World Journal of Advanced Research and Reviews
eISSN: 2581-9615 CODEN (USA): WJARAI
Cross Ref DOI: 10.30574/wjarr
Journal homepage: https://wjarr.com/

(RESEARCH ARTICLE)

Check for updates

Study of variation of technological and organoleptic quality of preserved and processed fresh fish in Lokossa in the South-West of Benin

Martinien Hospice Mahussi Assogba *, Elie Linton and Issaka Youssao Abdou Karim

Laboratory of Animal Biotechnology and Meat Technology, Department of Animal Production and Health, Polytechnic School of Abomey-Calavi, University of Abomey-Calavi, Abomey-Calavi, 01 BP: 2009 Cotonou, Benin.

World Journal of Advanced Research and Reviews, 2025, 28(01), 571-580

Publication history: Received on 31 August 2025; revised on 06 October 2025; accepted on 08 October 2025

Article DOI: https://doi.org/10.30574/wjarr.2025.28.1.3477

Abstract

Fish is a significant source of protein in Benin. The purpose of this study was to determine differences in sensory and technological fish quality in Lokossa township. Samples (80) of whole, pre-treated *S. melanotheron* and *C. guineensis* were collected. Following statistical analysis of data collected, *S. melanotheron* yield (93.94%) was lower compared to *C. guineensis* yield (97.35%) ($p<0.05$). Conversely, threading yield of *S. melanotheron* (32.82%) was better than that of *C. guineensis* (23.98%) ($p<0.05$). Similarly, SVI of *S. melanotheron* (6.06) was better than that of *C. guineensis* (2.65) ($p<0.05$). Eye, gills, spine, viscera and peritoneum freshness for *S. melanotheron* and *C. guineensis* were the same ($p>0.05$). However, skin and abdominal cavity freshness of both species varied significantly ($p<0.001$).

Only one quality index was recorded for *C. guineensis*: the B index of around 25%. 75% of *S. melanotheron* were of the “Extra” class. Luminosity (L*) and Redness index (a*) were similar ($p>0.05$) for the two species. But large differences ($p<0.05$) were observed in the effect of species towards yolk index (b*) and chromaticity. Flesh color was not influenced by storage time or sex. Tenderness, juiciness, flavor, and overall rating were also similar for *C. guineensis* and *S. melanotheron*. But cooked fish (4.02) was significantly softer ($p<0.001$) than fried fish flesh (2.88). Similarly, flavor of cooked fish (3.58) was more intense compared to flavor of fried fish (3.12) ($p<0.05$). Control of the factors of variation will enable us to have maximized yields and processed products of the same quality.

Keywords: Tilapia; Ability; Fish; Cooking; Frying; Food safety

1. Introduction

According to the [1], global fish production has exceeded that from capture fisheries since 2022. This increase is due to the growing global population and ever-increasing demand for animal protein. In fish-producing countries, inadequate quality and safety measures lead to losses at various stages of fish handling and marketing. These losses include physical losses due to poor handling and storage, economic losses due to spoilage or increased processing costs, and nutritional losses due to fish being unfit for consumption [2,3].

Despite significant advances in fish production and improved capture technologies, further action is required to minimize the loss and waste of these products [1]. It is estimated that up to 35 per cent of global fisheries and aquaculture production is lost or wasted each year [4].

In Benin, however, as in other countries in the West African subregion, post-harvest losses are estimated at around 20% [5].

* Corresponding author: Martinien Hospice Mahussi Assogba

The majority of fish caught in Benin's freshwater is sold fresh. The rest is processed using traditional methods such as smoking, frying, salting and drying [6–8]. For example, 10% of tilapia is smoked for preservation, 5% is fried and some of this fried tilapia is sent to Togo for export[9]. Processing is intended to maintain and/or improve the sanitary, technological, nutritional and organoleptic value of the product [10]. Low quality of the product restricts its competitiveness on both domestic and foreign markets. Within food technology, the major issue of fish processing in African countries, particularly Benin, is the traditional mode of processing, whereby the final products are consumed as a whole fish (fried or cooked) or steaks. Filleting is not practiced in processing. [11] explains that fillets represent the main economic and nutritional value of fish production because they are the main edible part of the fish.

Several studies were carried out on the sanitary quality of fish and how it is associated with processing methods [12–21] and sensory and technological fish quality [22–24]. However, few studies have examined variation in sensory and technological quality in the Lokossa agroecological zone. The current study will attempt to provide a better understanding of the suitability of fish for processing and organoleptic value. This study aims to establish variation in the sensory and technological quality of fish consumed in the Lokossa township.

