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Evaluation of the Bacteriological Quality of Fish and the Equipment Used for Their Handling in the Adam's Fishing Company of Conakry (Republic of Guinea)

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Abstract

In Conakry, ensuring the consumption of safe and healthy seafood is a priority for the Ministries of Trade and Health of the Republic of Guinea. Given their importance to the local population, both in terms of food security and as a source of income, implementing good handling and prompt consumption practices is essential to reducing the risk of foodborne illness. The objective of this study was to evaluate the bacteriological quality of three fish species (*Pseudotolithus*. *Elongatus*, *Pseudotolithus senegalensis*, *and Cynoglossus senegalensis*), water, ice, and processing tables were collected from Adam's Fishing Company in Conakry. Agar plating and membrane filtration were used to enumerate contamination indicators. Data analysis revealed that the total aerobic mesophilic flora (TAMF) concentration of the three fish species, during both sampling campaigns, exceeded the WHO reference value (5×10^4 CFU/g). The TAMF bacterial load observed during the first campaign was generally higher than that recorded during the second. Among the species studied, *Pseudotolithus* "*Elongatus*" exhibited the highest level of contamination, with a load of 99.8×10^3 CFU/g. The four ice samples analyzed showed microbial contamination with total coliform counts of 200 CFU/100 mL, fecal streptococci at 60 CFU/100 mL, and total aerobic mesophilic flora (TAMF) exceeding 500 CFU/100 mL. These values exceed the limits recommended by the WHO for ice used in fish preservation, indicating a potential health risk for consumers due to non-compliance with good hygiene practices throughout the fish handling chain (ice, surfaces, equipment). These results underscore the need for regular monitoring of the microbiological quality of water

and ice, as well as staff training in hygiene and disinfection practices.

Keywords

Bacteriological Quality, *Pseudotolithus elongatus*, Total Aerobic Mesophilic Flora, Fecal Coliforms, Membrane Filtration

1. Introduction

Fish is a major source of animal protein, vitamins, minerals and essential fatty acids [1]. In Guinea, and particularly in Conakry, it constitutes the staple food for a large part of the population [2]. Fishing is an important economic activity, generating jobs and contributing to food security. The trade and consumption of fish are essential to the daily lives of urban and coastal households [3]. Fish is highly perishable, especially in tropical countries where temperatures are high. In the absence of good preservation practices (cold chain, equipment hygiene, water and ice quality), it can be rapidly contaminated by pathogenic microorganisms [4].

The fish deteriorates very quickly after capture. It provides a favorable environment for the proliferation of bacteria (coliforms, Salmonella, Staphylococcus, Vibrio, etc.) [5]. During capture, transport, processing and marketing, fish can be contaminated by water, ice, processing tables, utensils and even the hands of handlers. The absence of strict hygiene measures increases the risk [6]. Consuming contaminated fish poses a risk of food poisoning and waterborne diseases. These infections can have a significant impact in terms of morbidity, especially in areas with high consumption such as Conakry [7].

Indeed, according to Tamgno (2021), approximately 25% of fish in Sub-Saharan Africa are lost due to a lack of effective means of preservation and processing [8]. There are few local studies on the bacteriological quality of fish and equipment in Guinean fishing enterprises, highlighting the need to document the level of bacteriological contamination of fish and equipment used in order to prevent health risks. Providing useful scientific data to health authorities, fishermen, and processors to improve practices justifies this study.

General objective: To evaluate the bacteriological quality of fish and the equipment used to handle them in the Adam's fishing company of Conakry.

Specific objectives:

1) Identify and quantify the bacterial flora present in commercially available fish.

2) Determine the level of bacterial contamination of the equipment (treatment table, water, ice).

3) Compare the results to the microbiological reference standards.

2. Materials and Methods

2.1. Study Area

The study area corresponds to the Adam's Fishing establishment, located in the

Commune of Dixinn. This is delimited to the east by the Communes of Ratoma and Matoto, to the west by the Commune of Kaloum, to the north by the Atlantic Ocean and to the south by the Commune of Matam.

Figure 1 shows the map of the study area.

