Macrothink Institute™

Journal of Food Studies
ISSN 2166-1073
2025, Vol. 14, No. 1

Study of the Effects of Salt Dosage in Brining on the Conservation and Quality (Organoleptic, Microbiological, and Chemical) of Fermented-Dried Yellow Horse Mackerel (*Caranx Rhonchus*)

Abdoulaye Diouf

Institut Universitaire de Pêche et Aquaculture (IUPA), Cheikh Anta Diop de Dakar (UCAD), BP 5005 Dakar-Fann, II bâtiment pédagogique/Rez de chaussée BP 5005 Dakar-Fann, Sénégal

Sitor Diouf (Corresponding author)

Institut Universitaire de Pêche et Aquaculture (IUPA), Cheikh Anta Diop de Dakar (UCAD), BP 5005 Dakar-Fann, II bâtiment pédagogique/Rez de chaussée BP 5005 Dakar-Fann, Sénégal

Jean Fall

Institut Universitaire de Pêche et Aquaculture (IUPA), Cheikh Anta Diop de Dakar (UCAD), BP 5005 Dakar-Fann, II bâtiment pédagogique/Rez de chaussée BP 5005 Dakar-Fann, Sénégal

Amy Thiaw

Institut Universitaire de Pêche et Aquaculture (IUPA), Cheikh Anta Diop de Dakar (UCAD), BP 5005 Dakar-Fann, II bâtiment pédagogique/Rez de chaussée BP 5005 Dakar-Fann, Sénégal

Received: April 28, 2025 Accepted: June 16, 2025 Published: June 27, 2025

doi:10.5296/jfs.v13i1.22973 URL: https://doi.org/10.5296/jfs.v13i1.22973

Abstract

In Senegal, the yellow horse mackerel (*Caranx rhonchus*) is a widely consumed small pelagic fish but highly perishable, requiring more appropriate preservation methods, especially in artisanal contexts. This study aimed to evaluate the effects of different brine concentrations (0%, 10%, and 15% salt) on the organoleptic, microbiological, and chemical quality of fermented-dried *Caranx rhonchus*, assessed at **T0 (**after drying the finished product), **T1 (**After one month of storage) and **T2** (After two months of storage). During this study, three solutions were prepared for fermentation (0%, 10%, and 15% salt). After 72 hours of fermentation, the fish immersed in the solution (0%) salt had completely liquefied, thus proving the "preservative effect of salt". The organoleptic analyses carried out during this experiment show that sensory parameters (color, texture, smell, taste, salinity) are more appreciated in the 15% salt batch compared to the 10% salt batch. As far as microbiological analyses are concerned, a total absence of *Salmonella*, *Escherichia coli*, staphylococci, and total coliforms was noted in both batches at both T1 and T2. However, Total Aerobic Mesophilic Flora (TAMF), yeasts, and molds were detected on both batches at both T1 and T2. TAMF was present in both samples at T1 and T1. However, the TAMF loads are higher for the 10% salt sample (40 CFU/g at T1 and 3.5.10 ^{2}CFU/g at T2) compared to the 15% salt sample (27 CFU/g at T1 to 1.8.10 ^{2}CFU/g at T2). For yeasts and molds, the average loads are higher for the 10% salt samples (2.10 ^{2}CFU/g at T1 and 4.1.10 ^{2}CFU/g at T2) compared to the 15% salt samples, which have average loads of 1.1.10 ^{2}CFU/g at T1 and 2.4.10 ^{2}CFU/g at T2. As for chemical analyses, experience shows that the Total Volatile Basic Nitrogen (TVBN) content increases over time. However, it is higher for horse mackerel fermented in brine of 10% salt (53.33 mg/100 g at T1 and 76.31 mg/100 g at T2) compared to those with 15% salt (28.91 mg/100 g at T1 and 36.41 mg/100 g at T2). This study also found that fermented horse mackerel with 10% salt had higher moisture content (17.32% at T1 and 21.48% at T2) than those with 15% salt (15.25% at T1 and 17.84% at T2). Regarding the NaCl content, it is more remarkable in the 15% salt sample (22.43% at T1 and 23.82% at T2) compared to the 10% salt sample (15.36% at T1 and 17.79% at T2). The experiment shows that horse mackerel fermented with 10% salt is more profitable (70% of the finished product) compared to those fermented with 15% salt (67% of the finished product).

Keywords: *Caranx rhonchus*, dosage, salt, brining, fermentation, conservation, quality

1. Introduction

Senegal, with a coastline of approximately 718 km, shares its maritime borders with Mauritania, The Gambia, Guinea-Bissau, and Cape Verde. According to the United Nations Convention on the Law of the Sea, it benefits from an exclusive economic zone (EEZ) of 200 nautical miles measured from the baseline (Maivha, 2023). Artisanal fishing and its processing play a key role in the national economy, contributing to food security and nutrition for the population (DPM, 2015). Approximately 30% of artisanal fish production is processed, a rate that can reach 90% in certain island areas where it constitutes the main outlet for fishery products (Sène, 2004; Anihouvi et al., 2005).

Artisanal processing not only allows the preservation of fish but also its commercial enhancement, promoting its distribution within the continent (Montet & Ray, 2011; Ray & Montet, 2014). Fermented products from the sea, widely consumed in West Africa, combine cultural, economic, and health issues (Fagbenro & Akinmoladun, 2014; Fall et al., 2019). However, the hygienic quality and standardization of artisanal processes remain a major challenge, particularly due to empirical practices in salt dosage and adherence to hygiene conditions (Oguntoyinbo, 2014; Kim et al., 1995).