2. Materials and methods

2.1. Study area

The city of Lokossa is located in the northwest of the Mono department. It has a latitude of 6° 37' 60" North and a longitude of 1° 43' 0" East. It is one of six municipalities in the department. Representing 16% of the area of Mono and 0.23% of the total area of Benin (112,622 km^2), it covers an area of 260 km^2 [25]. Bordered to the north by the Dogbo municipality in the Couffo department, to the south by the Athiémé and Houéyogbé municipalities, to the east by Bopa and to the west by Togo, the municipality is divided into five districts: Lokossa, Agamè, Koudo, Houin and Ouèdèmè-Adja. These districts are subdivided into eight neighbourhoods and 37 villages, making a total of 45 localities. The commune's capital, Lokossa, is located approximately 106 km from Cotonou, Benin's economic capital. It is also the capital of the Mono department [25]. Figure 1 shows the administrative map of Lokossa.

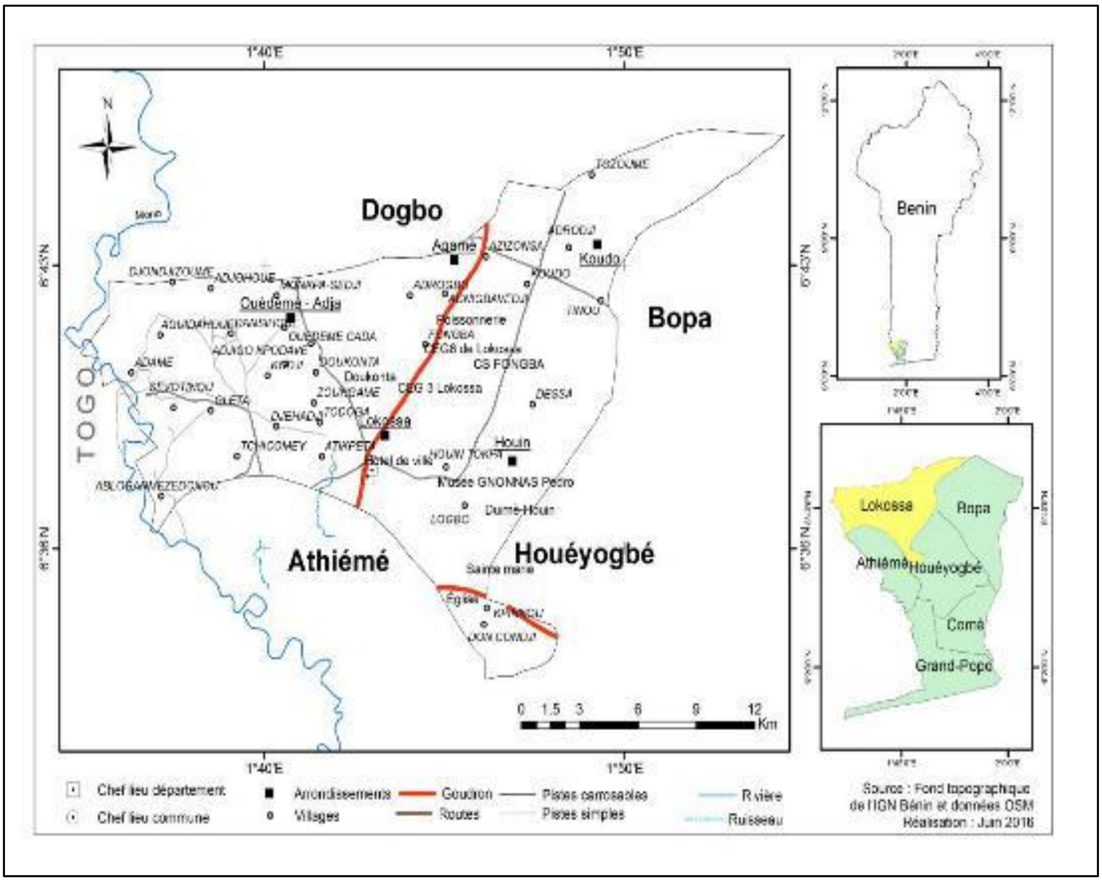

Figure 1 Geographical location of the township of Lokossa

2.2. Methodology

2.2.1. Sampling

Houin district, and more specifically the bank of the river Duimè, was chosen for fish sampling in order to assess sensory and technological quality changes during processing and/or preservation. The location is endowed with fishermen, fishmongers, and processors. Two fish species (*Coptodon guineensis* and *Sarotherodon melanotheron*) were targeted for sampling. The samples of whole fresh, pre-treated fish were collected from fishmongers in the districts of Lokossa Centre and Houin. Once samples collected, technological and organoleptic parameters were measured at the Laboratory of Animal Biotechnology and Meat Technology of the Department of Animal Production and Health of the Polytechnic School of Abomey-Calavi of the University of Abomey-Calavi (Benin). In total, sensory and technological quality were analyzed in 80 fish of both species (Table 1).