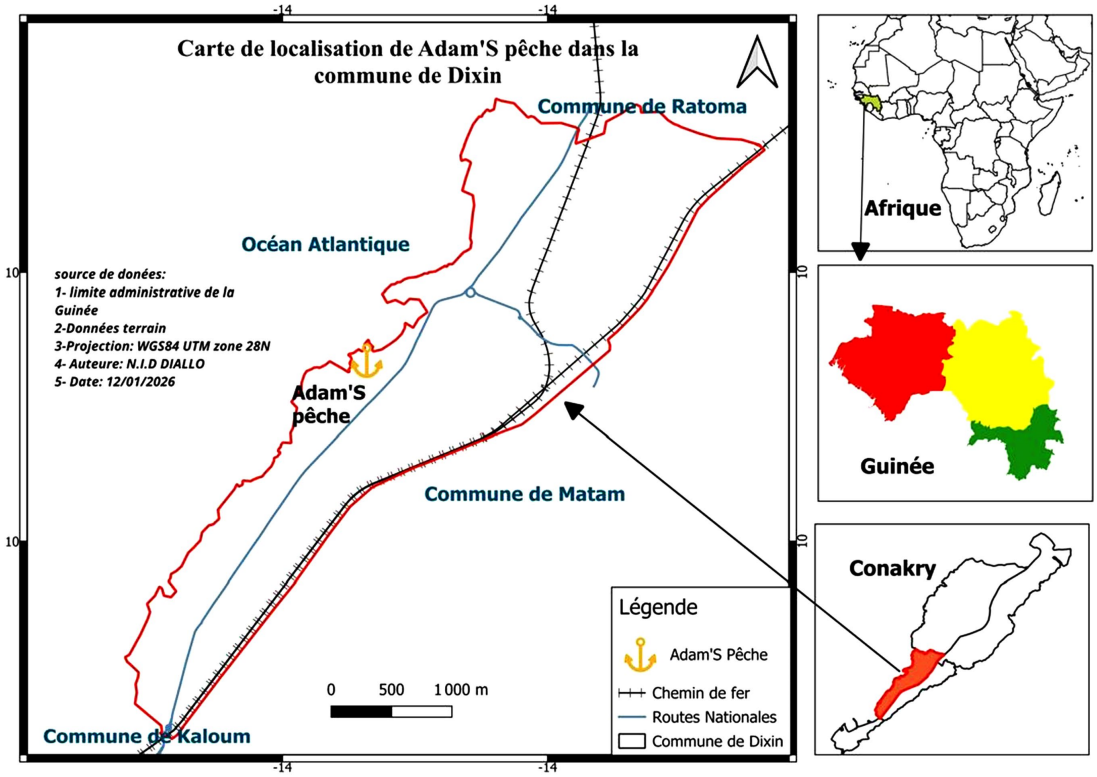

Figure 1. Map of the study area.

2.2. Study Framework

The Guinea Environmental Research Institute located at Abdel Nasser University in Conakry, which served as the setting for this study, comprises three sections: organic chemistry, inorganic chemistry and microbiology.

2.3. Work Equipment

The study material consisted of three species of fish, along with the equipment used for their handling, namely the processing table, wash water and ice.

2.4. Methods

This was a descriptive cross-sectional study conducted over a period of eight months.

2.4.1. Sampling

Two sampling campaigns were carried out: the first from March 5 to 8, 2024 and the second from October 9 to 13, 2024. During each campaign, six samples from three species of fresh fish were collected from the processing company, two of each species, as well as two samples of fish wash water, two samples of ice used for preser-

vation, and five samples taken by swabbing the surfaces of the processing tables.

The choice of species studied is justified by the fact that the company only exports four species of fish, three of which were selected for our analysis.

Sampling was carried out in two phases.

1) Fresh fish landed at the fishing company (sampling before processing): this step consisted of first performing an organoleptic analysis for sorting, followed by a bacteriological analysis in the laboratory. The fish used for the analyses were then destroyed.

2) Fish processed by the fishing company (sampling after processing):

During processing, several successive operations were carried out: organoleptic analysis, temperature measurement, weighing by species, first washing, second sorting, calibration, new weighing, second washing, draining of the trays, passage through the freezing tunnel, soaking, filming, packaging in cardboard boxes, labeling, storage and then export.

In total, the sampling included: fish (n = 12), fish wash water (n = 4), ice (n = 4) and swabs from processing tables (n = 10).

The sample size (n = 12) was determined taking into account available resources and in accordance with exploratory studies in food microbiology conducted in similar contexts.