Despite the presence of over 80 artisanal processing sites in Senegal, the potential for valorization remains underexploited, particularly for species such as the yellow mackerel (*Caranx rhonchus*), which is widely consumed but rarely used as raw material in artisanal fermentation (Chalchisa, 2022; Kim, 2020). The use of salt in these processes is often empirical, which limits the microbiological and organoleptic quality of the finished products.

Faced with these constraints, the present study proposes to explore the preservation of yellow mackerel through brining with different salt proportions. This technology, if proven effective, could enrich the range of artisanal products while ensuring better food safety (Martínez-Álvarez et al., 2017). The originality of this work lies in a multidimensional evaluation (organoleptic, microbiological, chemical) of the quality of the fermented-dried product, thus filling a gap in the scientific literature regarding the hygienic valorization of traditional African fishery products (Partelow, 2024).

The general objective was to evaluate the preservative effect of salt on the flesh of yellow spotted mackerel (*Caranx rhonchus*), as well as the organoleptic, microbiological, and chemical quality of the finished products. More specifically, it aims to:

- characterize the technology of variable salt brining;
- study the effect of salt on the organoleptic, microbiological, and chemical quality of the products over the course of storage.

2. Materials and Methods

2.1 Processing Method (Fermentation in Brine)

Fermentation in brine was carried out according to a set of unit operations and in compliance with Good Hygiene Practices (GHP) and Good Manufacturing Practices (GMP). The manufacturing technique is described by the following diagram:

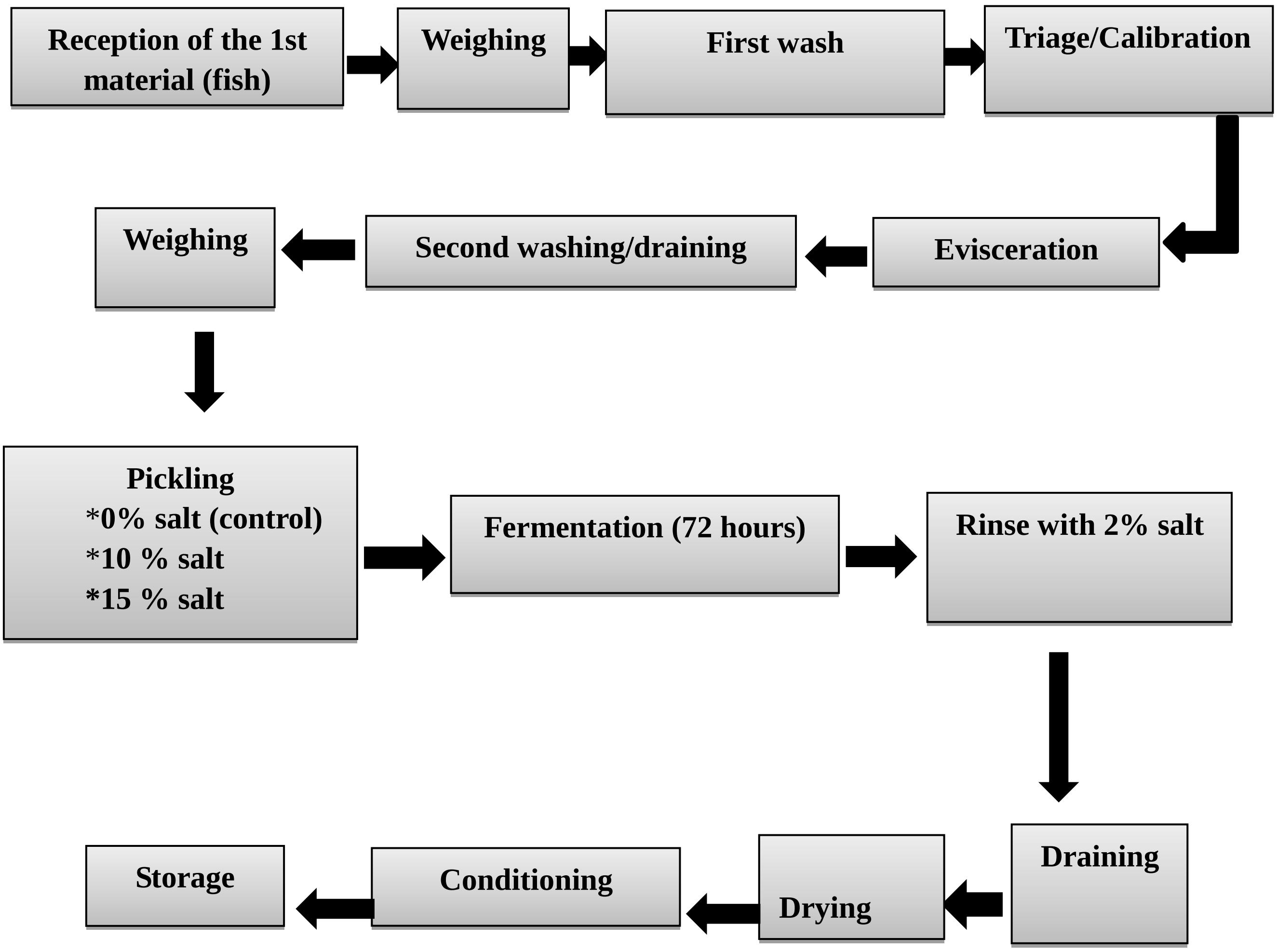

Figure 1. Flow diagram of dried fermented horse mackerel (*Caranx rhonchus*)

2.2 Microbiological Analysis Methods

The microbiological quality of a food is a significant element insofar as it contributes to the safety of consumers. Thus, various germs were the subject of research during the present study, with various methods of analysis. Table I shows the microbiological analysis methods applied by LANAC (National Laboratory for Analysis and Control).