Table 1 Sampling plan

Types of fish	Species	Number of fish sampled
Whole fish	*C. guineensis*	20
	S.melanotheron	20
Fresh pre-treated fish	*C. guineensis*	20
	S.melanotheron	20
Total		80

2.2.2. Technological measures

The various technological parameters were measured on fresh whole fish and pretreated fish. These parameters included pH, brightness (L*), red index (a*), yellow index (b*), and water content.

pH measurement

The pH at 6, 24, and 48 hours was measured on fish fillets using a pH meter (Hanna HI 99161, Instruments R, Italy) equipped with a combined electrode.

Water content

The water content of the fish was determined in accordance with [26]. This method is based on the loss of free water from the sample during drying. First, the empty crucibles were weighed and the “Xi” values were read and recorded. Next, 3–5 g of the product to be dried was added to the crucibles, and the new total mass, “Yi”, was recorded. The crucibles were then placed in an oven at 65 °C for 72 hours, after which they were heated to 105 °C for three hours to dry them. Once removed from the oven, the crucibles were placed in a desiccator to cool, after which they were weighed. After weighing, the crucibles were returned to the oven at 105 °C for 30 minutes, then removed, cooled and weighed again. This process was repeated until the difference in mass between two consecutive weighings of the same crucible was no greater than 0.01 g. The values obtained for the different crucibles were then recorded as Zi. The water content (WC) of the product was determined using the following calculation:

$$\mathrm{WC}\ (\%) = \frac{\mathrm{Yi} - \mathrm{Zi}}{\mathrm{Yi} - \mathrm{Xi}}$$

Yield measurement

The whole fish, the gutted fish, the viscera and the fat were weighed individually. These values were then used to calculate the following:

- Fish yield: Y (%) = (weight of gutted fish/total weight of whole fish) *100.
- Gonadosomatic Index: GSI (%), where GSI = (weight of gonads/total weight of whole fish) x 100.
- Viscerosomatic Index: VSI (%) = (weight of viscera/total weight of whole fish) x 100.
- Perivisceral Fat Index: PFI = (weight of perivisceral fat/total weight of whole fish) x 100.
- Filleting Yield: FY (%) = (weight of fillets/total weight of whole fish) x 100.

2.2.3. Sensory measures

Assessment of fish freshness

The freshness assessment was carried out on whole fish that had been pre-treated upon arrival at the laboratory. This was done using the organoleptic freshness assessment grid, in accordance with [27]. The loss of the initial freshness characteristics and the appearance of detectable decomposition phenomena by the human senses were appreciated. The different observation points were related to the fish external and internal examination which covers the skin appearance, its pigmentation and mucus, the eye appearance, its hue and curvature, the gills, hue and odor, flesh appearance, the state of the abdominal wall, abdominal cavity, spine, peritoneum and organs (liver, kidney, spleen, intestine, heart). Freshness is determined immediately after pH measurement.

Each of the points received a rating called "spoilage index", from 3 to 0, ranging from the freshest to the most spoiled. The ratings average of all the elements enables the evaluation of the freshness degree of the whole fish. When the ratings average is greater than or equal to 2.7, the fish quality is "Extra", greater than or equal to 2 and less than 2.7, it is of the category "A", for an average greater than or equal to 1.0 and less than 2.0, the quality is of category "B" and for an average less than 1.0, the fish quality is of the category "C" and the batch is to be withdrawn from the consumption.

Color measurements

Finally, the color measurement were performed using respectively a colorimeter (Konica Minolta CR-400 INC) with 5 repetitions per sample. The first data were taken 6 hours after sampling. The others were taken 24 and 48 hours later, as follows: after storing the samples in the refrigerator for 24 hours, they were removed and left in contact with air for one hour and thirty minutes at approximately 4 °C before the measurements were taken. The color was determined according to the CIE L* a* b* system and was taken at the internal face of whole, eviscerated, smoked and fried fish fillets. The red index (a *), the yellow index (b *) and the lightness (L) were measured and the chroma calculated as $C = (a^{*2} + b^{*2})^{1/2}$.

Organoleptic test

Fish fillets have been prepared for organoleptic and physical tests in accordance with Codex Alimentarius guidelines for organoleptic evaluation of fish, mollusc and crustaceans in laboratory CAC/GL 31-1999. Pieces of fillets of 200 g from each species and locality were appreciated by a jury of 10 panelists without any prior training, after cooking with water or frying with groundnut oil, all without seasoning. Marks were then given by the jury to each tested parameter (juiciness, tenderness and favor). The tenderness, juiciness and flavor's intensity marks ranged from 1 to 5. For tenderness, 1 corresponds to very hard, 2 to hard, 3 to acceptable, 4 to tender and the 5to very tender. As for the juiciness, 1 corresponds to very dry, 2 to dry, 3 to acceptable, 4 to soft and 5 to very soft. Finally, the flavor's intensity was very low (1), low (2), acceptable (3), high (4) and very high (5). All the data collected was recorded on a form in which each fish was assigned a number and all the information about it was noted.