2.4.2. Preparation of Samples for Analysis

a) Fish

The preparation of the stock suspension consisted of diluting the fish sample in distilled water. To do this, 25 g of fresh fish of each species were placed in an Erlenmeyer flask containing 225 ml of distilled water and then homogenized by stirring. The mixture was left to macerate for 18 hours to promote maximum release of bacteria. This preparation constituted the "stock suspension."

Since the microbial concentration of a food sample is generally unknown, several successive decimal dilutions are necessary to obtain a culture that allows for a reliable count, ranging from 30 to 300 colonies on solid medium (CEAEQ, 2014; 2016). Therefore, 1 ml of the stock suspension from each fish sample was transferred to 9 ml of sterile distilled water, corresponding to dilution factors of 10^{-1} and 10^{-2} [9].

From the obtained dilutions, a 1/100 fraction of each sample was filtered through a membrane to detect indicator organisms of contamination: total coliforms (TC), fecal coliforms (FC), and fecal streptococci (FS), on appropriate selective media. For the enumeration of total aerobic mesophilic flora (TAMF), 1 ml of the 1/100 dilution was directly inoculated onto agar.

b) Wash water and storage ice

For the water and ice samples, no prior dilution was carried out. A volume of 100 ml of each sample was directly filtered through a membrane.

c) Processing table

Using sterile swabs, the surfaces of the fish processing table were thoroughly scrubbed. Each swab was then immersed in 10 ml of sterile tryptone broth. The contents were vigorously agitated to release and disperse the bacteria in the liquid.

Subsequently, 1 ml of this suspension was taken for inoculation onto agar plates for enumeration.

2.4.3. Analysis of the Bacteriological Quality of the Samples

Membrane filtration was used for the detection of fecal coliforms (FC), total coliforms (TC), fecal streptococci (FS) and for the enumeration of total aerobic mesophilic flora (TAMF) by inoculation on agar.

2.4.4. Incubation and Enumeration of Microorganisms

Total coliforms (TC) were incubated on m-Endo Agar LES at 35.5˚C for 24 hours, while fecal coliforms (FC) were incubated on m-FC Agar Base at 44.5˚C for 24 hours. Fecal streptococci (FS) were incubated on Slanetz Bartley agar at 35.5˚C for 48 hours, and total aerobic mesophilic flora (TAMF) were cultured on standard PCA agar at 30˚C for 72 hours.

For the wash water and ice samples, the number of bacteria was expressed in colony-forming units (CFU) per 100 mL and calculated according to the following formula:

$$\text{Number of bacteria } (\text{CFU}/100\text{mL}) = \frac{\text{Number of colonies counted} \times \text{dilution factor}}{\text{Inoculum volume } (\text{m}^3\ \text{L})}$$

On the other hand, for samples taken from the surface of the processing table and from the fish flesh, the denominator of the formula corresponds respectively to the sampled surface (in cm^2) and to the homogenized flesh mass (in grams).

3. Results

The data from the sample analyses are recorded and summarized in Table 1 to Table 10.

Table 1 and Table 2 give the results of the bacteriological analysis of fish before and after treatment, during the first campaign.

Table 1. Bacterial load of fish before treatment during the first campaign.

Sample fish species	TC	FC	FS	TAMF
Pseudotolithus elongatus	3.8×10^2	1	0	99.8×10^3
Pseudotolithus senegalensis	2.8×10^2	0	0	25.2×10^3
Cynoglossus senegalensis	8.1×10^2	0	0	29.9×10^3
Reference standards UFC/g	$\mathbf{10^3}$	**0**	**0**	$\mathbf{5 \times 10^4}$

Table 2. Bacterial load of fish after treatment during the first campaign.

Sample fish species	TC	FC	FS	TAMF
Pseudotolithus elongatus	4.2×10^1	0	0	5.2×10^3
Pseudotolithus senegalensis	2.1×10^{-1}	0	0	2.1×10^3
Cynoglossus senegalensis	2.2×10^{-1}	0	0	2.9×10^3
Reference standards UFC/g	$\mathbf{10^3}$	**0**	**0**	$\mathbf{5 \times 10^4}$

Table 3 and Table 4 give the results of the bacteriological analysis of fish before and after treatment, during the second campaign.

Table 3. Bacterial load of fish before treatment during the second campaign.