Table I. Methodology for microbiological analyses of the germs sought

Microorganisms	Analysis methodology
E. coli	Enumeration and identification in a Tryptone–bile-glucuronide (TBX) culture medium at 44 ℃
Salmonella	Pre-enrichment, enrichment, isolation, confirmation, identification, and reading

Staphylococci	Enumeration and identification in Baird-Parker (BP) culture medium at 37 ℃
Total coliforms	Enumeration, identification in Violet Red Bile Lactose Agar (VRBL) culture medium at 30 ℃
TAMF	Enumeration, identification in a culture medium of Plate Count Agar (PCA) at 30 ℃
Yeasts and molds	Enumeration and identification in a culture medium of Chloramphenicol glucose Agar (CGA) agar at 25 ℃

2.3 Chemical Analysis Methods

Despite microbiological analyses, this study was also subject to chemical analyses. The methods used are shown in Table II.

Table II. Methodology for chemical analyses of the criteria sought in samples of dried fermented horse mackerel

Parameters	**Methodology of analysis**
NaCl	Test Portion 2 g, Mineralization at 600° C, Dissolution in H2O, Titration
Humidity	5g test portion, parboiling for up to 6 hours, desiccation, and weighing
TVBN	Test Portion 10 g, Deproteinization, Distillation, Titration

2.4 Finished Product Sampling Method

Each batch consisted of 10 fermented horse mackerel. Thus, for each sample, the meat was taken from 5 horse mackerel, about 50% of each batch. The samples collected in this way are weighed, homogenized, put in a jar, and sent to LANAC.

3. Results

3.1 Results of Organoleptic Analyses of the Raw Material

Figure 2. Results of organoleptic analyses of fresh yellow horse mackerel

The analysis of Figure 2 relating to the organoleptic assessments of the freshness of the raw material shows that out of 10 people chosen to carry out the analyses, 80% attest that the raw material is of satisfactory quality, compared to 20% who say that it has an acceptable state of freshness.

3.2 Results Relating to Organoleptic Analyses of the Finished Product

The following tables (III, IV, V, VI, VII, VIII) present the results of organoleptic analyses of dried fermented yellow horse mackerel (*Caranx rhonchus*), highlighting sensory parameters such as color, texture, taste, odor, salinity, and level of satisfaction during three time intervals.

3.2.1 Color

Table III. Results relating to the assessment of the color of dried fermented *Caranx rhonchus*

	T0				**T1**				**T2**			
	Color				**Color**				**Color**			
Samples	**B**	**J**	**M**	**N**	**B**	**J**	**M**	**N**	**B**	**J**	**M**	**N**
A batch of 10 % salt	0%	40%	50%	10%	0%	20%	80%	0%	0%	0%	100%	0%
A batch of 15 % salt	20%	20%	50%	10%	0%	20%	80%	0%	0%	0%	100%	0%

B : White, **J** : yellow, **M** : Brown, **N** : Black

T0 : after drying the finished product, **T1 :** After one month of storage, **T2** : After two months of storage.

The analysis in Table III shows that, as regards the color of the finished product of the 10% salt batch, 50% of the evaluators consider it to be brown at T0, 80% say so at T1, and 100% at T2. Concerning the 15% salt batch, this brown coloring is also supported by the evaluators, 50% of whom maintain that it is brown at T0. The same observations were made in T1 and T2 with the same values. This showed that the brown color always dominates in these two batches, with an appreciation rate that increases up to 100% at time T2. However, this coloring is more appreciated on the 10% salt batch.

3.2.2 Texture

The assessments of the texture of the finished product are presented in Table IV.

Table IV. Results relating to the assessment of the texture of dried fermented horse mackerel

Samples	**T0**				**T1**				**T2**			
	Texture				**Texture**				**Texture**			
	R	**TR**	**M**	**TM**	**R**	**TR**	**M**	**TM**	**R**	**TR**	**M**	**TM**
Batch of 10 % salt	70 %	30%	0%	0%	60%	40%	0%	0%	50%	40%	10%	0%
Batch of 15 % salt	90 %	10%	0%	0%	80%	20%	0%	0%	70%	30%	0%	0%

R : Rigid, **TR** : Very Rigid: **M** : Soft, **TM** : Very Soft

Concerning this table relating to the evaluation of the texture of finished products, 70% of the evaluators stipulated that the batch of 10% salt is made up of products with a rigid texture at T0; 60% confirm this rigidity at T1, and 50% at T2. Regarding the batch of 15% salt, 90% of people maintained that it is a product with a rigid texture at T0. This rigidity is confirmed at T1 and T2 with values of 80% and 70% respectively, hence the dominance of this criterion.