2.3. Statistical analysis

The Statistical Analysis System software [28] was used for the statistical analysis. Survey data was stripped, encoded and analyzed. The *Proc mean* procedure of SAS was used to calculate the means of the different technological and sensory parameters measured. They were compared by the Chi-Square test and by the bilateral Z-test. The Generalized Linear Models (*Proc GLM*) procedure was used for the analysis of variance. The sources of variation used in the analysis of variance model were: species, storage time, sex, and treatment method (boiled, fried). The F test was used to determine the significance of each effect of the model on the sensory and technological characteristics of the fish flesh, and the least squares means were estimated and compared in pairs using the t-test.

3. Results

3.1. Freshness state and quality index

Table 2 shows the freshness state of *S. melanotheron* and *C. Guineensis.* The freshness of the eye, gills, and spine; the color of the organs, skin, abdominal wall, abdominal cavity, and peritoneum of *S. melanotheron* was similar ($p>0.05$) to that of *C. guineensis* (Table 2). The freshness quality index B (average between 1 and 2) of around 25% was recorded in *C. guineensis*, and 75% of *S. melanotheron* were classified in the Extra index (average ≥2.7).

Table 2 Freshness state of *S. melanotheron* and *C. guineensis*

Parameters	***S. melanotheron***		***C. guineensis***		**Significance Test**
	Mean	SD	Mean	SD	
Skin	3.00	0.00	3.00	0,00	NS
Eye	3.00	0,11	2.83	0,11	NS
Gill	2.83	0.11	2.66	0.11	NS
Wall	3.00	0.00	3.00	0.00	NS
Cavity	3.00	0.00	3.00	0.00	NS
Spine	3.00	0.08	2.87	0.08	NS
Color of organs	3.00	0.06	2.83	0.06	NS
Peritoneum	3.00	0.17	2.75	0.17	NS
Total	29.66	0.00	28.87	0.44	NS
Mean	2.96	0.04	2.83	0.04	NS

NS : p>0.05 ; SD : Standard Deviation

3.2. Effect of species, sex, and storage duration on fish color

Table 3 shows the effect of species, sex, and storage time on fish color. No significant differences were observed in terms of the effect of sex and storage time on overall color (p>0.05) for either fish species. Similarly, brightness (L*) and redness (a*) were similar (p>0.05) in the two tilapia species. However, *S. melanotheron* had a higher yellowness (b*) and chromaticity (C*) than *C. guineensis* (p<0.05).

Table 3 Effect of species, sex, and duration on the sensory characteristics of fish

Variables		**L***		**a***		**b***		**Chromacity**	
		Mean	SD	Mean	SD	Mean	SD	Mean	SD
Species	*S. melanotheron*	47.45a	8.98	3.86a	2.18	5.52a	4.94	39.13a	41.31
	C. guineensis	47.52a	3.54	2.64a	1.38	2.56b	1.64	11.41b	9.26
	Significance test	NS		NS		*		*	
Sex	Female	47.25a	3.68	3.87a	1.72	4.27a	4.07	28.51a	32.47
	Male	47.72a	8.91	2.63a	1.91	3.81a	3.89	22.03a	33.68
	Significance test	NS		NS		NS		NS	
Duration (hour)	6	49.46a	4.7	2.54	1.97	2.16a	3.44	15.48a	30.22
	24	45.06a	9.09	3.00	1.88	3.43a	2.95	17.7a	21.38
	48	47.94a	5.48	4.21	1.62	6.54a	4.23	42.63a	39.82
	Significance test	NS		NS		NS		NS	

L*: lightness; a*: red index ; b*: yellow index ; SD : Standard Deviation; Intra-class averages in the same column followed by different letters differ significantly at the threshold of 5% ; NS : p>0.05 ; *: p <0.05.

3.3. Color variability by sex and storage duration in fish

The brightness, red index, yellow index, and chromaticity of males did not differ (p>0.05) from those of females in any of the species (Table 4). Similarly, for each species, the four-color indices did not vary (p>0.05) according to the duration of fish storage (6h, 24h, and 48h).

Table 4 Interaction between species and sex and between species and storage duration on fish color

Varaibles		**L***		**a***		**b***		**Chromacity**	
		Mean	SD	Mean	SD	Mean	SD	Mean	SD
S. melanotheron	Female	47.53	4.25	3.93	1.84	4.76	4.58	31.45	36.88
	Male	47.23	19.26	3.65	3.52	7.81	6.3	62.18	53.72
C. guineensis	Female	46.43	1.00	3.70	1.64	2.82	1.76	19.70	14.27
	Male	47.88	4.04	2.29	1.19	2.48	1.70	8.65	5.73
Significance test		NS		NS		NS		NS	
S. melanotheron	6h	50.89	6.69	3.21	2.62	3.64	4.61	26.59	42.25
	24h	40.97	10.68	3.32	2.42	4.11	4.31	24.31	29.74
	48h	50.50	7.26	5.06	1.32	8.82	5.26	66.49	45.7
C. guineensis	6h	48.04	1.19	1.88	1.01	0.68	0.72	4.37	4.06
	24h	49.15	5.86	2.68	1.44	2.75	0.72	11.09	8.09
	48h	45.37	0.29	3.36	1.57	4.27	0.47	18.78	9.70
Significance test		NS		NS		NS		NS	

L*: lightness; a*: red index ; b*: yellow index ; SD : Standard deviation; NS : not significant at the 5% threshold.