Sample fish species	TC	FC	FS	TAMF
Pseudotolithus elongatus	4.1×10^2	0	0	49.8×10^3
Pseudotolithus senegalensis	2.1×10^2	0	0	25.2×10^3
Cynoglossus senegalensis	2.3×10^2	0	0	31.1×10^3
Reference standards UFC/g	**10^3**	**0**	**0**	**5×10^4**

Table 4. Bacterial load of fish after treatment during the second campaign.

Sample fish species	TC	FC	FS	TAMF
Pseudotolithus elongatus	1.2×10^{-1}	0	0	31.2×10^3
Pseudotolithus senegalensis	1.1×10^2	0	0	15.3×10^3
Cynoglossus senegalensis	4.2×10^2	0	0	21.4×10^3
Reference standards UFC/g	**10^3**	**0**	**0**	**5×10^4**

Table 5 and Table 6 give the results of the bacteriological analysis of the wash water during the first and second campaigns before and after treatment.

Table 5. Bacterial load of the wash water during the first campaign.

Wash water sample	TC	FC	FS	TAMF
Before treatment	10	0	7	>500
After treatment	6	0	0	46
Reference standards UFC/100mL	**<10**	**0**	**0**	**≤500**

Table 6. Bacterial load of the wash water during the second campaign.

Wash water sample	TC	FC	FS	TAMF
Before treatment	6	0	0	92
After treatment	4	0	0	200
Reference standards UFC/100mL	**<10**	**0**	**0**	**≤500**

Table 7 and Table 8 give the results of the bacteriological analysis of the fish processing table during the first and second campaigns before and after treatment.

Table 7. Showing bacterial load of the fish processing table during the first campaign.

Surface treatment table	TC	FC	FS	TAMF
Before treatment	10×10^3	0.1×10^1	0	52.1×10^3
After treatment	0	0	0	25.2×10^3
Reference standards UFC/25cm²	**10^3**	**0**	**0**	**5×10^4**

Table 8. Bacterial load of the fish processing table during the second campaign.

Surface treatment table	TC	FC	FS	TAMF
Before treatment	5.1×10^2	0.1×10^1	0	46.2×10^3
After treatment	2.1×10^1	0	0	35.4×10^3
Reference standards UFC/25cm²	**10^3**	**0**	**0**	**5×10^4**

Table 9 and Table 10 give the results of the bacteriological analysis of the ice during the first and second campaigns before and after treatment.

Table 9. Bacterial load of ice during the first campaign.

Ice sample	TC	FC	FS	TAMF
Before treatment	6	0	9	>500
After treatment	0	0	0	>500
Reference standards UFC/100mL	**<10**	**0**	**0**	**≤500**

Table 10. Bacterial load of ice during the second campaign.

Ice sample	TC	FC	FS	TAMF
Before treatment	200	4	60	224
After treatment	6	2	0	300
Reference standards UFC/100mL	**<10**	**0**	**0**	**≤500**

Interpretation and Discussion of Results

Fish have microorganisms in their digestive tract, gills, and skin; their proportions vary between 10^3 - 10^9 CFU/g for the intestines and gills, and 10^2 - 10^7 CFU/cm² for the skin. During the animal's life, muscle tissue remains sterile and microorganisms do not invade it while alive, but after capture, from surfaces such as the skin or gills, or during butchering, these microorganisms can penetrate the muscle, which promotes spoilage or poses a risk to the consumer [10].

Bacterial contamination of the flesh occurs only after capture. The sources of this contamination are diverse and can be divided into two groups: endogenous and exogenous [11].

Data analysis revealed that the concentration of total aerobic mesophilic flora (TAMF) in the three fish species during both sampling campaigns exceeded the WHO reference value (5×10^4 CFU/g). The TAMF bacterial load observed during the first campaign was generally higher than that recorded during the second.

During the first campaign, conducted in March at the height of the dry season, the ambient temperature exceeded 30˚C. Conversely, the second campaign, carried out in October at the end of the rainy season, took place in relatively lower temperatures. These temperature variations are a factor influencing the rate of microbial proliferation and deterioration.

Among the species analyzed, *Pseudotolithus elongatus* had the highest contamination load, reaching 99.8×10^3 CFU/g. This high value could be attributed either

to increased sensitivity of the species to degradation, or to more prolonged exposure to air and heat before storage.