3.2.3 Smell

Table V. Results relating to the assessment of the Smell of dried fermented horse mackerel

Samples	T0			T1			T2		
	Smell			Smell			Smell		
	B	MB	M	B	MB	M	B	MB	M
Batch of 10% salt	80%	20%	0%	70%	30%	0%	60%	40%	0%
Batch of 15 % salt	80%	20%	0%	80%	20%	0%	70%	30%	0%

B : Good, **MB :** Worse, **M** : Bad

The analysis of Table V reveals that as far as the smell of the finished product is concerned, the batch of 10% salt became less and less good over time, going from 80% at T0 to 70% at T1 and 60% at T2. Concerning the batch of 15% salt, the smell degraded more slowly compared to the batch of 10% salt. Indeed, for the batch of 15% salt, the smell is assessed as good by 80% of the evaluators at times T0 and T1. This appreciation rate only decreased in T2 with a value of 70%.

3.2.4 Taste

The taste assessments of dried fermented horse mackerel are illustrated in Table VI:

Table VI. Results relating to taste assessments of dried fermented horse mackerel

Samples	T0			T1			T2		
	Taste			Taste			Taste		
	A	MA	D	A	MA	D	A	MA	D
Batch of 10 % salt	60%	30%	10%	70%	30%	0%	60%	30%	10%
Batch of 15 % salt	80%	20%	0%	60%	30%	10%	60%	20%	20%

A : Pleasant, **MA** : Less pleasant, **D**: Disagreeable

The analysis in Table VI shows that, as regards the taste of the finished product, the batch of 10% salt is 60% pleasant at times T0 and T2. The taste is more appreciated at time T1 with a value of 70%. For the batch of 15% salt, the taste became less pleasant over time, going from 80% at T0 to 60% at T1 and T2.

3.2.5 Salinity

The results relating to the salinity of the finished product are shown in Table VII.

Table VII: Results relating to the assessment of the salinity of dried fermented horse mackerel

	T0			T1			T2		
	Salinity Levels			Salinity Levels			Salinity Levels		
Samples	**MS**	**S**	**TS**	**MS**	**S**	**TS**	**MS**	**S**	**TS**
Batch of 10 % salt	20%	70%	10%	40%	60%	0%	60%	40%	0%
Batch of 15% salt	0%	20%	80%	0%	30%	70%	0%	80%	20%

MS: Less salty, **S**: Salty, **TS**: Too salty

With respect to salinity, most evaluators maintain that the batch of 10% salt is salty. This salinity is decreasing with values of 70%, 60% and 40% respectively from T0 to T2. For the batch of 15% salt, it is considered too salty compared to the batch of10% salt. Indeed, for the batch 15% salt, the products are appreciated as too salty by 80% of the evaluators at T0 and 70% at T1. This salinity rate decreases at time T2 according to 20% of the evaluators.

3.2.6 Level of Consumer Satisfaction

Based on the analyses of sensory parameters such as color, texture, taste, smell and salinity, the evaluators were able to give their level of satisfaction, and these results are shown in Table VIII.

Table VIII. Results on the level of satisfaction of dried fermented horse mackerel

Samples	T0				T1				T2			
	Levels of consumer satisfaction				Levels of consumer satisfaction				Levels of consumer satisfaction			
	TS	S	MS	NS	TS	S	MS	NS	TS	S	MS	NS
Batch of 10%sel	20%	80%	0%	0%	20%	70%	10%	0%	0%	60%	40%	0%
Batch of 15%sel	10%	90%	0%	0%	0%	80%	20%	0%	0%	70%	30%	0%

TS: Very satisfactory, **S** : Satisfactory, **MS** : Less satisfactory, **NS** : Unsatisfactory

The study in Table VIII shows that as far as the level of satisfaction is concerned, the batch of 10% salt became less and less satisfactory over time, going from 80% at T0 to 70% at T1 and 60% at T2. As for the batch of 15% salt, the level of satisfaction is higher compared to the batch of 10% salt. The analysis of this table shows that for this batch of 15% salt, the products are considered satisfactory by 90% of the evaluators at T0 and 80% at T1. The level of satisfaction became less appreciated, with a value of 70% at T2.

3.3 Results of Microbiological Analyses of Fermented Yellow Horse Mackerel

Dried

The results of the microbiological analyses of dried fermented horse mackerel in Colony Forming Units (CFU/g) are recorded in Table IX.

Table IX. Results of microbiological analyses of dried fermented yellow horse mackerel

Germs (Batch / Time)	Results (CFU/g)				Reference method used
	T1		T2		
	10% salt	15% salt	10% salt	15% salt	
E. coli	0	0	0	0	NF ISO 16649-2
Salmonella	0	0	0	0	NF EN ISO 6579-1
Staphylococci	0	0	0	0	NF EN ISO 6888-1
Total coliforms	0	0	0	0	NF EN ISO 4832
TAMF	40	27	$3.5.10^{2}$	$1.8.10^{2}$	NF EN ISO 4833-2
Yeasts and molds	2.10^{2}	$1.1.10^{2}$	$4,1.10^{2}$	$2.4.10^{2}$	NF V 08-059

T1: After one month of storage, **T2**: After two months of storage.

The analysis of Table XI reveals a total absence of *Salmonella*, *Escherichia coli*, staphylococci, and total coliforms at T1 and T2.