3.4. Variation in the sensory characteristics of fish depending on species and treatments

There was no variation in tenderness, juiciness, flavor, or overall rating between the fish samples (whole or pretreated) of the two species (Table 5). Cooked fish were more tender ($p<0.001$) and had a higher flavor rating ($p<0.05$) than fried fish, regardless of preparation method. However, the juiciness and overall ratings of the two preparation methods were identical ($p>0.05$). For each species of fish (whole or pre-processed), the ratings for tenderness, juiciness, flavor, and overall quality did not differ according to the preparation method (Table 6).

Table 5 Variation in the sensory characteristics of fish according to species and treatments

Variation factors		**Tenderness**		**Juiciness**		**Flavor**		**Acceptance**	
		Mean	SD	Mean	SD	Mean	SD	Mean	SD
Species	*S. melanotheron* (Whole)	3.40a	0.14	3.05a	0.14	3.35a	0.16	6.57a	0.25
	S. melanotheron (Pre-processed)	3.27a	0.14	2.72a	0.14	3.15a	0.16	6.07a	0.25
	C. guineensis (Whole)	3.60a	0.14	3.00a	0.14	3.32a	0.16	6.60a	0.25
	C. guineensis (Pre-processed)	3.55a	0.21	3.15a	0.20	3.6a	0.32	6.80a	0.35
	Significance test	NS		NS		NS		NS	
Modes	Boiling	4.02a	0.11	3.13	0.11	3.58a	0.12	6.47	0.19
	Frying	2.88b	0.11	2.82	0.11	3.12b	0.12	6.55	0.19
	Significance test	***		NS		*		NS	

*NS : p>0.05 ; *: p <0.05;* ***: p<0.001; SD : Standard Deviation; Means in the same column followed by different letters differ significantly at the 5% level.

Table 6 Variation in the sensory characteristics of fish depending on species and processing method

Species	Modes	Tenderness		Juiciness		Flavor		Acceptance	
		Mean	SD	Mean	SD	Mean	SD	Mean	SD
S. melanotheron (Whole)	Boiling	4.05	0.21	3 .40	0.20	3.40	0.22	6.60	0.35
	Frying	2.75	0.21	2.70	0.20	3.30	0.22	6.55	0.35
S. melanotheron (Pre-processed)	Boiling	3.90	0.21	2 .75	0.20	3.50	0.22	6.25	0.35
	Frying	2.65	0.21	2.70	0.20	2.80	0.22	5.90	0.35
C. guineensis (Whole)	Boiling	4.15	0.21	3.20	0.20	3.55	0.22	6.65	0.35
	Frying	3.05	0.21	2.80	0.20	3.10	0.22	6.65	0.35
C. guineensis (Pre-processed)	Boiling	4.00	0.29	3.20	0.28	3.90	0.32	7.10	0.50
	Frying	3.10	0.29	3.10	0.28	3.30	0.32	7.10	0.50
Significance test		NS		NS		NS		NS	

SD : Standard Deviation ; NS : p>0.05.

4. Discussion

4.1. Technological qualities of fish

There are no significant differences in the viscera, fillet, fat, and gonad indices between *C. guineensis* and *S. melanotheron*. The respective whole weights and yields of *S. melanotheron* and *C. guineensis* are 145.35 g and 93.94%, and 143.85 g and 97.35%. [22] reported other results for the same fish species, obtaining a whole weight of 113.33 g with a yield of 78.54% for *S. melanotheron* and a yield of 74.05% for *C. guineensis* with a weight of 85.34 g.

These differences in yield could be explained by differences in size. Additionally, high demand for fish and a lack of resources for intensive farming could explain the low weights of fish in our ponds and other bodies of water. According to [29] the largest and thickest fish have the best yields. This does not seem to be the case in the present study. Furthermore, the fillet yields of *S. melanotheron* and *C. guineensis* were 32.82% and 23.98%, respectively. These results differ from those of Assogba (2018c), who obtained filleting yields of 58.59% for *S. melanotheron* and 67.89% for *C. guineensis*.
These results differ from those of [30], who found a filleting yield of 36% ± 1% for *Oreochromis niloticus*, a species in the same family as tilapia. According to [31], filleting yield is related to fish size and shape. The yields obtained in this study are also below the range defined by [32], who states that the filleting yield for species commonly involved in aquaculture fluctuates between 40 and 70%. However, these variations could also be due to genetic and non-genetic factors. Several authors confirm this, stating that an organism's morphology results from the interaction between genetic factors and environmental conditions [33–35].