On the other hand, the concentrations of indicator bacteria of fecal pollution (fecal coliforms, fecal streptococci and total coliforms) were in compliance with the limit values set by the WHO for both sampling campaigns.

Of the four wash water samples analyzed, only one showed a concentration of TAMF above the WHO limit value (≤500 CFU/100mL).

The four ice samples analyzed showed microbial contamination with total coliform counts of 200 CFU/100mL, fecal streptococci of 60 CFU/100mL, and a flora Total aerobic mesophilic (TAMF) greater than 500 CFU/100mL. These values exceed the standards recommended by the WHO for ice used in fish preservation.

Furthermore, the bacterial load in TAMF recorded on the surfaces of the treatment tables, during the two sampling campaigns, was also high and exceeded the limit value set by the WHO.

The results obtained indicate a significant microbial contamination in fish, ice, and on processing surfaces.

1) Fish:

Total aerobic mesophilic flora (TAMF) concentrations exceeding the WHO reference value (5×10^4 CFU/g) indicate poor microbiological quality of the fish, likely due to inadequate hygiene during handling, storage, or transport. The fact that *Pseudotolithus elongatus* either the most contaminated species can be explained by its greater sensitivity to degradation or by a longer exposure to air and heat before storage.

Indicator bacteria of fecal pollution (FC, FS, TC): the values found are in accordance with WHO standards, suggesting the absence of contamination of fecal origin. recent fecal contamination, which means that the observed contamination is more likely of environmental origin or related to handling, and not to direct pollution by wastewater.

2) Ice

The simultaneous presence of total coliforms, fecal streptococci and TAMF > 500 UFC/100mL in all ice samples shows that the ice used for preservation is not microbiologically safe. It constitutes a vector of recontamination fish after capture. This contamination can come from the water used to make ice, of the production chain, or storage conditions.

3) Treatment surface

TAMF loads exceeding the WHO limit on processing tables indicate inadequate surface hygiene. This likely reflects insufficient cleaning or inappropriate disinfection between work operations, thus promoting cross-contamination of handled products.

These results indicate a potential health risk for the consumer, due to a Failure to comply with good hygiene practices throughout the fish handling chain (ice, surfaces, equipment). They emphasize the need for regular monitoring of the microbiological quality of water and ice, as well as the staff training on hygiene and

disinfection practices.

We recommended that Adam's Pêche implement a risk prevention system based on the HACCP (Hazard Analysis and Critical Control Points) method. Its implementation should not present any major difficulties.

Lamis, AB *et al*. (2022), in a study conducted in Algeria on the evaluation of the microbiological quality of seafood, reported a bacterial load of 3,100,000 CFU/g in TAMF. This value is significantly higher than that obtained for *Pseudotolithus elongatus* during the first campaign, *i.e.* 998,000 UFC/g in TAMF [12].

N'guessam *et al*. in Côte d'Ivoire 2018, on frozen fish (*Trachurus trachurus*, *scumbers combrus*) and fresh (*Chrysichthys nigrodigitafus*) show that coliform loads are high (7.1×10^2 and 8.1×10^1 CFU/g) in fresh fish. These values are slightly higher than the values found (410 CFU/g) on *Pseudotolithus elongatus* in total coliforms [13].

Justin *et al*. (2019), in the Democratic Republic of Congo, reported a fecal coliform load of 32,000 CFU/g in commercially available fresh fish, whereas our study revealed no presence of fecal coliforms (0 CFU/g) [14].

Furthermore, Mamadou F. *et al*., in Côte d'Ivoire, found average levels of fecal coliforms (1496 CFU/g) and total coliforms (252 CFU/g) in fresh fish at the Abobo-Doumé landing site. However, the average concentration of total coliforms reported in their study remains lower than that measured in *Pseudotolithus elongatus* in our work (400 CFU/g) [15].

4. Conclusions

The assessment of the bacteriological quality of the fish, ice, and processing surfaces revealed significant microbial contamination, particularly in total aerobic mesophilic flora (TAMF), exceeding the limits set by the WHO. These results reflect a lack of hygiene at the various stages of handling and preserving fish.

They thus demonstrate a potential health risk for the consumer, linked to a failure to comply with good hygiene practices throughout the entire processing chain.

These findings highlight there need for control regular of the microbiological quality of water, ice and work equipment, as well as the formation of staff to proper cleaning and disinfection practices in order to reduce the risk of contamination.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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