On the other hand, TAMF was detected in both batches at T1 and T2. Regarding the T1, the TAMF load (40 CFU/g) is higher for the batch of 10% salt compared to the batch of 15% salt, with a TAMF load of 27 CFU/g. Thus, the 5% increase in salt reduced the bacterial load TAMF to 32.5%, i.e., 13 inhibited germs. At the same time, at T2, the TAMF load ($3.5.10^{2}$ CFU/g) remains higher for the batch of 10% salt compared to the batch of 15% salt with a TAMF load of $1.8.10^{2}$CFU/g, i.e., a reduction of 48.5% of about 90 inhibited germs.

Concerning yeasts and molds, at T1, the load (2.10 ȻCFU/g) is higher for the batch of 10% salt compared to the batch of 15% salt, with a load of 1.1.10 ȻCFU/g. Thus, the 5% increase in salt reduced the bacterial load (yeast and mold) to 45%, i.e., 90 inhibited germs. Correlatively, at T2, the Yeasts and molds load ($4.1.10^{2}$ CFU/g) remained higher for the batch of 10% salt compared to the batch of 15% salt with a load of $2.4.10^{2}$ CFU/g, i.e., a reduction of 41.46% % for about 170 germs.

3.4 Results of Chemical Analyses of Dried Fermented Yellow Horse Mackerel

The results of the chemical analyses carried out are presented in Table X.

Table X. Results of chemical analyses of fermented yellow horse mackerel dried at time T1 and T2

Parameters \ Time / Batchs	Results (%)				Reference method used
	T1		T2		
	10%	15%	10%	15%	
Na Cl	15.36 %	22.43 %	17.79 %	23.82 %	Titrimetry
Humidity	17.32%	15.23 %	21.48%	17.84%	Steaming
TVBN	53.33 mg/100g	28.91 mg/100g	76.31 mg/100g	36.41 mg/100 g	NF V04-407

T1: After one month of storage, **T2**: After two months of storage.

The analysis in Table XII shows the presence of TVBN at both T1 and T2. However, the TVBN content (53.33 mg/100 g) is higher in the batch of 10% salt compared to the batch of 15% salt, with a content of 28.92 mg/100g. Thus, the 5% increase in salt reduced the TVBN content by 45.7%. Regarding the T2, the TVBN content remained higher for the batch of 10% salt (76.31%) compared to the batch of 15% salt (36.41%), i.e., a reduction in TVBN content of 52.2%.

As far as moisture is concerned, it is higher on the batch of 10% salt (17.32%) compared to the batch of 15% salt (15.23%). The analysis of the results shows that the 5% increase in salt resulted in a 12.06% decrease in water content. In the same way, at T2, the water content remained higher in the batch of 10% salt (21.48%) compared to the batch of 15% salt (17.84%), i.e., a reduction of 16.9%.

As for the NaCl content, it is more remarkable in the batch of 15% salt (22.36%-23.82%) compared to the batch of 10% (15.36%-17.79%).

4. Discussion

The results of the organoleptic analyses of the raw material show 80% quality A (satisfactory), 20% quality B (acceptable), and no non-conformities were noted (absence of quality C samples). These results are satisfactory but remain different from those of Kande (2024) and Thiaw (2022), who had worked on different species, respectively the *Solea* and *Octopus*, with 90% quality A and 10% quality B. The difference in these results is due to the industry's quality requirements, which are neglected by some suppliers, but also to the nature of the products exported (fresh or frozen). Exporters of fresh produce are more demanding on the level of freshness.

The present study shows that for both samples, the brown color remains dominant at T0, T1, and T2. Both samples are appreciated for having the typical color of fermented fish. However, the brown color is more appreciated at T2 (100% of the evaluators for both types of samples (10% salt and 15% salt) compared to T1 (80% of the evaluators for both types of samples (10% salt and 15% salt). Thus, at time T0, this brown coloring is less appreciated by the evaluators, including 50% of the evaluators for the two samples (10% salt and 15% salt). These results are satisfactory and remain better than those of Dieng (2022), who had obtained an average of 33.33% on these three samples during his work on the fermentation of *Clarias gariepinus* salted with the effects of spices (curry, ginger, onion, bay leaf, and garlic). This difference could be due to the effects of the spices added by the latter during its fermentation process, which can change the color.

Regarding the texture, this study shows that the two batches are judged to be rigid in texture by the evaluators at T0, T1, and T2. Nevertheless, both batches were more rigid at T0 (70% of the evaluators for the batch of 10% salt and 90% of the evaluators for the batch of 15% salt compared to T1 (60% of the evaluators for the batch of 10% salt and 80% of the evaluators for the batch of 15% salt. As for T2, the texture becomes less rigid (50% for the batch of 10% salt and 70% for the batch of 15% salt. This is because the stiffness decreases over time. These results are higher than those of Faye (2022), which had a rigidity that was well appreciated by 60% of the evaluators during its study on Clarias smoking. This difference could be explained by the fact that the species used do not have the same flesh.

The analysis of the taste of the finished products reveals that the batch of 10% salt is considered more pleasant at T1 with an average of 70% compared to T0 and T2 with an average of 60%, i.e., a difference of 10% in favor of T1. For the batch of 15% salt, the taste becomes less pleasant over time, going from 80% at T0 to 60% at T1 and T2. These results are better than those of Dieng (2022), who had an average of 46.67% in his experience with clarias fermentation. The results of the present study are close to those of Faye (2022), which had an average pleasant taste appreciation of 80% of the raters. This dissimilarity could be due to the effects of spices, but also to the difference in processing techniques and the nature of the fish species used. In addition, the change in taste that occurs at T2 could be due, on the one hand, to the increase in the water content of horse mackerel during storage and on the other hand, to the effect of the increase in yeasts and molds, which makes the products less pleasant and therefore less appetizing.