In this study, the viscerosomatic indices (VSI) for *S. melanotheron* and *C. guineensis* were 6.06% and 2.65%, respectively. Fish with high visceral mass have low fillet yield. Visceral mass depends on the gonadosomatic index (GSI), viscerosomatic index (VSI), and perivisceral fat index (PFI). *C. guineensis* has a high GSI (0.82) and PFI (2.02), which are higher than those of *S. melanotheron* (0.46 and 1.64, respectively). Therefore, *C. guineensis* has a low fillet yield. Therefore, the higher the weight of the gonads and perivisceral fat, the lower the fillet yield.

The pH of *C. guineensis* was similar to that of *S. melanotheron* after 6, 24, and 48 hours. However, *S. melanotheron*'s pH changed from 5.87 to 6.36 over 48 hours. These results differ from those of [22], who observed a significant species effect, with *S. melanotheron* at 6.36 and *C. guineensis* at 6.60. The difference in pH may be due to the varying sample sizes in the two studies.

4.2. Sensory qualities of fish

Color is also an important feature as it determines whether or not the consumer will purchase meat. Its importance is increasing with the development of meat distribution in large and medium-sized stores, where the consumer is completely in control of their purchasing decision and has a wide choice, as is the case with Its importance is increasing with the development of meat distribution in large and medium-sized stores, where consumers are completely in control of their purchasing decisions and have a wide choice, as is the case with salmon fillets [36,37].

No significant differences were observed in the effect of sex or storage time on the overall color of the two fish species ($p>0.05$). Similarly, brightness (L*) and redness (a*) were similar in both species of tilapia ($p>0.05$). However, *S. melanotheron* had a higher yellow index (b*) and chromaticity ($p<0.05$) than *C. guineensis*. These similarities could be explained by the preservative effect of refrigeration on fish and the inability of fish to synthesize carotenoid pigments, which are precursors to light production. These pigments are obtained through food intake [10]. A decrease in brightness (L*) was observed during storage, while the red (a*) and yellow (b*) indices increased during the same period. Similar results were obtained for the yellow index (b*) between species in a study conducted on *Platax orbicularis* by [38].

The tenderness, juiciness, flavor, and acceptance ratings of *S. melanotheron* and *C. guineensis* were not different. These results are consistent with those reported by [22] for the same fish species. [39] also had similar findings for horse mackerel and mackerel. Tenderness and flavor were different depending on the preparation process (boiling vs. frying). Boiled water-cooked fillets were more tender and flavorful compared to oil-cooked fried fillets. This variability is thought to be due to the effect of cooking and frying on muscle fibers. [40] provided for this variation by outlining that, above a cooking temperature of 60°C, collagen fibers degrade their original structure and become soluble. This results in the loss of water by exudation. The proteins become contracted and cannot hold water, and some of the soluble fraction (water, lipids, mineral salts, soluble proteins, etc.) is lost.

At the same time, the oxidation of polyunsaturated fatty acids releases volatile aromatic compounds that promote flavor in fish flesh [31]. The authors state that oil frying of small fish results in 30% water loss and soluble nitrogenous substances, and a change in the fat content to a lesser degree. These various losses, and especially the degradation of lipids, can hence account for the low grade given to frying in oil. For fried fish's tenderness, the authors explain that in high temperatures, only the outside of the fish is cooked, with the inside remaining raw and not well dehydrated. This process of frying can make flesh tough. Fish fillets boiled with boiling water are nice and juicy.

5. Conclusion

The study says that the sensory and technological properties of fish are greatly altered between storage or processing for consumption and death. Yield varies with the size of the fish. The fillet yield depends on the gonadosomatic index (GSI), viscerosomatic index (VSI), and perivisceral fat index (PFI). The change in pH is species-dependent. Coloration is also dependent on species, but particularly on the yellow index. Color is a function of the preservation process (refrigeration). Red and yellow indices increase while brightness remains the same. Tenderness and flavor are a function of the processing process. Cooking improves the flavor and tenderness of fish. These will be controlled to achieve high-quality, consistent finished goods that meet consumer specifications.

Compliance with ethical standards

Acknowledgments

Author thank Professor Issaka YOUSSAO ABDOU KARIM and everyone who contributed to this study.

Disclosure of conflict of interest

No conflict of interest in our manuscript

Statement of ethical approval

Ethical standards have been respected.

References

[1] FAO, IFAD, WHO, WFP, and UNICEF. Summary of The State of Food Security and Nutrition in the World 2024 – Financing to End Hunger, Food Insecurity, and All Forms of Malnutrition 2024. https://doi.org/10.4060/cd1276fr

[2] Abila OR. Food safety in food security and food trade-case study: Kenyan fish exports. vol. 10. Washington, D.C: International Food Policy Research Institute. Vision Focus Brief ; 2003. https://hdl.handle.net/10568/157331.

