CFU/g	$F > 2.10^2$ CFU/g
Appreciation	Satisfying octopuses	Acceptable octopuses	Not satisfying octopuses
Samples	92	7	8
Averages	<10	$0.8.10^2$	$06.7.10^2$
Percentages (%)	85.98	6.54	7.48

Table 7. Contamination of octopus by Aerobic Sulphite-Reduces.

Contamination	$F \leq 2$ CFU/g	$2 < F \leq 20$ CFU/g	$F > 20$ CFU/g
Appreciation	Satisfying octopuses	Acceptable octopuses	Not satisfying octopuses
Samples	107	0	0
Averages	<1	0	0
Percentages (%)	100	0	0

Table 8. Contamination of octopus by Staphylococci.

Contamination	$F \leq 10^2$ CFU/g	$10 < F \leq 10^3$ CFU/g	$F > 10^3$ CFU/g
Appreciation	Satisfying octopuses	Acceptable octopuses	Not satisfying octopuses
Samples	107	0	0
Averages	<100	0	0
Percentages (%)	100	0	0

The average temperature at the reception of the octopuses is 2.8°C and at the end of their transformations it is 20.7°C. There is an increase in temperature during the octopus transformation process. This increases the average temperature from 2.8°C to 20.7°C. But with a reduced transformation time, this would avoid a multiplication of microorganisms. Low temperatures slow or inhibit bacterial growth. All bacterial activity is stopped at a temperature of -10°C (Thiam, 1983). So with a storage temperature of -18°C we obtain a longer expiry date. But all the time there are bacteria which develop their activity at extreme temperatures (low as well as high). Cuq (2016) indicates that the lowest temperature at which a microorganism could be observed growing is -24°C and the highest is 90°C. The overall average TVB-N of frozen octopus is 15.43 mg of nitrogen (N) per 100 g of meat. This average is below the threshold limit of the standard, which is 35 mg of nitrogen (N) per 100 g of flesh. The comparison of our results with the accepted standards shows that 98.82% of the samples are satisfactory. This satisfaction rate shows monitoring of the quality of fish products intended for export and the local market. This reflects proper application of hygiene rules and good manufacturing practices.

The average of the total mesophilic aerobic flora counted in the frozen octopus samples is $3.8.10^4$ CFU/g. This shows that frozen octopuses are less contaminated with total mesophilic aerobic flora. The comparison of these results with the accepted standards shows that 98.13% of the octopus samples are satisfactory. Indeed, this rate of satisfaction with the results testifies to the proper application of hygiene rules and good

manufacturing practices. The average level of octopus contamination is $3.8.10^4$ CFU/g. This rate is higher than that of Wané (1994) and Niyonzima (2009). Indeed, these authors respectively isolated $63.43.10^3$ CFU/g, $1.6.10^3$ CFU/g in 2005 to reach $1.66.10^4$ CFU/g of product in 2006. Although this average rate of octopus contamination is below of the standards indicated, an improvement in the manufacturing processes is essential in view of the results of Wané (1994) and Niyonzima (2009). The average number of faecal coliforms counted in frozen octopus samples is 63.06 CFU/g. regarding these octopuses, 85.98% of the results are satisfactory. This rate of satisfaction of octopuses in faecal coliforms can sometimes be explained by good preservation at the level of fishing boats or by the strict application of hygiene rules. The average rate of contamination of octopuses by faecal coliforms is 63.06 CFU/g. This rate is higher than that of Wané (1994) and Niyonzima (2009). These authors who also worked in Senegal isolated respectively 25.43 CFU/g and less than 10 CFU/g.

The average number of sulphite-reducing anaerobic bacteria counted in the frozen octopus samples is less than 1 CFU/g, with 100% of the samples satisfactory. No ASRs found in the samples. While 16.09 CFU/g and less than 10 CFU/g of octopus product were obtained respectively by Wané (1994) and Niyonzima (2009). This shows good application of hygiene rules and good manufacturing practices, but also good water quality. The average of presumed pathogenic Staphylococci counted in the frozen octopus samples are all below 10^2 CFU/g, with 100% of the samples satisfactory. The average is lower than the reference microbiological criterion but higher than that of Niyonzima (2009) which is lower than 10 CFU/g of product in 2005 and 103 CFU/g of product in 2006. On all the samples analyzed, no Salmonella was isolated. All the results of the salmonella research were in conformity with the standards in force: absence of salmonella in 25g of product. The work of Doua (2012), Niyonzima (2009), Ndiaye (1998) and Niang (1992) gave the same results. These results demonstrate compliance with the cold chain, proper application of hygiene rules and staff in good health.

Conclusion

Frozen octopuses, intended for the local market and for export, were subjected to biochemical and microbiological analyzes in a company in Côte d'Ivoire. This study allowed us to assess their level of contamination and alteration. The various analyzes carried out by LANADA show that these frozen products have a low average level of contamination overall. These results are on the whole satisfactory. In terms of faecal coliforms, octopuses have an average satisfaction rate of 7.48%. In view of these results, efforts have been made on the whole by the fishermen and the company responsible for processing these fish products. These results demonstrate compliance with the cold chain and application of hygiene rules and good manufacturing practices. The processing companies must make more effort in improving the hygienic quality for more confidence in the different markets by avoiding the intoxication of the population.

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Conflict of interest

We declare that there is no conflict of interest between the authors of this study and any institution or previous publication.

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