Regarding the smell of the products in this study, the evaluators confirmed that they smelled good on both batches at T0, T1, and T2. However, the smell of the batch of 15% salt is considered good by 80% of the evaluators at T0 and 70% at T1. This appreciation rate decreased at T2 to a value of 60%. As for the batch of 10% salt, the smell becomes less and less good over time, going from 80% at T0 and T1 to 70% at T2. These results are satisfactory compared to those of Faye (2022), which had a product whose smell is described as good by 65% of the evaluators.

As for salinity, analyses have shown that horse mackerel fermented with 15% salt is saltier than those with 10% salt at T0, T1, and T2. Thus, the batch of 15% salt is considered too salty compared to the batch of 10% salt. Indeed, for the batch of 15% salt, the products are appreciated as too salty by 80% of the evaluators at time T0 and 70% at T1. This salinity rate decreased at T2 with a value of 20%. Concerning the batch of 10% salt, the majority of the evaluators maintained that it is salty with decreasing values respectively (70%, 60%, 40% from T0 to T2). These results do not corroborate those of Sène et al. (2020), who had used a concentration of 33% in their study on the fermentation and drying of catfish hybrids (*Clarias anguillaris* x *Clarias gariepinus*). However, previous studies conducted in Côte d'Ivoire by Kouakou et al. (2013) have also shown that immersion salt concentrations vary from 20 to 35% (m/v which corresponds to the ratio of salt mass to water volume. In addition, the results of this study are similar to those of Decree No. 69-132 on February 19th, 1969, on the control of fishery products, which stipulated that for dried salted fish, the salt content can vary between 10 and 20%. The results of this present study are inferior to those of the authors cited remain acceptable from the point of view of salinity. With regard to the assessment of the level of satisfaction, the dried fermented horse mackerel is considered satisfactory in all the analyses carried out.

The observation that emerges at first glance from the microbiological analyses is that the results show a total absence of *Salmonella*, total coliforms, *Escherichia coli*, and staphylococci at both T1 and T2. As in various studies conducted by other authors, including Sène et al. (2020), the absence of *Salmonella* in this study shows that the product is safe for consumption. As far as total coliforms are concerned, the results are better than those of Diatta (2013), who found an average of 10^2 CFU/g in samples treated with garlic extracts, 3.33 CFU/g for those treated with moringa extracts at "Seuty Ndiaré", and 3.33 CFU/g for those treated with garlic extracts at "Yarakh" during his study on the smoking of *Arius africanus*. According to studies by Mossel (1967), Silliker and Gabis (1976), the high level of coliforms is an indicator of contamination due to mishandling. For staphylococci, the results of the present study are satisfactory compared to those of Sène et al. (2020), who had found a load of less than 10 CFU/g during their work on dried fermented *Clarias*. The suspected pathogenic staphylococci, represented by Staphylococcus aureus, are among the germs from human contamination. Their presence could be due to non-compliance with hygiene rules; thus, their absence in the products of this experiment would be due to the experimental and working conditions respecting Good Manufacturing Practices and Hygiene (GMP/GHP).

TAMF (Total Aerobic Mesophilic Flora) was present on both samples at T0 and T1. However, the TAMF loads are higher for the sample of 10% salt at T1 (40 CFU/g) and at T2 ($3.5.10^2$ CFU/g) compared to the sample of 15% salt at T1 (27 CFU/g) at T2 ($1.8.10^2$ CFU). However, these bacterial loads detected during this study are lower than the value given by the AFNOR standard (1996), which stipulates that the TAMF must not exceed 105 CFU/g in dried fish.

Other authors, such as Sène et al. (2020) found values much higher than those in the present study, with a load of $7.20.10^{8}$ CFU/g on dried fermented clarias. In addition, the results of Fall et al. (2019) are lower than those found in this research, with respective loads of 5.2 log 10 CFU/g, 5.9 log 10 CFU/g, and 6.5 log 10 CFU/g. for samples from Guedj (Senegal), Adjuevan (Côte d'Ivoire), and Lanhouin (Niger). The difference in these results is due to the useful manufacturing methods and the non-compliance with Good Manufacturing Practices (GMP).

It also emerges from this study that samples with 10% salt are more contaminated with yeasts and molds with medium loads (2.10^{2}CFU/g at T1 and $4.1.10^{2}$UFG/g at T2) compared to the samples of 15% salt which have medium loads ($1.1.10^{2}$CFU/g at T1 and $2.4.10^{2}$UFG/g at T2). These results are better than those of Abdouallahi et al. (2016), who obtained loads between 2,104 CFU/g and 4,104 CFU/g in their studies on dried fish in Ouagadougou (Burkina Faso) and N'Djamena (Chad). The lower yeast contamination rate indicates an improvement in drying by increasing the duration of exposure to the sun. Indeed, the drop-in water activity slows down the development of yeasts and molds, knowing that a high level of yeasts and molds could result from storage in a humid atmosphere.