[3] F.A.O. Assessment of post-harvest losses in Togo's artisanal marine fisheries. Lomé 2020 ;70p. https://doi.org/10.4060/ca8716fr.

[4] F.A.O. Global food losses and food waste – Extent, causes and prevention. Rome, 2011.

[5] Anihouvi VB, Hounhouigan JD, Ayernor GS. The production and marketing of lanhouin, a condiment made from fermented fish from the Gulf of Benin. Cahier Agriculture, 2005 ;14 :323–30.

[6] Anihouvi VB, Ayernor GS, Hounhouigan JD, Sakyi-dawson E. Quality characteristics of lanhouin : A traditionally processed fermented fish product in the Republic of Benin. African Journal of Food, Agriculture, Nutrition and Development, 2006 ;6 :1–15.

[7] F.A.O. The State of World Fisheries and Aquaculture 2016. Contributing to food security and nutrition for all. Rome ; 2016.

[8] Brito UT, A. S, Aboudou K, Alidou C, Goudjinou C, Soumanou MM. Analysis of production practices and quality of smoked fish sold in southern Benin. European Scientific Journal ESJ, 2022 ;18:17. https://doi.org/10.19044/esj.2022.v18n17p154.

[9] Rurangwa E, Berg J, Laleye P, Duijn AP, Rothuis AJ. Exploratory mission on fishing, fish farming, and aquaculture in Benin : a quick scan of the sector to identify opportunities for intervention. IMARES report C072/14, LEI report, vol. 14–049. 2014.

[10] Choubert G. Preservation/processing methods and sensory quality of fish. 13th Muscle Science and Meat Technology Day 2010 :91–8.

[11] Bugeon J, Lefevre F, Cardinal M, Uyanik A, Davenel A, Haffray P. Flesh quality in large rainbow trout with high or low fillet yield. J Journal of Muscle Foods, 2008 ;21 :702–21.

[12] Wabi KA. Evaluation of the microbiological and physicochemical quality of frozen horse mackerel "*Trachurus trachurus*" sold in the vicinity of the University Campus of Abomey Calavi in Benin. Masters Thesis Food Qual. Control Stand. Technol., Abomey-Calavi, Benin : University of Abomey-Calavi ; 2010, p. 44.

[13] Degnon GR, Dougnon TJ, Toussou S, Migan SY. Assessment of the microbiological and physicochemical quality of fish caught and sold at the industrial fishing port of Cotonou. J Appl Biosci 2012 ;6 :166–74.

[14] Degnon RG, Agossou VE, Adjou ES, Dahouenon-Ahoussi E, Soumanou MM, C SD. Assessment of the microbiological quality of horse mackerel (*Trachurus trachurus*) during the traditional smoking process. Journal of Applied Biosciences, 2013 ;67 :5210–8. https://doi.org/10.4314/jab.v67i0.95042.

[15] Chabi NW, Konfo CTR, Emonde PDM, Capo Chichi MT, Chabi Sika KJK, Alamou Y, Keke M, Dahouenon-Ahoussi E, Baba-Moussa L. S. Performance of an improved smoking device (Chorkor oven) on the quality of smoked fish in the municipality of Aplahoué (southeastern) Benin. Journal of Innovation and Applied Studies, 2014 ;9 :1383-1391.

[16] Kpodekon M, Hounkpè E, Sessou P, Yèhouenou B, Sohounhloué D, Farougou S. Microbiological Quality of Smoked Mackerel (*Trachurus trachurus*), Sold in Abomey-Calavi Township Markets, Benin. Journal of Microbiology Research 2014 ;4 :175–9.

[17] Babadjidé CL, Fangnon B, Hedible SC. Quality of fish sold at the artisanal fishing port of Cotonou (POPAC) European Scientific Journal, 2015 ;11 :1857–7881.

[18] Assogba MHM, Salifou CFA, Agossa R, Dahouda M, Chikou A, Farougou S, et al. Effect of processing and preservation processes on microbiological quality of *Coptodon guineensis* and *Sarotherodon melanotheron* in South Benin. Journal of Microbiology and Mycology, 2018 ;7 :25-34 2309-4796.

[19] Assogba MHM, Salifou CFA, Houemenou G, Silemehou JAS, Agossa R, Dahouda M, Chikou A, Farougou S, Kpodékon M, Youssao AKI. Smoking effect on bacteriological quality of Atlantic mackerel (*Scomber scombrus*) and Horse mackerel (*Trachurus trachurus*) in South Benin. International Journal of Advance Research, 2018 ;6 :117–24. https://doi.org/10.21474/IJA.