As far as chemical analyses are concerned, the results of this study are satisfactory considering the chemical quality criteria of dried salted fish. For the TVBN content, it is more significant in the sample of 10% salt (53.33 mg/100 g at T1 and 76.31 mg/100 g at T2) compared to the sample of 15% salt (28.91 mg/100g at T1 and 36.41 mg/100g at T2). These values are lower than those given by the Senegalese Association for Standardization, which stipulates that the TVBN level of dried fermented fish must be less than or equal to 350 mg/100 g. They are better than previous studies by Dione (2003) and Anihouvi et al. (2005) on dried braised and dried fermented fish, respectively. Their successive values were respectively 119.74 mg/100 g and 249.1 mg/100 g much higher than those of this study (53.33 -76.31) mg/100 g for horse mackerel fermented in 10% salt brine and (28.91-36.41) mg/100 g for horse mackerel fermented in a brine of 15%. As TVBN is an indicator of the level of freshness of the products, horse mackerel fermented with 10% salt will deteriorate faster than those fermented with 15% salt, given its evolution over time in both types of samples.

Diouf (2021) and Fall and al. (2014) found humidity levels of 46.82% and 50.3% during their studies on smoking and fermentation. These values are higher than those found in this study, ranging from 17.32% at T1 to 21.48% at T2 for the samples of 10% salt and 15.25% at T1 to 17.84% at T2 for the samples of 15% salt. Indeed, the water content makes it possible to know if the product can be stored for a longer or less long period. High humidity indicates a product that is difficult to store for a long time. Because of these results, horse mackerel with 15% salt will have a longer shelf life compared to those with 10% salt.

As for the NaCl content, it is more remarkable in the samples of 15% salt (22.43% at T1 and 23.82% at T2) compared to the samples of 10% salt (15.36% at T1 and 17.79% at T2). These NaCl concentrations obtained in the samples are higher than those obtained by Fall et al. (2019), who had obtained NaCl concentrations between 5.2% and 10.7% in their studies relating to the fermentation of *Clarias*. These high salt contents can be explained by the quantities of salt (10% and 15%) used during fermentation, but also by different transformation processes.

5. Conclusion

In West Africa, particularly in Senegal, fermented fish plays a significant role in diversifying the local supply of animal protein, both in urban and rural areas. These products not only serve as important nutritional resources but also contribute to household incomes, especially for women. *Caranx rhonchus* stands out for its nutritional and economic value; however, its high perishability requires appropriate preservation methods.

This study investigated the effects of salt concentration during brining on the preservation and quality (organoleptic, microbiological, and chemical) of fermented-dried *Caranx rhonchus*. The findings confirm the preservative effect of salt, support the hypothesis that brine fermentation is an effective conservation method, and provide insights into weight and temperature changes, shelf life, and overall product quality.

Organoleptic analyses revealed favorable sensory attributes likely to meet consumer expectations. Chemically, salting improved the nutritional composition and maintained sensory parameters. Microbiological tests confirmed proper processing and storage, ensuring product safety.

Future research should include comparative studies on wet salting over extended storage periods (e.g., six months) and explore suitable packaging for fermented-dried products. Additionally, this approach could be applied to other fish species to broaden its relevance.

Acknowledgments

At the end of the work, we express our sincere gratitude to all the colleagues who fully invested themselves and maintained scientific rigor during this study. Without love for work, passion for research, and respect for each individual's commitments, it would have been impossible for this work to be accomplished, and that is why we are very grateful for the contributions made by the authors of this document. We cannot conclude without giving a heartfelt tribute and great appreciation to the editorial members of this journal for the time they dedicated to correcting and improving the document.

Authors' contributions

This work is the result of perfect synergy among the authors. Each of the authors made a considerable effort to bring this work to completion. The research idea was proposed by Sitor Diouf, and the other authors contributed their thoughts on the subject and confirmed it. Amy Thiaw conducted the laboratory work, and the results obtained were recorded and processed by Sitor Diouf, Jean Fall, and Abdoulaye Diouf. The document was revised by all the authors before being submitted to the journal by Sitor Diouf. In short, this study is the result of teamwork.

Funding

Not applicable

Competing interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper. The authors have simply done this work as lovers of research and service to the community. It is the result of a commitment made by the authors to serve humanity through scientific research.

Informed consent

Obtained.

Ethics approval

The Publication Ethics Committee of the Macrothink Institute.

The journal's policies adhere to the Core Practices established by the Committee on Publication Ethics (COPE).

Provenance and peer review

Not commissioned; externally double-blind peer reviewed.

Data availability statement

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

Data sharing statement

No additional data are available.

Open access

Copyrights

References

Abdouallahi, H. O., Zongo, Ch., Tapsoba, F., Tidjani, A., & Savadogo, A. (2016). *Evaluation de la qualité hygiénique et des paramètres physicochimiques des poissons séchés vendus dans les villes de N'Djamena (Tchad) et d'Ouagadougou* (Burkina Faso). 21p.

AFNOR. (1996). Analyse microbiologique. Tome 2: Contrôle de la qualité des poissons alimentaires. Paris: Ed AFNOR. 545p.

Anihouvi, V. B., Hounhouigan, J. D., & Ayernor, G. S. (2005). *La production et la commercialisation au lanhouin, un condiment à base de poisson fermenté du Golfe du Bénin. Cahiers Agricultures.*

Chalchisa, T. (2022). An overview of fermented fish products. *Fisheries and Aquaculture Journal, 13*, 294. https://doi.org/10.35248/2150-3508.24.15.353

Diatta, H. K. (2013). Effets des extraits des végétaux sur la qualité microbiologique du Machoiron fumé (*Arius spp*). Mémoire de DESS en Pêche et Aquaculture, Université Cheikh Anta Diop de Dakar. 68p.

Dieng, D. (2022). Effets des épices (poudre de curry, gingembre, oignon, laurier et ail) sur la qualité organoleptique et l'évolution de la masse du *Clarias Gariepinus* salé fermenté séché.

Dione, B. D. (2003). *Étude de la qualité microbiologique et chimique du poisson braisé-séché.* 47p.

Diouf, F. (2021). *Effets du dosage de l'extrait de coriandre (Coriandrum saltivum) sur la qualité organoleptique, microbiologique et chimique du chinchard jaune* (*Caranx rhonchus*).

DPM (Direction des Pêches Maritimes). (2015). *Rapport annuel de la pêche artisanale.*

Fagbenro, O. A., & Akinmoladun, O. F. (2014). African fermented fish products in scope of risks: A review. *International Food Research Journal, 21*(2), 425-432.

Fall, M., Diop, M. B., Montet, D., Maiga, A. S., & Guiraud, J. T. (2019). Fermentation du poisson en Afrique de l'Ouest et défis sociétaux pour une amélioration qualitative des produits (Adjuevan, Guedj et Lanhouin): Revue de la littérature. *Cahiers Agricultures, 28*(7). https://doi.org/10.1051/cagri/2019007

Fall, N. G., Tounkara, L. S., Diop, M. B., Thiaw, O. T., & Thonart, P. (2014). *Étude socioéconomique et technologique de la production du poisson fermenté et séché (Guedj) au Sénégal.*

Faye, S. (2022). *Effets des extraits de curry (Murraya koenigii) et de persil (Petroselinum crispum) sur la qualité organoleptique et microbiologique du Clarias Fumé* (Clarias Gariepinus).

Kande, K. (2024). *Évaluation de l'application de la roue de DEMING dans une entreprise de traitement et d'exportations des produits halieutiques : cas de la SACEP. 71p.*

Kim, S. M. (2020). The present condition and development prospect of the fermented fishery products. *Food Science and Industry, 53*(2), 200-214.

Kim, Y. M., Kang, M. C., & Hong, J. H. (1995). Quality evaluation of low-salt fermented seafoods. *Korean Journal of Fisheries and Aquatic Sciences, 28*, 301-308.

Kouakou, A. C., Kouadio, F. N. G., Dadie, A. T., Montet, D., & Djè, M. K. (2013). *Production et commercialisation de l'adjuevan, poisson fermenté de Côte d'Ivoire. Cahiers Agricultures, 22, 559-567. que).* (2023). Rapport sur les zones maritimes du Sénégal.

https://doi.org/10.1684/agr.2013.0673

Martínez-Álvarez, O., López-Caballero, M. E., Gómez-Guillén, M. C., & Montero, P. (2017). Fermented seafood products and health. In J. Frias & P. E. Martinez-Villaluenga (Eds.), *Fermented foods in health and disease prevention* (pp. 177-202). Academic Press. https://doi.org/10.1016/B978-0-12-802309-9.00009-1

Montet, D., & Ray, R. C. (2011). Fermented fish and fish products: An overview. In D. Montet & R. C. Ray (Eds.), *Aquaculture Microbiology and Biotechnology,* Volume 2 (pp. 132-172). CRC Press. https://doi.org/10.1201/b10923-9

Mossel, D. D. A. (1967). Ecological principles and methodological aspects of the examination of foods and feeds for indicator microorganisms. *Journal of Association of Agricultural Chemistry, 50,* 91-120. https://doi.org/10.1093/jaoac/50.1.91

Oguntoyinbo, F. A. (2014). Safety challenges associated with traditional foods of West Africa. *Food Reviews International, 30*(4), 338-358. https://doi.org/10.1080/87559129.2014.940086

Partelow, S. (2024). Standardization of fermented fish products technology. *Fisheries and Aquaculture Journal, 15,* 353. https://doi.org/10.35248/2150-3508.24.15.353

Ray, R. C., & Montet, D. (2014). Fermented fish and fish products: Snapshots on culture and health. In R. C. Ray & D. Montet (Eds.), *Microorganisms and Fermentation of Traditional Foods* (pp. 188-222). CRC Press. https://doi.org/10.1201/b17307-9

Sène, N. M. (2004). La commercialisation des produits halieutiques séchés au Sénégal, de 1945 à 1969. In Outre-mer, 91, 2e semestre 2004. Les instruments de l'échange, pp. 73-95. https://doi.org/10.3406/.2004.4112

Sène, W., Fall, J., Loum, A., Diago, M., Sagne, M., Diouf, A., Diouf, N., Jatta, S., Ndong, D., Pelebe, R. O. E., & Diouf, M. (2020). Effets du salage, de la température et du séchage sur la qualité biochimique et microbiologique des hybrides de poisson-chat (*Clarias anguillaris* * *Clarias Gariepinus*) en milieu d'élevage au Sénégal. Sciences de la Vie, de la Terre et Agronomie, 8.

Thiaw, A. (2022). Étude de la technologie de fabrication et de la gestion de la qualité du poulpe commun (*Octopus vulgaris*) congelé et exporté par Tamou Fishing. 57p.