[20] Brito UTAS, Aboudou K, Goudjinou C, Alidou C, Zannou A, Gbaguidi M. Physicochemical and microbiological qualities of two imported fish species (*Trachurus trachurus* and *Scomber scombrus*) and two local fish species (*Clarias garieprinus* and *Oreochromis aureus*) sold in Benin. Ivorian Journal of Science and Technology ; 2021 ; 38 :311–23.

[21] Bokossa HKJ, Tchakpa C, Gokou KG, Yabi I, Johnson RC. Quality and freshness of imported *Trachurus trachurus* (horse mackerel) and *Scomber scombrus* (mackerel) stored in cold rooms in Benin. Journal of Applied Biosciences, 2022 ;173 :17990–8001.

[22] Assogba MHM, Salifou CFA, Ahounou SG, Dahouda M, Chikou A, Farougou S, et al. Influence of processing and preservation processes on technological and organoleptic qualities of *Coptodon guineensis* and *Sarotherodon melanotheron* in south Benin. International Journal of Bioscience 2018 ;13 :75–93. https://doi.org/10.12692/ijb/13.3.75-93.

[23] Assogba MHM, Salifou CFA, Tobada P, Aboudou AK, Bakary AB, Dahouda M, et al. Impact of break in cold chain on the technological and organoleptic qualities of Atlantic mackerel (*Scomber scombrus*) and Horse mackerel (*Trachurus trachurus*) in south Benin. Journal of Microbiology and Biotechnology Food Science, 2019 ;8 :1242–8. https://doi.org/10.15414/jmbfs.2019.8.6.1242-1248.

[24] Assogba MHM., Chaffa A.F., Lederoun D., Youssao AKI. Comparative study of the freshness of fish from fishmongers and Lake Nokoué in the municipality of Abomey Calavi in Benin. Moroccan Journal of Agricultural and Veterinary Sciences, 2025 ;13 :1–8. https://doi.org/10.5281/zenodo.14995845.

[25] P.D.C. Municipal Development Plan : second generation of the Lokossa Commune, 2011 :85.

[26] Codex Stan 167-(1989). Determination of the water content of whole fish using the cross-section method :9–11.

[27] Règlement 103/76/CEE. Council Regulation of January 19, 1976, laying down common marketing standards for certain fresh or chilled fish, 1976 : 29. http://data.europa.eu/eli/reg/1976/103/oj)

[28] Institute SAS. Statistical Analysis Software (SAS) User's Guide Version 9.4. Cary, NC : SAS Institute, Inc - References - Scientific Research Publishing ; 2016.

[29] Lefèvre F, Bugeon J, Goardon L, Kerneis T, Labbe L, Panserat S, Medale F, Quillet E. Quality of rainbow trout flesh after seven generations of selection for muscle lipid content. 16th Muscle Science Meat Technology Conference, 2016, p8.

[30] Rutten MJM, Bovenhuis H, Komen H. Modelling fillet traits based on body measurements in three Nile tilapia strains (*Oreochromis niloticus* L.). Aquaculture 2004 ; 231,113-122.

[31] Lefèvre F, Jérôme Bugeon J. Biological determinism of fish quality. Issue 12èmes Muscle Science and Meat Technology, Tours, France ; 2008, p. 217–8. Hal-02752892

[32] Bencze Rora AM. Primary processing (Evisceration and filleting). In "Farmed Fish. Quality" (S. C. Kestin, and P. D. Warris). Blackwell Science, Bristol, UK. 2001 ; 249-260.

[33] Armstrong JD, Kemp PS, Kennedy GA, Ladle M, Milner NJ. Habitat requirements of Atlantic salmon and brown trout in riversands treams. Fisheries research, 2003 ;62 :143–70.

[34] Blake RW. Fish functional design and swimming performance. Journal of Fish Biology, 2004 ;65 :1193–222.

[35] Turan C. Stock Identification of Mediterranean Horse Mackerel (*Trachurus mediterraneus*). Using Morphometric and Meristic Characters. ICES Journal of Marine Science, 2004 ;61 :774–81.

[36] Monin. Biological factors affecting beef quality. INRA Animal Production, 1991 ;4 :151–60.

[37] Faucouneau B. Diversification, domestication, and quality of aquaculture products. INRA Animal Production, 2004 ;17 :227–36.

[38] Knockaert C. Smoking fish, Edition IFREMER -1995, 178 p.

[39] Silemehou AS. Effect of smoking on the sensory and bacteriological qualities of *Scomber scombrus* (common mackerel) and *Trachurus trachurus* (horse mackerel. Wlacodji Littoral Dep. Masters Thesis Stand. Qual. Control Food Technol., University of Abomey-Calavi, Abomey-Calavi, Bénin ; 2011, p. 80.

[40] A.N.S.E.S. Report on the consumption of fish, mollusks, and crustaceans: Nutritional and health aspects for humans, 2010 :130.